# Thrift Scale Economies: An Alternative Approach

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*This study investigates economies of scale in the thrift industry. Scale economies are estimated using the translog cost function and data for all GAAP-solvent FSLIC-insured thrifts for the period 1986 to 1989. The findings from our single product approach applied to a large sample suggest that for all practical purposes, meaningful economies of scale do not exist for most output ranges. This is consistent with the findings from other recent studies that have used a multiproduct approach applied to smaller and more geographically confined samples.*

## INTRODUCTION

The trend toward consolidation in the thrift industry received a substantial boost from the passage of the Financial Institutions Reform, Recovery and Enforcement Act (FIRREA) in August 1989. FIRREA came after ten years of increased financial pressure on the industry as a result of earlier moves toward deregulation. FIRREA imposed higher capital requirements and higher deposit insurance premiums on thrifts while it allowed less liberal asset powers. The question of how this consolidation will affect operating efficiency is a subject of considerable interest.

The two principal recent studies of thrift scale economies are LeCompte and Smith (1990) and Mester (1987). While the findings differ somewhat depending on model specification and sample period, the basic conclusion from both studies is that, for the early 1980s, returns to scale are approximately constant.[1] Both studies employ a multiproduct approach, which has been used increasingly in the scale economies literature over the past several years. This approach can result in severe multicollinearity, however, when applied to a small sample. The Mester (1987) study produces a negative estimate of marginal cost, which, according to Berger, Hanweck, and Humphrey (1987, p. 509), "theoretically invalidates measures derived from these cost functions." In addition, in a major review of bank cost studies, Gilbert (1984) has written that because of small, geographically restricted samples, existing studies do not provide evidence that is relevant for many policy issues. This article argues that there are advantages to a large sample, single product

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[1] LeCompte and Smith (1990) did find evidence of economies of scale in 1983, but only up to $50 million in assets.


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study as a check on the conclusions of smaller sample, multiproduct studies of scale economies. We apply such an approach to the thrift industry using data for the period 1986 to 1989.[2] Another purpose of this paper is to provide estimates of scale economies for several specific size classes, something that is not always done in other studies.[3] We briefly summarize recent research on scale economies at commercial banks and thrifts and then discuss single product and multiproduct cost studies. Our data and estimation method and empirical results follow.

## FINANCIAL INSTITUTION SCALE ECONOMIES LITERATURE REVIEW

Evidence on scale economies in the financial services industry is mixed. Early banking studies summarized in Benston (1972) conclude that scale economies are present throughout a wide range of size classes. Some later studies of commercial banking cost structures (i.e., Benston, Hanweck, and Humphrey, 1982; Benston, Berger, Hanweck, and Humphrey, 1983; and Gilligan, Smirlock, and Marshall, 1984) conclude that scale economies are exhausted quickly beyond a relatively small asset size and that cost curves are either flat or upward sloping at higher output levels. This literature is summarized in Gilbert (1984). In contrast, Murray and White (1983) find evidence of scale economies in credit unions.

Studies of savings institutions similarly have yielded conflicting results. Goldstein, McNulty, and Verbrugge (1987) and McNulty (1982, 1983) report evidence of scale economies, while LeCompte and Smith (1990) and Mester (1987) suggest approximately constant returns to scale in most model specifications. The Mester (1987) study uses a sample of California institutions in which over one-half of the firms are state-chartered stock firms that have engaged in diversified activities for some time. The study by LeCompte and Smith (1990) uses a sample of 431 institutions from the southwestern portion of the United States for two years, 1978 and 1983. In contrast, the study by Goldstein, McNulty, and Verbrugge (1987) is based on four years of pre-1980 data for all FSLIC-insured institutions. Thus, the latter results reflect the effects of more specialized activities (primarily residential lending) in a highly regulated era. In addition, this study excludes interest cost from the definition of total cost.

