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Who Competes with Whom?
The Case of Depository Institutions

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Abstract:

Little empirical work exists on the substitutability of depository institutions. In particular, the willingness of consumers to substitute banks for thrifts and to switch between multimarket and single-market institutions (i.e., institutions with large vs. small branch networks) has been of strong interest to policymakers. We estimate a structural model of consumer choice of depository institutions using a panel data set that includes most depository institutions and market areas in the U.S. over the period 1990–2001. Using a flexible framework, we uncover utility parameters that affect a consumer's choice of institution and measure the degree of market segmentation for two institution subgroups. We use our estimates to calculate elasticities and perform policy experiments that measure the substitutability of firms within and across groupings. We find both dimensions – thrifts and banks, and single- and multimarket institutions – to be important market segments to consumer choice and, ultimately, to competition in both urban and rural markets.

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1 Introduction

Understanding how customers substitute among firms is central to analyzing competition and applying antitrust policy. In retail banking, the volume of merger applications in recent years and the need for regulatory transparency has led to a reliance on established market definitions based previous economic research and anecdotal evidence. While the empirical studies of this industry have emphasized geographic market definition, policymakers often make additional judgments based on charter type (e.g., commercial banks versus thrift institutions) and institution size and scope.[1] Although recent work suggests that some such market segmentation may occur, no study has attempted to measure empirically the degree of substitutability across specific groupings of institutions.

We estimate a structural empirical model in which we specify two dimensions of market segmentation – banks versus thrifts, and multimarket versus single-market institutions – and evaluate the degree of substitutability between the two segments. This framework, introduced by Bresnahan, Stern and Trajtenberg (1997) (BST), allows ex-ante groupings of elements of the choice set without imposing a hierarchical structure on consumer choice patterns. For each grouping, a common parameter is estimated that reflects the within-group correlation in choices. Not only does this demand system allow for flexible substitution patterns across multiple dimensions of market segmentation, it also lets us test straightforward statistical hypotheses that evaluate the degree of substitutability between groupings.

We use our estimates to calculate price elasticities between institution pairs both within and acrosss firm groupings. In addition, we perform two counterfactual experiments. First, we predict the proportion of customers that switch from an institution to other institutions of the same or a different type, conditional on a switch. Second, we perform a test based on the DOJ/FTC merger guidelines to determine whether a collusive deposit rate decrease by

[1] Thrift institutions include savings and loan association and savings banks.

each market segment would be profitable, implying separate markets for antitrust purposes. Our estimates of the substitution parameters, our computed elasticities, and both policy experiments imply that segments based on banks and thrifts as well as single-market and multimarket depository institutions comprise distinct markets in most urban and rural areas.

Our large panel represents nearly a census of banks and thrifts in the United States over the years 1990-2001. We follow the recent empirical evidence and regulatory practice of treating banking markets as local (either MSA or rural county). Summing institutions over markets and years generates a sample size of 256,589 institution/market/year observations from regulatory data. We match in a rich set of additional market-level regressors and price instruments from several external sources.

Our counterfactual experiments can be applied directly to merger policy. In its analysis of bank mergers, the Federal Reserve Board typically treats commercial banks and thrifts asymmetrically, weighting thrift deposits at 50 percent when calculating measures of market concentration.[2] The Department of Justice gives thrifts either zero or 100 percent weight, depending on the extent to which the thrifts engage in commercial and industrial lending. We test behavioral responses to price changes explicitly to see how customers move from a firm in one segment to firms in the same versus another segment.

In addition, we improve on previous structural work in banking by including thrifts as well as banks in our analysis, and by carefully modelling the outside good on a market-specific basis. Dick (forthcoming), with the first structural paper on banking markets, estimates a nested logit model using data on commercial banks only. She assumes that the size of the potential market (which determines the share of the outside good) is constant per household across markets. In contrast, we allow the potential market size to vary across markets, based on market income, the number of households, and the number of business

[2]In some cases, thrift deposits are weighted by the Federal Reserve at 100 percent in calculations of Herfindahl-Hirschmann indexes (HHIs); this occurs when the relevant thrifts have balance sheets that closely resemble bank balance sheets.

establishments. This adjustment accounts for differences in market characteristics that could over- or underestimate the potential market size and introduce bias into estimates of price response. Finally, we estimate our model with market-specific fixed effects to account for time-invariant market-specific differences in the valuation of the outside good.

In the extant literature, three studies have examined the degree of competition between banks and nonbanks. Amel and Hannan (1999) estimate residual supply curves for certain deposit products to investigate whether nonbank institutions should be included with banks to define product markets. Based on their finding that bank own-price elasticities are very low, they conclude that banks face insufficient competition from nonbanks to prevent substantial price increases in the event of a price increase by a hypothetical monopoly bank. Their study does not allow for the computation of institution-specific cross-price elasticities, and does not include thrift institutions directly in the analysis.

Cohen (forthcoming) tests more directly for bank and thrift substitutability. Extending earlier models of equilibrium entry, he uses specification tests to compare models estimated under assumptions of substitutability versus market independence. He rejects the hypothesis that banks and thrifts operate in independent product markets. In work developed simultaneously with ours, Cohen and Mazzeo (2004) extend Cohen's study by testing for competition between single- and multimarket institutions, as well as between banks and thrifts. They find limited competition across product groupings, a result consistent with ours. Two limitations of the approach applied in these papers is that the conceptual framework does not incorporate parameters that estimate the degree of substitutability explicitly and does not allow for policy experiments. In addition, we estimate our model for nearly all U.S. markets, while both these papers restrict their sample to small non-MSA markets. Thus, our results can be applied to both large and small markets.

Recent studies have also illustrated important differences in the behavior of multimarket and single-market financial institutions. Biehl (2002) finds that banks with branches in multiple markets offer lower deposit rates than those with branches in only one market. Hannan and Prager (2004) find that multimarket institutions offer lower deposit rates than single-market institutions; in addition, they find that the deposit rates offered by single-market banks are affected by the share of market branches operated by multimarket banks, suggesting that multimarket firms may compete differently than single-market firms. Dick (forthcoming) finds significant market segmentation between multistate and single-state banks.

Our results support the presence of market segmentation among subgroups of depository institutions. We are able to statistically reject the multinomial logit, as well as the nested logit using either firm grouping as the higher-order choice, where market segmentation either does not affect substitution or affects substitution in only a single dimension. Our computed elasticities show within-group substitution is stronger than cross-group substitution. Our estimates of the percentages of customers moving to other firms within versus across groups, conditional on a switch, shows a large proportion of customers remaining with the same group. Finally, our calculation of the percentage of markets in which a single group could profitably implement a collusive deposit rate decrease points toward market segmentation along both dimensions in most markets. Our evidence suggests that market segmentation is stronger in urban markets and somewhat weaker in rural markets. That is, thrifts and banks, as well as multimarket and single-market banks, appear to compete more directly in rural markets than in urban markets.

These findings support the position taken by antitrust regulators that banks and thrifts are imperfect substitutes. In addition, segmentation between multimarket and single-market institutions suggests that branch network could also be considered in policy decisions on mergers and branch divestitures.

2 Model

We use a nonnested, discrete-choice random utility model of a consumer's choice of depository institution. The following discussion applies the methodology of Bresnahan et al. (1997) to our application. Each consumer in a local market ($m \in 1, ..., M$) may choose to establish an account at any of the financial institutions in the local market ($j \in 1, ..., J_m$), or may opt for an outside alternative ($j = 0$), which may include, among other alternatives, an account at a credit union or brokerage firm, or no account at all.