## SINGLE PRODUCT AND MULTIPRODUCT COST STUDIES

As Berger, Hanweck, and Humphrey (1987) point out, financial institution cost studies can use either the production approach or the intermediation approach. In the production approach, banks are considered to be producing loan and/or deposit accounts using

[2] Mester (1987) uses data on 149 California S&Ls for 1982. LeCompte and Smith (1990) use data on 431 S&Ls in the Ninth FHLBB District (Arkansas, Louisiana, Mississippi, New Mexico, and Texas) for 1978 and 1983. Texas dominates this sample, and the results may be affected by special conditions in Texas such as the speculative real estate boom that was in process by 1983. This would have an effect on non-interest operating cost because real estate lending is a high cost activity. It also would affect interest cost because many institutions were paying high rates to attract deposits to obtain funds to lend in the boom.

[3] LeCompte and Smith (1990) do report scale economy estimates by size class. Mester's (1987) results are for one state and cannot necessarily be generalized. With a sample of only 149 thrifts, there would be few in certain output ranges.

labor and capital as inputs. Therefore, operating cost is the dependent variable and output is measured as the number of accounts. Under the intermediation approach, financial institutions transform (intermediate) deposits and other liabilities into loans and other assets. Total costs include both operating and interest costs and output is measured in dollar terms. The focus of this discussion and this study will be the intermediation approach because it is used in most other recent studies and because it allows us to consider all types of costs.

Researchers also have the choice of a single product or multiproduct approach. The disadvantage of the single product approach is that it aggregates outputs with different costs. The multiproduct approach, however, also has limitations. Before Mester's (1987) article appeared, the conventional approach in thrift scale economies research was the single product approach.[4] Both LeCompte and Smith (1990) and Mester (1987) use the multiproduct approach. In multiproduct studies, cost is considered to be a function of various types of output, $x_1 \ldots x_n$. The translog cost function typically is used, in which case interaction terms between the various output variables must be included. These allow the estimation of cost complementarities.

To keep the functional form manageable, multiproduct studies typically limit the number of output items to two or three. For example, Mester's (1987) three outputs are mortgage loans, other loans, and cash, securities, and real estate investments. The study excludes from the third category (cash, securities, and real estate investments), however, liquid assets needed to meet the regulatory minimum. This exclusion assumes that a dollar of a certain asset added to the portfolio to meet the regulatory minimum does not increase total cost, but an equivalent amount of the same asset added for discretionary liquidity or for income does increase cost. This is clearly not the case.

In contrast, LeCompte and Smith (1990) define output as mortgage loans, consumer loans, and investments and commercial loans. The third category (investments and commercial loans) includes outputs for which cost would be expected to be lower than average per dollar of output (e.g., investment in treasury bills) and activities that are typically high cost (e.g., real estate development and commercial lending).[5] In addition, both studies put mortgage loans in a separate class from mortgage-backed securities. This treatment ignores the fact that the cost of originating individual loans for the portfolio is substantially greater than the cost of acquiring mortgage-backed securities. Furthermore, thrifts created many mortgage-backed securities by securitizing loans and then put these securities into their portfolio. Thus, securitization further blurs the distinction between the two types of assets. In the absence of specific functional cost data to guide the disaggregation process, researchers must make many arbitrary assumptions to do a multiproduct cost study for thrifts.

As illustrated above, there is simply no consensus in scale economy studies for thrifts on how to define output, and studies have used various output definitions. In the

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[4] Mester (1987), after reviewing the literature extensively, indicates that "the author knows of no other published multiproduct cost study of S&Ls" (p. 423).

[5] The authors consider this breakdown "unconventional". It is used to capture cost dependencies between traditional and new lending areas (LeCompte and Smith, 1990, pp. 1341-1342). An additional related motivation may have been to keep the number of output categories to three.

final analysis, the choice of explanatory variables depends on the personal preferences of the researchers. The justification for multiproduct studies is to achieve a higher degree of precision than single product studies. As indicated above, however, studies fall on a continuum: both single product and multiproduct studies aggregate unlike outputs.

We believe that there are serious practical limits to expanding the number of additional output items in multiproduct studies. Interaction terms need to be specified for all outputs with the translog form, so the functional form can become unmanageable. Furthermore, as Berger, Hanweck, and Humphrey (1987, p. 508) indicate, large numbers of interaction terms in relatively small sample studies often result in highly collinear data which may make estimates of the contribution of one variable difficult to interpret.[6]

An alternative to expanding the range of output items is to consider total assets as the best available proxy for total output and specify a somewhat more manageable functional form. This is the approach taken in this paper. The use of a single product model specification, coupled with observations for over 2000 institutions, avoids extreme multicollinearity that results from inclusion of many variables that vary with size and interaction terms based on these same variables. We use one variable to represent the principal factor—size—which leads cost to vary from one institution to another; we include the major factors affecting cost for a given size institution as control variables.[7] Thus, we control for differences in product mix, which satisfies the major criticism of the single product approach. (Because outputs with different cost are aggregated, however, not all differences in product mix are considered specifically.)

With a large sample (resulting in a large degree of variation within the sample) and the model specification adopted here, the resulting estimates should be more precise than those based on smaller sample, multiproduct models. This approach has the additional advantage of allowing the inclusion of a large number of other factors that affect total cost that are not included in most other studies.

Recent studies have indicated that a single product approach is empirically valid. For example, Clark (1984) and Hunter and Timme (1986) conduct sensitivity tests using total earning assets, total loans, total deposits, total loans and investments, and total deposits plus total loans. Both studies find the results to be unaffected by the choice of the output measure. In addition, Lawrence (1989, p. 377) concludes that "one product models with no cross-product terms appear to capture the data adequately."

## ESTIMATION METHOD AND DATA

We use the translog cost function to estimate scale economies.[8] The notation is as follows:

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[6] Functional cost data, which have been used extensively for banks, are not available for thrifts in adequate size sample. Because cost data for thrifts are available only in aggregate form, a similar dependent variable (aggregate output) is used in this study.

[7] The institutions represented here vary in size from $10 million to over $5 billion in total assets, so the major factor causing differences in aggregate cost would be size.

[8] This is the major functional form used in scale economy studies. See Brown, Caves, and Christensen (1979), Christensen and Greene (1976), Benston *et al.* (1982, 1983), Gilligan and Smirlock (1984), and Goldstein, McNulty, and Verbrugge (1987) for discussions and applications of this approach. Limitations of this approach are discussed in LeCompte and Smith (1990).

TC = Total operating costs for the institution, both including and excluding interest cost;
Q = Total output of the institution;
B = Number of offices operated by the institution; and
$X_j$ = Vector of other factors affecting operating costs.

The translog cost model is expressed as:[9]

$$(1)\ \ln TC = \beta_0 + \beta_q \ln Q + \beta_{qq} 1/2(\ln Q)^2 + \beta_b \ln B + \beta_{bb} 1/2(\ln B)^2 + \beta_{bq}(\ln B)(\ln Q) + \Sigma_j \beta_j \ln X_j + \varepsilon$$

The data used in the study are from the Federal Home Loan Bank Board (FHLBB, now the Office of Thrift Supervision) financial reports for the period 1986 to 1989. The data are derived from balance sheet and income statements submitted to the FHLBB by all federally insured thrift institutions.

All FSLIC-insured associations with over $10 million in assets and positive capital according to Generally Accepted Accounting Principles (GAAP) at the end of 1989 are included in the data set. The last year for which we had data available is 1989. The data from previous years are included to check the consistency of the results over time. The asset sizes range from $10 million to more than $5 billion. The sample size is 2,285 firms for each year.