Conditional on a choice j, consumer i receives a known (but unobservable to the researcher) level of utility V_{ijm}. These utility valuations are assumed to be drawn independently across consumers from a generalized extreme value (GEV) distribution,

$$F(V_{i0m}, ..., V_{iJ_m m}) = \exp -G(e^{-V_{i0m}}, ..., e^{-V_{iJ_m m}}). \tag{1}$$

The consumer selects the option j that provides the greatest utility. Defining δ_{jm} to be the expected value of V_{ijm} and $\delta_m \equiv [\delta_{0m}, ..., \delta_{J_m}]$, the closed-form solution for the expected market share of institution jm is[3]

$$s_{jm} = \frac{e^{\delta_{jm}} \left(\partial G(e^{\delta_m})/\partial \delta_{jm}\right)}{G(e^{\delta_m})}. \tag{2}$$

Following Bresnahan et al. (1997), we specify the following functional form for $G(e^{\delta_m})$:

$$\begin{aligned} G(e^{\delta_m}) \quad = \quad & a_T \left[\left(\sum_{k \in T} e^{\delta_{km}/\rho_T} \right)^{\rho_T} + \left(\sum_{k \in NT} e^{\delta_{km}/\rho_T} \right)^{\rho_T} \right] + \\ & a_M \left[\left(\sum_{k \in M} e^{\delta_{km}/\rho_M} \right)^{\rho_M} + \left(\sum_{k \in NM} e^{\delta_{km}/\rho_M} \right)^{\rho_M} \right] + e^{\delta_{0m}}, \end{aligned} \tag{3}$$

where T is the set of thrifts, NT is the set of banks, M is the set of multimarket firms, and

[3] See McFadden (1978).

NM is the set of single-market firms. The terms ρ_T and ρ_M are parameters constrained so that $0 < \rho_T, \rho_M \leq 1$, $a_T \equiv (1-\rho_T)/(2-\rho_T-\rho_M)$, and $a_M \equiv 1-a_T$. Given this specification, the market share in equation (2) can be expressed as

$$s_{jm}(e^{\delta_m}) = \frac{a_T e^{\delta_{jm}/\rho_T}\left(\sum_{k\in T(j)} e^{\delta_{km}/\rho_T}\right)^{\rho_T-1} + a_M e^{\delta_{jm}/\rho_M}\left(\sum_{k\in M(j)} e^{\delta_{km}/\rho_M}\right)^{\rho_M-1}}{G(e^{\delta_m})}, \quad (4)$$

where $T(j) = T$ if institution j is a thrift, and $M(j) = M$ if j is a multimarket firm; likewise, $T(j) = NT$ if j is a bank, and $M(j) = NM$ if j is a single-market firm.

The GEV model allows us to nest other frequently-used functional forms. When $\rho_T = \rho_M = 1$, equation (4) reduces to the market share function for the multinomial logit model. Similarly, when either $\rho_T = 1$ or $\rho_M = 1$ (but not both) the market share function in (4) is identical to the nested logit with nesting in the M or T dimension, respectively.

We assume that in equilibrium, the predicted market shares $s_{jm}(\delta_{jm})$ will equal the observed market shares S_{jm}. Since the solution to all J_m+1 mean valuations is not identified, we define $\delta^*_{jm} \equiv \delta_{jm} - \delta_{0m}$. With this transformation and conditional on values for ρ_T and ρ_M, we follow Berry (1994) and invert the market share function $s_{jm}(\delta^*_{jm})$ to yield the unique solution to δ^*_{jm}.

We specify the mean utility valuations δ_{jm} to be a linear function of product characteristics:

$$\delta_{jm} = \alpha + X_{jm}\beta + p_{jm}\gamma + \xi_j + \Delta\xi_{jm}, \quad (5)$$

where X_{jm} is a matrix of observable characteristics of each financial institution, p_{jm} is the deposit rate offered by institution jm, ξ_j is the value of unobserved product characteristics that are constant across markets, and $\Delta\xi_{jm}$ are the values of the unobserved characteristics of financial institution j that are market specific. Financial-institution fixed effects are used to capture the unobserved characteristics of financial institution j that are constant across markets and over time, ξ_j.[4]

We are only able to identify the differences between the mean utility valuation of each product and the mean valuation of the outside good, δ^*_{jm}. If the mean utility valuations of the outside good, δ_{0m}, differ across markets, the resulting unobserved market-specific heterogeneity may result in biased coefficient estimates.[5] In empirical applications of aggregate discrete-choice models that involve a single market, this bias is not a problem, since α picks up the entire effect of δ_{0m}. Bias is also not a problem when the outside good represents an option that can reasonably be expected to be constant across markets. In the context of the banking industry, however, where the outside good accounts for options like credit union accounts (the availability of which varies substantially across geographic markets), the assumption of a constant outside good valuation is dubious. To account for unobserved (time invariant) market-specific heterogeneity caused by cross-market differences in the value of the outside good, we include market dummy variables in the estimation of equation (5). Since deposit rates are likely to be correlated with unobserved product characteristics, we instrument for deposit rates.

To calculate the values of ρ_T and ρ_M, we postulate that the at the true values of ρ_T and ρ_M the residuals from the estimation of equation (5) should be uncorrelated with a matrix of exogenous instruments, Z. With this moment condition, Generalized Method of Moments (GMM) yields the following estimator for ρ_T and ρ_M:

$$\min_{\rho_T,\rho_M} L = \widehat{\Delta\xi}' \left(Z\Omega Z'\right) \widehat{\Delta\xi}, \tag{6}$$

[4]Nevo (2000) shows that firm-level fixed effects are identified in aggregate discrete choice models.

[5]In the case of cross market heterogeneity in the valuation of the outside good, the expected value of $\widehat{\beta}$ is equal to $\beta + E\left[(X'X)^{-1}X'\delta_{0m}\right]$. So, $\widehat{\beta}$ will be biased provided that observable bank characteristics including price are correlated with the valuation of the outside good.

where Ω is the optimal weighting matrix.[6]

The GMM function is highly nonlinear.[7] In particular, $\partial\xi/\partial\rho$ is highly nonlinear in ρ, which can cause extensive problems for estimation. To deal with this problem, in addition to the matrix of instruments used to instrument for deposit price in equation (5), we employ the set of instruments proposed by BST. Specifically, the BST instruments include the characteristics of institution jm as well as counts and means for the institutions that share a cluster with institution jm.[8]

3 Data

Our data set is a yearly panel of nearly all banks and thrifts in the U.S. for the years 1990-2001, where the level of observation is the institution/market. Consistent with empirical evidence from the banking literature and with current antitrust practice, we consider markets to be local in scope, and define them as Metropolitan Statistical Areas (MSAs) and rural counties not lying in MSAs.[9] Summing institutions over markets and years generates a total sample size of 256,589 observations. Because the competitive environments likely differ substantially between urban and rural markets, we split the sample into observations occurring in MSAs versus non-MSA markets (counties). The descriptive tables and figures are therefore presented separately for MSA and rural markets.

[6] If the $\Delta\xi_{jm}$ are homoscedastic, then the optimal weighting matrix is $\Omega = (Z'Z)^{-1}$. We use this weight matrix in estimation.

[7] See Bresnahan et al. (1997)

[8] Since this application examines only single-product firms, we are unable to employ all of the instruments suggested by BST. However, the results of monte carlo experiments using simulated data for the single-product case suggest that the instruments we use for $\partial\xi/\partial\rho$ are sufficient to recover the true values of the parameters. Additional information about these monte carlo results is available from the authors upon request.

[9] See, for example, Amel and Starr-McCluer (2002) and Kwast, Starr-McCluer and Wolken (1997). We use geographic market definitions from 1990, holding them fixed over the sampling period.

3.1 Prices

Our price variable is an institution-level annual average deposit interest rate. We construct this rate by dividing annual interest paid on deposits by annual total deposits.[10] The income-statement and balance-sheet data come from the Federal Financial Institutions Examination Council's Reports of Condition and Income (or "Call Reports") for banks, and the Office of Thrift Supervision's Thrift Financial Report (SVGL) for thrifts.[11] We have data for nearly all the banks and thrifts in the U.S., as our information comes from a census (rather than a survey) of depository institutions.

Two drawbacks of our price measure are that it is computed rather than directly observed, and that it can be computed only at the institution level, rather than at the more disaggregated level of the institution and market. This restriction on the geographic distribution of prices presents no problem for the bulk of institutions, which operate in a single market or a very small number of markets, but may introduce measurement error in large organizations that span many markets. Evidence from directly-measured price data suggests that many multimarket banking organizations appear to price uniformly within a state, and some price uniformly across states.[12] Nonetheless, the assumption of uniform pricing for multi-state organizations will inevitably lead to some measurement error for these observations.

We control for potential outliers by noting those observations where either the interest expenditures or the imputed prices increase from one year to the next by over 400% or decrease from one year to the next by over 75%. All such prices are excluded from the estimation of the ρs (and thus are used only to calculate the δs). This filter affects fewer than 5% of the observations in both data sets (MSA and rural markets).

The yearly means of our computed institution-level deposit interest rates are compared

[10] A more disaggregated product definition was not available that was common to both banks and thrifts.
[11] We use second-quarter cumulative total interest payments and second-quarter deposit balances.
[12] See Heitfield (1999).

with market interest rates in figure 1. The changes in our rates over time coincide nicely with changes in market rates, though the spreads vary somewhat over the period. We believe these spread changes reflect actual pricing behavior in the industry.

3.2 Market Shares

Individuals and firms select their depository institutions as a discrete choice but supply deposits or borrow funds as a continuous variable. We construct market shares to reflect the customer decision to open an account at an institution (the discrete choice) rather than the decision of the quantity of deposits to supply. Thus, the market share reflects the number of accounts an institution has in any one market relative to the total number of market decisions.

3.2.1 Institution Accounts by Market

For institutions that operate in multiple markets, we can observe the total number of accounts an institution holds but not its total in each market. To allocate accounts within an institution across the markets in which it operates, we construct an estimate based on available data and modest assumptions. First, for each market, we estimate an average account balance. We form this estimate using market-level average household income from the BEA and household-level income and account balance data from the Survey of Consumer Finances (SCF). We use the SCF to predict household deposits using household income, then apply these regression coefficients to market average household income to predict the market average account balance.[13] We then divide each institution's total market deposits from the Summary of Deposits (SOD) by the predicted average account balance to get the

[13]Using the 1998 SCF, we performed a linear regression of household deposits on household income (conditional on possessing an account), then predicted average market deposits per household by applying the regression coefficients to average market income. The SCF indicates that higher income households hold higher account balances.

institution's predicted total market accounts.[14]

3.2.2 Total Market Decisions

To estimate the total number of market decisions, we use median household and business accounts from the SCF and the Survey of Small Business Finances (SSBF), and household and business establishment counts from the BEA and the Survey of Current Business. The SCF and SSBF show that the median number of accounts per household is three, and median accounts per business is two.[15] Using these numbers and preliminary estimation of the model as a guide, we represent total market decisions as 3 times the number of households plus 2 times the number of firms in the market.

3.2.3 Inside- and Outside-Good Shares

We compute market shares by dividing each institution's market accounts by the corresponding total market decisions. The outside-good share is taken to equal one minus the sum of the inside good shares. The outside-good shares increase somewhat over the sampling period, as is shown in figure 2. The inside-good shares, however, remain relatively constant over time. The growth in the outside-good share is consistent with the fact that total (industry-wide, as opposed to institution-level) deposits decline over the period, both in absolute terms and relative to the population of households and businesses. This trend may be driven in part by the growth of money-market mutual funds, as well as by rapid growth in equity values over the latter part of the sample. The average inside-good share can remain constant despite the decline in total deposits due to the increase in mean institution size and the decrease in the number of institutions over the period (see section 3.5).

Our methodology accounts for cross-market heterogeneity in the calculation of average

[14] We assume that an institution is operating in a market in a given year if it has positive deposits and at least one branch located in the market during the year.

[15] The 75th percentile is four accounts per household.

account balances and market shares. As discussed earlier, this approach differs from that of Dick (forthcoming), who calculates national annual average account balances from Call Report data (dividing nationwide deposits by the nationwide number of deposit accounts). Accounting for heterogeneity is preferable to the national mean approach, as estimates using national means are potentially biased. Specifically, in higher-income (higher-balance) markets, institution market shares are likely to be overstated, while the reverse is true for lower-income (lower-balance) markets. Such a bias could result in overstated price elasticities for higher-income markets and understated elasticities for lower-income markets.

3.3 Institution Characteristics

The institution characteristics used to construct the variables in X that shift customer utility include the institution's number of branch offices in the market, real total institution assets, and institution employees per branch. The number of branches may affect consumer utility by providing access to a large local network. Institution assets proxies for unobservable characteristics such as access to a complex bundle of services, or access to a very large geographic network. Finally, employees per branch may serve as a measure of service quality. Summary statistics of these variables are shown in table 1. The data on institution branches come from the SOD. Assets and total institution employees come from the Call Reports and SVGL.

3.4 Instruments

We employ several groups of instruments for price in addition to the BST instruments previously mentioned; a list is provided in table 2. Our additional instruments are correlated with institution cost, market structure, and market demand shocks.

First, a set of market variables reflects market-specific demand and cost conditions.

Market-level demographics and income variables from the BEA are used to instrument for market demand. These variables include total wage disbursements, employment, population, number of households, population growth rate, and income growth rate. Wage disbursements and employment are correlated with the cost level in each market. Population and total number of households are correlated with market structure and the competitive outcome in each market.[16] Finally, the population growth rate proxies the degree of switching costs in each market.[17]

We also include institutional cost proxies from the Call Reports. The institutional cost variables include average employee salary and salary per branch. Finally, we employ a set of interactions between market and institution variables. We use interactions of population with multimarket and single market variables, population with the multistate dummy, and income with branch density.

3.5 Sample Composition

The population of banks and thrifts has undergone some compositional changes over our sample period. As was mentioned earlier, we capture an era of considerable consolidation, which was driven by both deregulation and the economic environment. The Riegle-Neal Act of 1994, which was fully phased in by 1997, essentially removed restrictions on interstate branching and banking. Also, in the latter half of the 1990s, climbing asset prices likely fueled the trend toward consolidation, particularly among large banking organizations. Some effects of this merger wave are apparent in our data. Figure 3 depicts mean real assets and real total deposits over the sampling period. The dramatic growth in mean institution size is apparent for institutions located in both urban and rural markets. Trends in the data also affect the variables by which we define market segmentation. The proportion of institutions

[16] We find strong significant correlations between market concentration and market population.

[17] We include this variable on the premise that customers who are new to the market do not perceive switching costs and therefore may be more responsive to price differences. See Kiser (2002).

present in multiple markets, shown in figure 4, rises steadily over the period. The proportion of thrift institutions declines over the period.

Descriptive statistics of the utility shifters X, the deposit interest rate, the variables we use to construct our market segmentation groupings, and information on the computed market shares are shown in table 1, broken down by urban and rural markets. Some noteworthy differences between the means of urban and rural observations are the average network size as measured by local branches, with larger average networks in urban areas, and average employees per branch, with greater average employee ratios in urban areas. The average thrift ratio is greater in urban markets, while the average multimarket ratio is slightly greater in rural markets. Finally, mean institution market shares are slightly higher in urban markets, while the mean outside good share is considerably greater in rural markets.

4 Results

We now turn to the results and analysis from the estimation of our model. The main results are summarized in table 3. We estimate the model using observations lying in MSA and rural markets separately. All models are estimated using market, institution, and year dummy variables (these coefficients are not reported).

In general, most coefficients have the expected signs and are significant at the 5% level. Note that because the deposit supply curve slopes up, the positive sign on the deposit interest rate (price) coefficient is expected. In all model specifications, the utility derived from an institution's branches in the market is concave. The coefficients on branch density, the log of firm assets, and employees per branch are also all positive, as expected. The coefficient on income is negative, which may reflect a greater tendency of wealthier households to opt for the outside good (e.g., brokerage accounts).