The total operating costs (TC) for each association are defined as expenditures on personnel, office occupancy, all other operating expenses, plus all interest expenses. Output (Q) is defined as total assets of the individual association. The output homogeneity variables used in estimation should capture the major effects of variability in output mix on operating costs. Mester (1987) and LeCompte and Smith (1990) include both interest and operating cost in the definition of total cost. Earlier studies, such as Goldstein, McNulty, and Verbrugge (1987), focus only on operating cost. Following the intermediation approach, we include both interest and operating cost. We also ran the regressions excluding interest cost to see if there were a bias in earlier studies that exclude interest cost. Because large firms tend to substitute purchased funds for core deposits, there is likely to be a bias toward showing scale economies if only operating costs are included. By comparing the two sets of elasticities—one including and one excluding interest cost—we can show the magnitude of this bias, if it exists.

The variable B is defined as the number of offices operated by the individual association. The other factors reflect differences in product mix. The vector of other factors ($X_j$) influencing operating costs (each measured in dollar volume) and the hypothesized signs (shown in parenthesis) are as follows:[10]

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[9] Because not all possible interaction effects are considered, this equation can be considered as a modified translog.

[10] The expected signs reflect the fact that asset size is an explanatory variable in the regressions. For example, liquidity would be expected to reduce costs because liquid assets are less costly than mortgages, at a given asset size. In other words, because we already are controlling for asset size, the regression coefficient measures the impact of substituting one asset for another and keeping total asset size constant.

- Cash and investments (INV) are included because investment in these assets is less labor intensive than investment in residential mortgages;
- Mortgage loans serviced for others (SERFO) and mortgage loans services by others (SERBY) also affect costs. Loans serviced for others results in extra operating costs (+), while loans serviced by others reduce cost for a given level of assets (-);
- Loans other than mortgages (OTH) and investment in service corporations (SERV) represent diversification from normal lines of business. These items are likely to be more costly (+);
- Deposit composition, defined as NOW accounts and passbook and money market accounts (SAV), is included because NOW accounts and money market accounts (SAV) require more servicing and are therefore more labor intensive (+);
- Borrowed funds (BOR) are included because they require less non-interest operating expense than a corresponding amount of retail deposits (-). The expected sign is negative in the non-interest expense equation; when interest and non-interest expense are combined, the expected sign is positive;
- The average cost of funds (ACF) is defined as the average rate paid during the year by each institution on deposits and other borrowing. This variable accounts for the effect of varying liability maturity structures and competitive factors in different markets (+). The price of labor is employee expense divided by average total deposits. The price of capital is defined as occupancy expense divided by average total deposits.[11];
- Finally, we include a dummy variable (SM) for form of organization, stock versus mutual (stock = 1, mutual = 0). The stock-mutual dummy variable reflects the possibility of expense preference behavior, which Verbrugge and Goldstein (1981) suggest can be expected to be stronger at mutuals. The argument is that management is not responsible to a group of shareholders, so it has less incentive to keep expenses under control (-).

While this single product approach is useful for estimation purposes, especially to confirm the results of other studies, there are several limitations and points of clarification that require attention. In this model, some of the control variables are actually output or product mix variables, e.g., NOW, passbook, and money market accounts, loan servicing, and other loans. Thus, we do consider multiple outputs just like the studies reviewed above. Because these are control variables, however, we do not include them as interaction terms or in squared terms in order to keep the functional form manageable. The only variables with squared and interaction terms are the number of branches (B) and the level of output (Q), for we consider these to be the major factors affecting cost. This treatment makes the equation a modified translog. In a pure translog equation, all variables would be included in squared or interaction terms. The likely consequences of this single product approach applied to a large sample are less multicollinearity and more precise estimates than would otherwise be the case.

We also use an aggregate output measure that includes some things that other authors have considered as separate outputs. Some of these are produced at low cost per dollar of assets (e.g., cash and investments), and some are produced at high cost per unit

[11] The definitions of input prices are similar to those used in Mester (1987) and LeCompte and Smith (1990).

(commercial loans). We take product mix into account through the vector of control variables. Nonetheless, the problem of aggregating unlike outputs still exists for this study.