The market segmentation parameters, ρ_T and ρ_M, are both significantly different from 1 and 0 at the 1% level in both samples. Our rejection of the hypothesis that $\rho_T = \rho_M = 1$ implies rejection of the simple multinomial logit model, in which market segmentations would not matter for substitution. We also reject both joint hypotheses that $\rho_T \in (0,1)$ and $\rho_M = 1$, and that $\rho_T = 1$ and $\rho_M \in (0,1)$, thereby rejecting the nested logit model at the 1% level. The results for MSA markets and rural markets are comparable, though the coefficient magnitudes differ slightly. In MSA markets, ρ_T is estimated to be 0.27 and ρ_M is 0.28. In rural markets, ρ_T is 0.48 and ρ_M is 0.61. These results suggest the presence of market segmentation between multimarket and single-market institutions and between thifts and banks, where institutions are closer substitutes to institutions within the same grouping than to institutions across groupings. These correlations are stronger in urban markets than in rural markets.[18]

4.1 Elasticities

While our estimates of ρ_T and ρ_M allow us to test hypotheses about market segmentation, structural calculations of elasticities provide more explicit information about substitutability. We calculate own- and cross-price elasticities for institution pairs over the entire sample. A summary of these elasticities is presented in tables 4 and 5, which display the mean, median, and standard deviation of the own- and cross-price elasticities for the different market segmentations (bank/thrift, multimarket/single market) in both samples for our model. These numbers represent institution-specific or institution-pair elasticities. The mean cross-price elasticity refers to the mean percentage change in the number of accounts at the first type of institution resulting from a percent change in the interest rate of the second type of institution, with the mean taken over all such institution-type pairs in the sample.

[18] We checked the robustness of our estimates over time by separating the data set into three subsamples: 1990-1993, 1994-1996, and 1997-2001. The estimates of ρ_T and ρ_M do not differ substantially across any of the three periods for either rural or urban markets. Our results are also robust to alternative definitions of multimarket banking.

For example, the mean bank-thrift cross-price elasticity is the average over all bank/thrift pairs of the percent quantity increase for an individual bank from a percent increase in the deposit rate at an individual thrift.[19]

The median own-price elasticities are 2.29 in MSAs and 1.41 in rural markets. The median cross-price elasticity, however, is smaller for MSAs than for rural markets. Both these facts are consistent with the larger customer choice set in MSAs. In our data set, we find an average of 28 institutions for MSA markets (20 banks and 8 thrifts) and an average of 5 institutions for rural markets (4 banks and 1 thrift). Because of the greater number of local competitors, a given bank in an MSA faces a greater customer loss from dropping its deposit rate than an analogous rural bank. However, the departing customers are spread across more competing institutions, resulting in much smaller pairwise cross-price elasticities.

While the magnitudes of the elasticities differ across the two samples, similar patterns emerge. As expected, cross-price elasticities are greater (on the order of 2 to 3 times) for institutions from similar segments (e.g., bank to bank or multimarket to multimarket) and smaller for institutions from different segments. For both samples, banks face less elastic demand than do thrifts, and single-market institutions face less elastic demand than do multimarket institutions. Our MSA estimates are smaller than those obtained by Dick (forthcoming), who estimates median own-price elasticities of 10.9 in a nested logit model and 5.9 in a multinomial logit model.[20] We attribute this difference to our careful modeling of market-specific outside-good shares as described in section 3.2.3, and from our use of market fixed effects. We believe that our adjustments to prevent over- or underestimating the potential market size results in more reasonable elasticities.

The cross-price elasticity estimates give an overview of substitutability of the different

[19] Stated formally, if $BANKS_m$ denotes the set of banks and $THRIFTS_m$ the set of thrifts in market m, then the mean bank-thrift cross price elasticity is equal to $\sum_m \left(\sum_{i \in BANKS_m} \sum_{j \in THRIFTS_m} \frac{\partial Q_i}{\partial p_j} \frac{p_j}{Q_i} \right) / (\#BANKS_m \times \#THRIFTS_m)$.

[20] Amel and Hannan (1999) estimate only market-level demand and, hence, do not calculate bank-specific price elasticities.

segments. These elasticities depend on the implied number of customers who switch in response to a change in deposit rates and the existing account base of the other institutions to which switching customers might migrate. To focus more directly on the consumer switching behavior, we calculate the probability that a consumer, conditional on switching from one institution, chooses each of the other institutions in the market. We then aggregate these probabilities to give a picture of the behavior of customers who choose to switch from their existing institution.

Table 6 shows the mean, median, and standard deviation of the percentage of switching households for each market segment.[21] For example, the bank-bank row shows the percentage of customers who, conditional on leaving their existing bank in response to a decrease in the deposit rate offered, opt for another bank in the market. In this example, on average, 89.2 percent of customers who leave a bank in response to a deposit rate decrease are predicted to migrate to another bank in the market, whereas 10.8 percent migrate to a thrift.

The results of the switching probabilities suggest that the bank customers are more loyal to that type of institution than are customers of thrifts. While 89.2 percent of bank customers in MSAs who decide to switch to another institution would choose another bank, only 69.0 percent of thrift customers would choose another thrift. Customer loyalty to institution type in rural markets is similar for banks (84.5 percent of bank customers would choose another bank), but lower for thrifts (50.3 percent). Interestingly, while loyalty to multimarket institutions is more pronounced in MSA markets than loyalty to single-market institutions (89.2 percent and 75.7 percent, respectively), the numbers are almost identical in rural markets (61.9 and 62.0 percent, respectively).[22]

[21] To ensure that each customer has the option of choosing for each type of institution, only those markets that have one or more of each type of institution as an alternative for the customer to switch to are included in calculating the switching percentages.

[22] These figures are influenced by the number of each type of institution in the market. As most markets have more banks than thrifts, for example, the greater propensity of switching customers to choose banks would be observed even in the absence of segmentation among these institution types.

While these results suggest that customers tend to be loyal to a particular type of financial institution, they do not necessarily indicate that the market for deposit services is segmented according to these industry groupings. To determine whether these correlated preferences are sufficient to establish the existence of segmented markets we utilize a test that follows the spirit of the DOJ/FTC *Horizontal Merger Guidelines* (U.S. DOJ/FTC 1997). We test whether all firms in a particular market segment, acting in concert, could profitably institute a "small but significant and nontransitory increase in price" (SSNIP). Specifically, we compute the proportion of geographic markets in which a 5 percent orchestrated decrease in deposit rates among all firms in a segment would be profitable, holding the deposit rates of all other institutions in the market constant. That is, we test whether a sufficiently small share of customers would switch their accounts away from the colluding firms so as to make the joint decrease in rates profitable for the cartel. Under this test, if such an increase is profitable then the firms in that segment constitute an independent market.

We employ our test in a slightly different manner than that suggested by the *Horizontal Merger Guidelines*. The guidelines recommend beginning with a narrowly defined set of competitors and expanding the set until the marginal firms included would make the cartel unprofitable. In contrast, we fix the set of competing firms *ex ante*, and perform the test on the predetermined groupings as is relevant for our case.[23]

Table 7 shows the percentage of markets where a coordinated 5 percent decrease in deposit rates among all of the institutions in that market segment proves to be jointly profitable.[24] The results indicate that the specified market segments frequently constitute independent product markets. Banks are able to profitably decrease deposit rates in 99 percent of MSA markets and 94 percent of rural markets. Similarly, multimarket institutions constitute independent segments in 99 and 90 percent of the MSA and rural markets, respectively.

[23]Our application is similar to the "potential market power test" performed by Ivaldi and Verboven (2002) for a hypothetical merger between two European heavy truck manufacturers.

[24]A thorough discussion of the assumptions underlying our test is provided in the Appendix.

While thrifts (94 and 64 percent) and single-market intitutions (89 and 65 percent) do not pass the test as frequently, both do so in the majority of cases for both MSA and rural markets.

Further decompositions of each institution into segment pairs produce similar, though less conclusive, results. Multimarket banks constitute a distinct market segment in 95 percent of MSAs and 83 percent of rural markets. Single-market banks and multimarket thrifts are able to profitably decrease deposit rates at similar rates in MSA markets (84 and 86 percent, respectively) and rural markets (63 and 61 percent). Only single-market thrifts failed to show a profitable joint rate decrease a majority of the time in either MSA markets (47 percent) or rural markets (17 percent).

Note that a conclusion of independent product markets from our modified SSNIP test does not imply that firms in one grouping do not affect the prices of those in another. Thus, while our results imply that substitution between subgroups is weak in many markets, our finding is not inconsistent with Cohen's rejection of banks and thrifts as entirely independent markets. Our findings are also consistent with Cohen and Mazzeo's findings of more direct competition within firm groupings.

5 Conclusion

We use a generalized extreme value framework introduced by Bresnahan et al. (1997) to investigate market segmentation among depository institutions. We find significant market segmentation in banks/thrifts and single-market/multimarket institutions in both urban and rural markets. The estimated segment parameters, ρ_T and ρ_M, are both significantly different from 1 at the 1 percent level, rejecting the hypothesis that either pairs of institution types do not matter to substitution. As expected, we also find deposit supply to be increasing in the institution's deposit interest rate, institution branches and branch density in the market, and employees per branch. We estimate the mean own-price (-rate) elasticity of deposit supply for banks to be 2.29 in urban markets and 1.46 in rural markets, and that of thrifts to be 2.71 in urban markets and 1.55 in rural markets. More importantly, our results indicate limited switching (as a result of a price increase) between institutions from different firm groupings.

Bank merger policy is currently predicated on the notion that banks and thrifts are imperfect substitutes. Our findings indicate that, in fact, banks and thrifts do not appear to be very close substitutes. While our estimates do not quantify a specific recommended weighting of thrifts, they support the asymmetric weighting of thrifts relative to banks in merger policy. Moreover, we draw similar conclusions about the substitutability between multimarket and single-market banks, even though current merger policy does not explicitly assume differences in these types of institutions.

Our results could be applied to areas beyond the appropriate weights used to compute concentration measures. Divestiture policy is one such area. If the consumer choice of depository institution reflects a match between consumer preferences and firm characteristics, our model would predict that branches divested to firms of similar characteristics should experience less "runoff" than branches divested to dissimilar firms. For example, in a merger between two single-market thrifts where a divestiture would be recommended to prevent an increase in market power, the model would predict that runoff would be minimized by divesting branches to another single-market thrift. An important complication of this prediction is that for mergers between large institutions that warrant branch divestitures, divesting to a similar (large) firm could increase the market power of the firm purchasing the divested branches.[25] Nevertheless, in general, runoff could potentially be limited by considering the initial match between consumers and firms in choosing the purchasers of divested branches. Future research could test these implications for deterring deposit runoff.

Our evidence may also bear on the "mitigating factors" that are assumed to lessen the

[25] Presumably, the purchasing multimarket bank should be one without an initial presence in the market.

anticompetitive effect of a particular proposed merger. For example, if an acquirer and a target firm are from different market segments, it is reasonable to assert that they compete less directly than would two firms from the same segment.

While our findings support the policy stance among antitrust regulators that banks and thrifts are imperfect substitutes, our estimates are obtained purely from the deposit side of the market and not the loan side. Further research could address this aspect of substitutability. Finally, additional work could investigate the differences in product and service offerings that determine the weakened substitutability between the market segments we consider here.

Table 1: Descriptive statistics of selected variables

	MSA Markets		**Rural Markets**	
Variable	Mean	St Dev	Mean	St Dev
Thrift Indicator	0.29	0.45	0.17	0.38
Multimarket Indicator	0.53	0.50	0.63	0.48
Deposit Rate	0.05	0.01	0.05	0.01
Branches	6.01	12.18	1.84	1.46
Branches Squared	184.42	1649.58	5.52	13.51
Branch Density (Branches/sq mi)	0.004	0.01	0.003	0.003
Real Total Assets ($1,000,000)	8.21	2.20	7.72	2.29
Employees per Branch	21.42	57.53	15.28	10.84
Inst. Number of States	1.54	2.16	1.58	2.38
Inst. Number of Markets	10.74	33.96	14.74	41.78
Inst. Average Salary ($1,000)	16.97	9.92	15.62	5.41
Inst. Salary per Branch ($1,000)	556.93	9,481.76	249.76	237.11
Mkt. Household Income ($1,000)	66.81	16.60	48.96	10.12
Mkt. Wage Disbursements ($1,000)	27,411.02	38,456.11	323.19	351.00
Mkt. Employment (1,000)	836.09	1,021.21	14.62	14.18
Mkt. Wages Per Employee ($1,000)	28.41	6.48	20.48	3.99
Mkt. Households (1,000)	602.27	728.23	13.74	12.23
Mkt. Population Growth	0.01	0.01	0.01	0.02
Mkt. Income Growth	0.06	0.02	0.05	0.04

Table 2: Instruments

Market variables:	
	Wage disbursements
	Employment
	Average wage (disbursements/employment)
	Population
	Households
	Population growth rate
	Income growth rate
Institution cost:	
	Average salary ($/employee)
	Salary per branch
Market/institution interactions:	
	Income*branch density

Table 3: Results for MSA and rural markets

MSA Markets			
Independent Variable	Estimate	St. Dev.	T-Stat
ρ_T	0.27	0.0030	91.86
ρ_M	0.28	0.0028	101.29
Branches	0.02	0.0003	79.48
Branches^2	-0.0001	0.0000	-63.85
Branch density	8.76	0.21	42.43
log(assets)	0.13	0.027	4.93
Employees per branch	0.0001	0.0000	2.11
Income	-0.013	0.0005	-25.14
Deposit Rate	16.10	0.63	25.48

Rural Markets			
Independent Variable	Estimate	St. Dev.	T-Stat
ρ_T	0.48	0.0021	225.43
ρ_M	0.61	0.0030	200.20
Branches	0.30	0.0063	47.56
Branches^2	-0.018	0.0004	-40.34
Branch density	40.34	2.74	14.72
log(assets)	0.19	0.047	4.06
Employees per branch	0.012	0.0006	21.14
Income	-0.025	0.0009	-27.56
Deposit Rate	22.04	1.29	17.03

Note: All models include market, bank, and year dummy variables.

Table 4: Price elasticities for MSA markets

	Mean	Median	St. Dev.
Own-Price Elasticties			
All	2.44	2.31	0.81
Bank	2.31	2.20	0.73
Thrift	2.73	2.57	0.91
Multimarket	2.49	2.36	0.82
Single Market	2.38	2.25	0.79
Multimarket Thrift	2.71	2.54	0.93
Single-Market Thrift	2.77	2.61	0.87
Multimarket Bank	2.38	2.27	0.74
Single-Market Bank	2.25	2.13	0.72
Cross-Price Elasticities			
All	-0.034	-0.0049	0.11
Bank-Bank	-0.042	-0.0057	0.12
Bank-Thrift	-0.016	-0.0020	0.047
Thrift-Thrift	-0.053	-0.012	0.14
Thrift-Bank	-0.015	-0.0032	0.047
Multimarket-Multimarket	-0.085	-0.015	0.185
Multimarket-Single Market	-0.020	-0.0027	0.056
Single Market-Single Market	-0.027	-0.0065	0.082
Single Market-Multimarket	-0.0092	-0.0014	0.040

Note: All elasticities are institution specific and reflect elasticities between individual institutions. Cross-price elasticities reflect changes in quantity of the first listed institution type resulting from a price change in the second listed institution type. For example, Bank-Thrift represents the quantity response for a bank if a thrift changes its price.

Table 5: Price elasticities for rural markets

	Mean	Median	St. Dev.
Own-Price Elasticties			
All	1.48	1.41	0.50
Bank	1.46	1.41	0.48
Thrift	1.56	1.46	0.58
Multimarket	1.52	1.46	0.51
Single Market	1.40	1.34	0.47
Multimarket Thrift	1.56	1.47	0.58
Single-Market Thrift	1.55	1.44	0.55
Multimarket Bank	1.51	1.46	0.48
Single-Market Bank	1.39	1.34	0.46
Cross-Price Elasticities			
All	-0.16	-0.099	0.18
Bank-Bank	-0.188	-0.13	0.19
Bank-Thrift	-0.094	-0.061	0.097
Thrift-Thrift	-0.27	-0.19	0.26
Thrift-Bank	-0.082	-0.054	0.089
Multimarket-Multimarket	-0.18	-0.11	0.20
Multimarket-Single Market	-0.11	-0.066	0.12
Single Market-Single Market	-0.22	-0.16	0.20
Single Market-Multimarket	-0.12	-0.076	0.13

Note: All elasticities are institution specific and reflect elasticities between individual institutions. Cross-price elasticities reflect changes in quantity of the first listed institution type resulting from a price change in the second listed institution type. For example, Bank-Thrift represents the quantity response for a bank if a thrift changes its price.