## EMPIRICAL RESULTS

We estimate the translog function, as shown in equation (1) for each of the four years 1986 to 1989. The coefficients from the equations are reported in the appendix. In the text, we focus primary attention on the elasticities derived from the regression rather than on the coefficients because in the translog equation many of the coefficients have no meaning taken alone. What matters are the partial derivatives of cost with respect to output, which are the elasticity measures in equations (2) and (3). The measure of scale economies, i.e., the percentage change in total operating costs associated with a percentage change in output, can be calculated from equation (1). Following Benston, Hanweck, and Humphrey (1982), this measure of scale economies, SCE, at the plant (branch) level, is:

$$(2)\ SCE = \frac{\partial \ln C}{\partial \ln Q}$$

$$= \beta_q + \beta_{qq}\ln Q + \beta_{bq}\ln B$$

This equation follows from the fact that partial derivatives of logarithmic equations represent percent changes. If the percent change in cost is less than the percent change in output, average cost declines as output increases, an indication that economies of scale exist. We also define an augmented scale economy measure, SCE*, that represents economies at the firm (bank) level. This measure, outlined in detail in Benston, Hanweck, and Humphrey (1982), takes account of both branch and output expansion:

$$(3)\ SCE^* = SCE + SCB(Z),$$

where:

SCE = The scale economies measure as shown in equation (2);
SCB = A measure of office economies;

$$(4)\ \frac{\partial \ln C}{\partial \ln Q} = \beta_b + \beta_{bb}\ln B + \beta_{bq}\ln Q$$

where:

Z = Regression coefficient from the auxiliary regression:

$$(5)\ \ln B = Y + Z(\ln Q).$$

SCE* thus measures the elasticity of cost with respect to output after accounting for the amount of branch expansion that accompanies a given amount of output expansion (as measured by the auxiliary regression). The first term of equation (3) thus measures the percent increase in cost from expanding output with a fixed number of branches; the second term measures the percent increase in cost from adding enough branches to produce the additional output. The number of branches that need to be added is measured by the auxiliary regression. SCE* always will be greater than SCE because of the cost of adding branches. The auxiliary regression has no effect on the estimation of the translog function; its only purpose is to determine the typical value of B for a given Q (which is needed to calculate the elasticities).

Scale economies estimates (SCE) at the plant (branch) level are presented in Table 1. SCE values are shown for the average association in each of eight size classes for each year in the sample period. The results shown in Panel A are those in which interest costs are included in the definition of operating costs and the average cost of funds is included as an independent variable. For each year most of the elasticities are in the .90 to .97 range. The exception is the larger institutions, for which the results vary considerably depending on the year. For comparison purposes, interest costs are dropped from the results reported in Panel B of Table 1. The resulting SCE values are slightly lower for every asset size group (incorrectly indicating greater economies of scale), strongly confirming that a bias exists when interest costs are excluded.

The SCE* measure represents economies at the firm (bank) level. As shown in Panel A of Table 2, total cost SCE* estimates are almost all above .94. These are the most comprehensive estimates of the four panels because they include both interest and non-interest expense and they reflect the cost of additional branches. As McNulty (1981) has indicated, elasticities in this range indicate that expansion will produce little cost savings.[12] These results suggest that while scale economies exist, thrift regulators and managers who expect *meaningful* reductions in per unit costs as a result of mergers will be disappointed. In other words, these results suggest that meaningful economies of scale do not exist in the thrift industry, even at low output levels.[13] As is true for the results shown in Table 1, the addition of interest cost (as dictated by use of the intermediation approach) does matter—the elasticities in Panel B are uniformly less than those in Panel A. The results are consistent with the results of Mester (1987) and LeCompte and Smith (1990) who report approximately constant returns to scale in this industry.[14] The estimated elasticities (Panel A, Table 2) are similar to those of LeCompte and Smith (1990). The findings are also consistent with studies of commercial banks such as Benston, Hanweck, and Humphrey (1982) and Berger, Hanweck, and Humphrey (1987). For example, Berger, Hanweck, and Humphrey (1987, p. 519) find that "banks of all sizes

[12] For example, consider a typical $100 million thrift with $2 million in operating expense and a total cost elasticity of .95. If output doubles, costs increase 95 percent to $3.9 million. The ratio of operating cost to assets falls from 2.0 percent to 1.95 percent, a savings of only five basis points. If the elasticity were .97, the savings would be only three basis points.