Table 6: Switching percentages for MSA and rural markets

MSA Markets

	Mean	Median	St. Dev.
Percent Switching			
Bank-Bank	0.89	0.94	0.12
Bank-Thrift	0.11	0.061	0.12
Thrift-Thrift	0.69	0.72	0.13
Thrift-Bank	0.31	0.28	0.13
Multimarket-Multimarket	0.89	0.95	0.14
Multimarket-Single Market	0.11	0.051	0.14
Single Market-Single Market	0.76	0.77	0.13
Single Market-Multimarket	0.24	0.24	0.13

Rural Markets

	Mean	Median	St. Dev.
Percent Switching			
Bank-Bank	0.85	0.87	0.10
Bank-Thrift	0.15	0.13	0.10
Thrift-Thrift	0.50	0.52	0.16
Thrift-Bank	0.50	0.48	0.16
Multimarket-Multimarket	0.62	0.63	0.21
Multimarket-Single Market	0.38	0.37	0.21
Single Market-Single Market	0.62	0.64	0.21
Single Market-Multimarket	0.38	0.36	0.21

Note: All switching percentages are institution specific and reflect switching from an individual institution to an institution type.

Table 7: Market Tests for MSA and rural markets

MSA Markets

	Share Passed
Major Classification	
Banks	0.99
Thrifts	0.94
Multimarket	0.99
Single Market	0.89
Minor Classification	
Multimarket Banks	0.95
Single-Market Banks	0.84
Multimarket Thrifts	0.86
Single-Market Thrifts	0.46

Rural Markets

	Share Passed
Major Classification	
Banks	0.94
Thrifts	0.64
Multimarket	0.90
Single Market	0.65
Minor Classification	
Multimarket Banks	0.83
Single-Market Banks	0.63
Multimarket Thrifts	0.61
Single-Market Thrifts	0.17

Note: All elasticities are institution specific and reflect elasticities between individual institutions. Cross-price elasticities reflect changes in quantity of the first listed institution type resulting from a price change in the second listed institution type. For example, Bank-Thrift represents the quantity response for a bank if a thrift changes its price.

Figure 1: Mean computed deposit interest rates and market rates

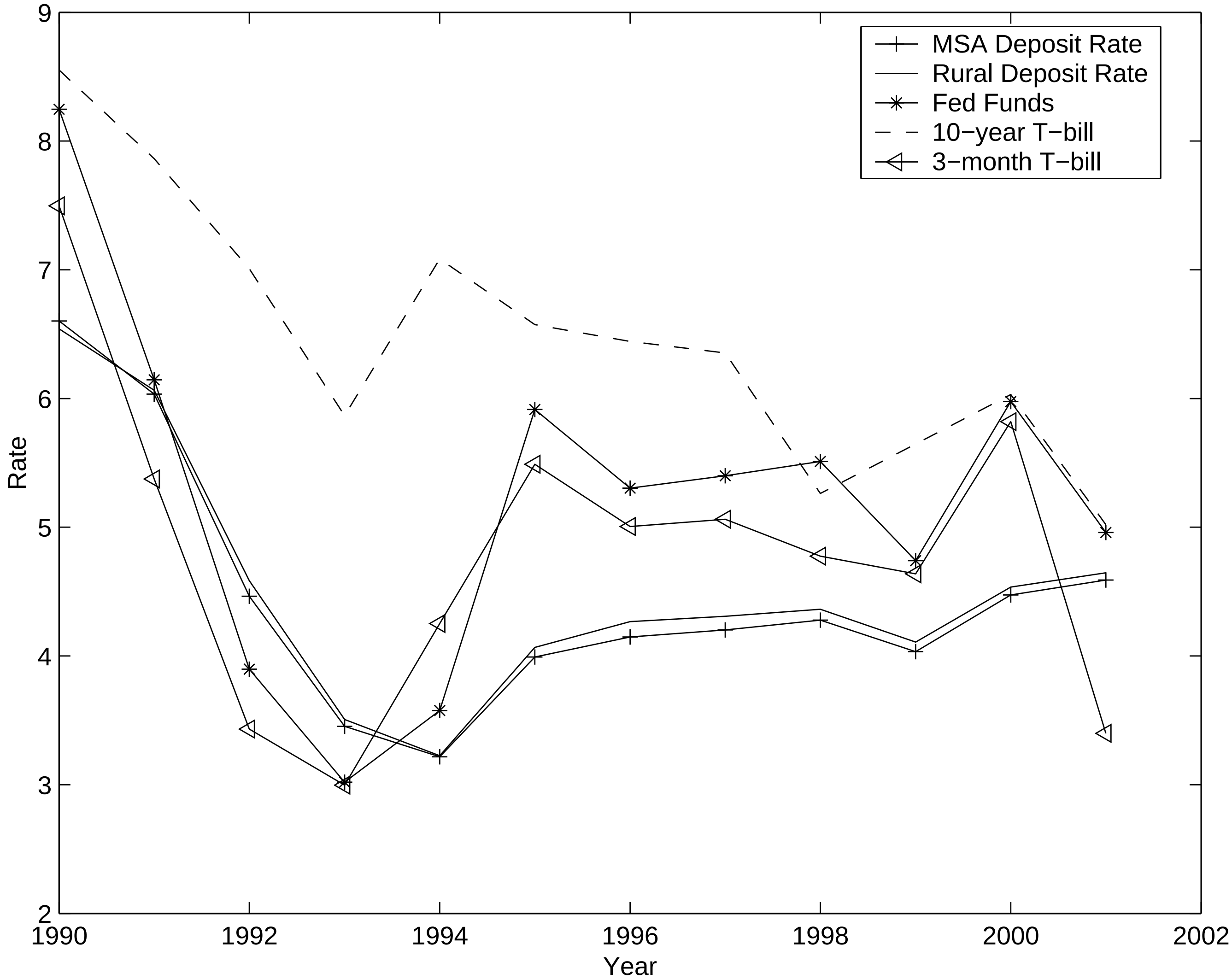


Figure 2: Mean outside-good and institution market shares

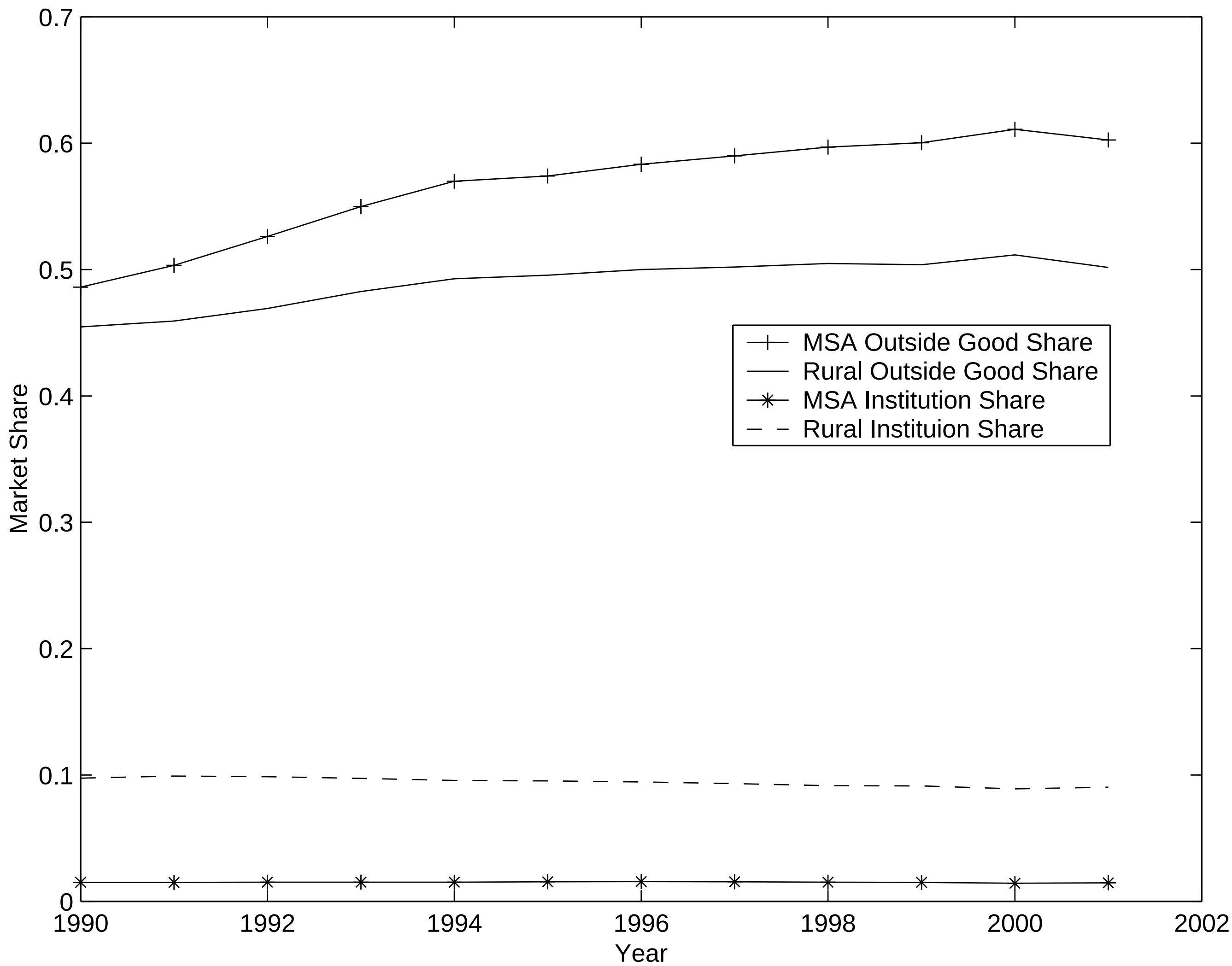


Figure 3: Mean institution assets (1996 dollars)

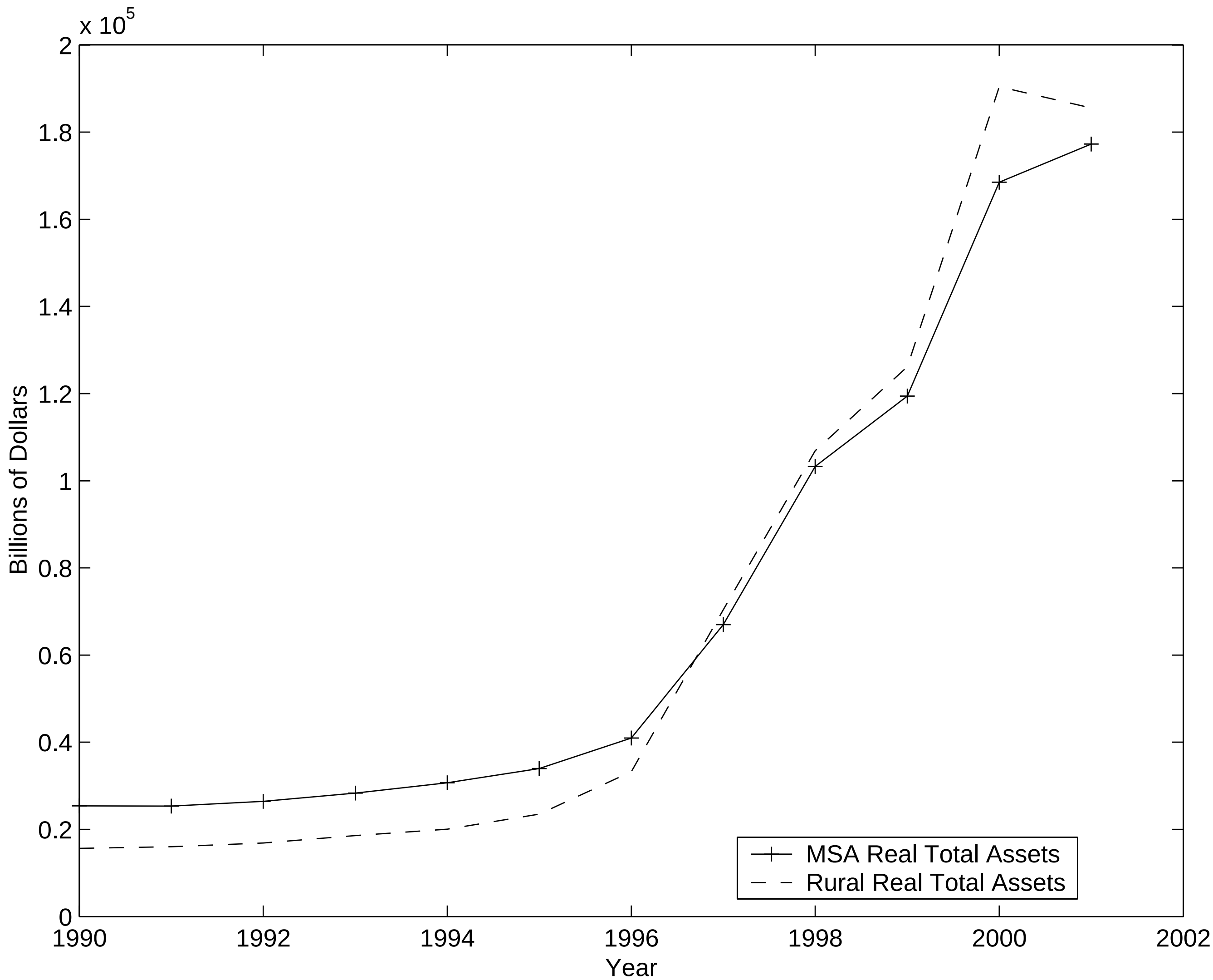
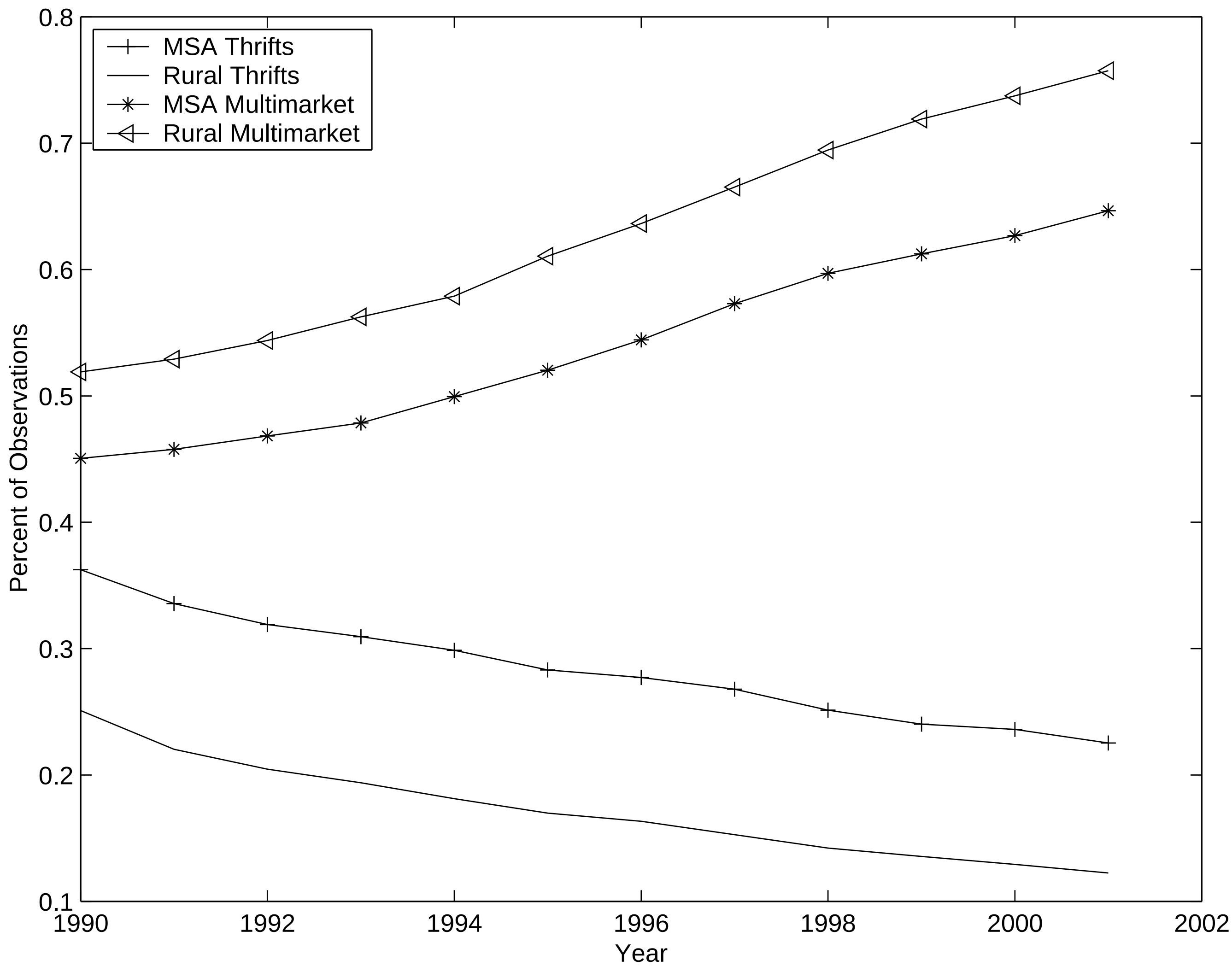