[13] The focus here is economies of scale rather than returns to scale because factor proportions change as scale changes.

[14] The term returns to scale applies to the situation in which there are equiproportionate changes in all inputs. In the present approach, assuming that firms minimize cost, inputs vary in the optimal way as output expands. This is characterized as economies of scale.

**Table 1—Savings Institution Scale Economy Estimates (SCE) by Size Class and by Year**

| Total Assets ($ millions) | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|
| Panel A: Total costs defined to include interest costs (total cost SCEs) | | | | |
| 10 - 25 | 0.942 | 0.933 | 0.908 | 0.961 |
| 25 - 50 | 0.932 | 0.927 | 0.915 | 0.970 |
| 50 - 100 | 0.925 | 0.923 | 0.919 | 0.975 |
| 100 - 250 | 0.918 | 0.919 | 0.923 | 0.979 |
| 250 - 500 | 0.911 | 0.915 | 0.927 | 0.983 |
| 500 - 1000 | 0.905 | 0.912 | 0.929 | 0.986 |
| 1000 - 5000 | 0.895 | 0.906 | 0.934 | 0.993 |
| ≥ 5000 | 0.880 | 0.896 | 0.943 | 1.004* |
| Panel B: Operating costs defined to exclude interest costs (operating cost SCEs) | | | | |
| 10 - 25 | 0.881 | 0.863 | 0.860 | 0.930 |
| 25 - 50 | 0.876 | 0.866 | 0.865 | 0.942 |
| 50 - 100 | 0.872 | 0.867 | 0.866 | 0.947 |
| 100 - 250 | 0.868 | 0.866 | 0.866 | 0.948 |
| 250 - 500 | 0.863 | 0.865 | 0.865 | 0.947 |
| 500 - 1000 | 0.859 | 0.864 | 0.863 | 0.947 |
| 1000 - 5000 | 0.854 | 0.864 | 0.863 | 0.950 |
| ≥ 5000 | 0.844 | 0.865 | 0.864 | 0.957 |

All elasticities are significantly different from one, except as indicated

*Not significantly different from 1

This table shows estimates of the elasticity of the following equation with respect to lnQ:

(1) $\ln TC = \beta_0 + \beta_q \ln Q + \beta_{qq} 1/2(\ln Q)^2 + \beta_b \ln B + \beta_{bb} 1/2(\ln B)^2 + \beta_{bq}(\ln B)(\ln Q) + \Sigma_j \beta_j \ln X_j + \varepsilon$

where:

TC = Total operating costs for the institution, both including and excluding interest cost;
Q = Total output of the institution;
B = Number of offices operated by the institution; and
$X_j$ = Vector of other factors affecting operating costs.

The data are Federal Home Loan Bank Board (FHLBB, now Office of Thrift Supervision) financial reports for the period 1986 to 1989. The data are derived from balance sheets and income statements submitted to the FHLBB by all federally insured thrift institutions. All 2,285 FSLIC-insured associations with over $10 million in total assets and positive GAAP capital at the end of 1989 are included in the data set

Significance is tested by computing elasticities for each institution and testing these using the hypothesis that the elasticity is equal to one

in branching states are within one to three percent of minimum cost". The results for non-interest expense are also consistent with the Goldstein, McNulty, and Verbrugge (1987) study that examines the pre-1980 thrift environment.