Figure 4: Sample proportions of thrifts and multimarket institutions



6 Appendix

6.1 Depository Institution Theory

We begin with a description of the theoretical behavior of financial institutions that provides the basis of our modified SSNIP test. Institutions in each of the four different segments are all assumed to act in the same profit-maximizing fashion and to face the same options and constraints.

We model a depository institution as an organization that accepts deposits or wholesale funds as inputs to extend loans or to invest in the wholesale funds market. Demand for the firm's loans in market i is given by the function $Q_i(p)$, where p is the loan interest rate set by the institution. The volume of deposits is a function of the deposit interest rate, d, offered by the bank and is denoted $q_i(d)$. We assume that each institution that serves multiple markets is constrained to set the same deposit rates and loan rates across markets.

Each institution is also assumed to have access to a perfectly competitive wholesale funds market, where the firm can borrow or lend funds at the prevailing interest rate, w. While transacting in the wholesale funds market is assumed to be costless, there is constant marginal cost associated both with taking deposits and making loans, denoted by c_D and c_L, respectively.

With these assumptions, the profit function of the financial institution can be written as

$$\pi = (p - c_L) \sum_i Q_i(p) - (d + c_D) \sum_i q_i(d) - w \left(\sum_i (Q_i(p) - q_i(d)) \right). \tag{7}$$

This profit function gives rise to the following first-order conditions for the optimal loan rate p^* that satisfies

$$p = c_L + w - \frac{\sum_i Q(p)}{\sum_i \partial Q_i(p) / \partial p}, \tag{8}$$

and the optimal deposit rate d^*, satisfying

$$d = w - c_D + \frac{\sum_i q_i(d)}{\partial q_i(d)/\partial d}. \tag{9}$$

Note that the optimal loan and deposit rates are not directly linked. While the optimal deposit rate d^* and loan rate p^* are both functions of the wholesale funds rate w, neither is a function of the other. This implies that changes in the market for deposits have no effect on the quantity or pricing of loans made by depository institutions. Therefore when looking at how changes in the deposit market affect overall profitability and welfare, we can focus exclusively on changes in the market for deposits.

Because of this separability between the loan and deposit markets, we can use the profit function from equation 7 to calculate the change in profits each institution would experience from a coordinated change in deposit rates. In conducting this hypothetical test, for each segment we assume that all institutions within that segment lower their deposit rates by 5 percent, while holding the deposit rates of the other institutions constant. Denoting the new deposit rate offered by the institution whose profit function is given in equation 7 as d' and the new deposit supply curve facing the institution as $q_i'(d)$, the SSNIP will be profitable for this institution provided that

$$(w - d^* - c_D)\sum_i q_i(d^*) < (w - d' - c_D)\sum_i q_i'(d'). \tag{10}$$

To calculate the values in equation 10, we need estimates for $w - c_D$. Assuming that the realized market shares of each institution are equal to the market shares it expected to receive when setting its deposit rate, we are able to back out estimates of $w - c_D$ for each firm using the first-order condition for deposit rates (equation 9). Using these calculated values, we can calculate the profitability of the SSNIP.

If equation 10 holds, then the institution will find the SSNIP profitable. Furthermore, the difference between the right- and left-hand sides of equation 10 yields the increase in profits from the SSNIP for this particular firm. To judge whether a particular market segment passes the SSNIP test, we aggregate this difference in profits over all the firms in that market segment. If this aggregate value is positive, then the SSNIP is sufficiently profitable and that segment constitutes an independent market segment.

To operationalize this test, we make several assumptions. First, we do not have data on the deposit rates offered by some of the institutions in our sample. Without data on the deposit rate offered by the institution, we cannot simulate the change in deposit supply from a deposit rate decrease. We assume, therefore, that the mean utility that consumers receive from having a deposit account at these institutions remains constant in the event of a price change (specifically, we assume that the δ for each of these firms is unchanged). This amounts to assuming that these institutions do not participate in the hypothetical coalition that engages in a SSNIP. Consistent with this, we do not aggregate the profits of these firms into the calculation to determine whether the SSNIP is profitable. This assumption will bias our results against finding the market segment to be independent. This is the case because the presence of these firms gives customers of institutions in the same segment a closer substitute to their depository institution that does not have its attractiveness diminished by a lower deposit rate. This reduces the aggregate profits of the within-segment institutions. By excluding the change in profits at these institutions, which would be unambiguously positive given that they experience an increase in deposits without having to increase their deposit rates, we decrease the aggregate profits of the within-segment firms.

A second assumption inherent in our test involves the treatment of multimarket firms. We have assumed, both in constructing the data and in developing the theory here, that each firm sets a deposit rate that is constant across the markets in which it operates. In performing the SSNIP test, however, we assume that each multimarket institution when engaging in a SSNIP can decrease its deposit rates in solely that market. The alternative assumption would have required each of the multimarket institutions to decrease its deposit rates by 5 percent in each of the markets in which it operates. Profitability for these firms would then be largely dependent upon whatever losses or gains were experienced in other markets. Necessitating price changes in other geographic markets simply because firms are constrained to charge a single price across markets seems to us inconsistent with our research question (product market definition in a given geographic market). So while it may not be possible (or profitable) for these institutions to lower their deposit rates in just one market, we believe that this assumption is consistent with the hypothetical question asked by the SSNIP test.[26]

A third assumption underlying the SSNIP test performed in this paper is that the institutions outside of the market segment being examined continue to offer the same deposit rates after the SSNIP that they did beforehand, though they would likely find a decrease in deposit rates optimal following the SSNIP. This has the effect of increasing the estimated number of consumers who switch to institutions outside of the market segment and decreases the profitability of the SSNIP to inside market segment firms, biasing the test away from a finding of independent markets.

[26]The direction of bias introduced by this problem to our SSNIP test is ambiguous, since it depends entirely on the profitability for a multimarket firm of uniform pricing versus price discrimination across markets. This topic is beyond the scope of this paper.

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