## CONCLUSIONS AND IMPLICATIONS

We investigate scale economies in the thrift industry using a database consisting of all FSLIC-insured thrifts for the period 1986 to 1989. We conclude that scale economies exist, because most of the elasticity estimates are significantly less than one. These economies are slight, however, when interest cost is included in total cost and the cost of adding branches is considered. For all practical purposes, the industry is reasonably close

**Table 2—Savings Institution Augmented Scale Economy Estimates (SCE*) by Size Class and by Year**

| Total Assets ($ millions) | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|
| Panel A: Total costs defined to include interest costs (total cost SCE*s) | | | | |
| 10 - 25 | 0.957 | 0.952 | 0.936 | 0.984 |
| 25 - 50 | 0.952 | 0.949 | 0.940 | 0.987 |
| 50 - 100 | 0.950 | 0.948 | 0.943 | 0.990 |
| 100 - 250 | 0.948 | 0.946 | 0.946 | 0.993 |
| 250 - 500 | 0.946 | 0.945 | 0.949 | 0.996 |
| 500 - 1000 | 0.944 | 0.944 | 0.952 | 0.999 |
| 1000 - 5000 | 0.940 | 0.942 | 0.957 | 1.003 |
| ≥ 5000 | 0.934 | 0.938 | 0.964 | 1.010 |
| Panel B: Operating costs defined to exclude interest costs (operating cost SCE*s) | | | | |
| 10 - 25 | 0.915 | 0.897 | 0.892 | 0.968 |
| 25 - 50 | 0.911 | 0.897 | 0.893 | 0.970 |
| 50 - 100 | 0.910 | 0.898 | 0.894 | 0.972 |
| 100 - 250 | 0.908 | 0.899 | 0.896 | 0.976 |
| 250 - 500 | 0.906 | 0.901 | 0.897 | 0.977 |
| 500 -1000 | 0.905 | 0.902 | 0.900 | 0.979 |
| 1000 - 5000 | 0.902 | 0.903 | 0.901 | 0.982 |
| ≥ 5000 | 0.898 | 0.906 | 0.904 | 0.987 |

All elasticities are significantly different from one, except as indicated. (The elasticity estimate of .999 for 500-1000, total cost, 1989 was verified as significant)

This table shows estimates of the elasticity of the following equation with respect to lnQ:

$$(1)\ \ln TC = \beta_0 + \beta_q \ln Q + \beta_{qq} 1/2(\ln Q)^2 + \beta_b \ln B + \beta_{bb} 1/2(\ln B)^2 + \beta_{bq}(\ln B)(\ln Q) + \Sigma_j \beta_j \ln X_j + \varepsilon$$

where:

- TC = Total operating costs for the institution, both including and excluding interest cost;
- Q = Total output of the institution;
- B = Number of offices operated by the institution; and
- $X_j$ = Vector of other factors affecting operating costs.

These elasticity estimates reflect an augmented measure where the amount of branch expansion which typically accompanies a given amount of output expansion is reflected in total cost

The data are described in Table 1

to constant average cost for most output ranges. The results confirm the general conclusions of Mester (1987) and LeCompte and Smith (1990) for earlier periods based on multiproduct studies and geographically restricted samples. This suggests that both types of studies provide insight, as one type of study can be used to check and confirm the results of the other. We also conclude that researchers pursuing scale economies studies should be aware of the potential bias in ignoring interest costs as part of total operating costs. This bias was confirmed in 64 of 64 cases.

The results suggest that thrift regulators and managers who look for substantial cost savings in mergers and acquisitions are likely to be disappointed. There is little evidence of meaningful cost savings as output is increased.

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## APPENDIX—TRANSLOG COST FUNCTION PARAMETER ESTIMATES

### Table A1—Non-Interest Cost Equations, 1986 to 1989

| | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|
| $\beta_0$ | -4.4032 | -3.6336 | -2.3507 | -2.0478 |
| | (0.306) | (0.336) | (0.263) | (0.248) |
| $\beta_Q$ | 1.1169 | 1.0490 | 0.7811 | 0.7873 |
| | (0.057) | (0.063) | (0.048) | (0.045) |
| $\beta_B$ | -0.0884 | -0.0584 | 0.1452 | 0.1851 |
| | (0.044) | (0.069) | (0.053) | (0.049) |
| $\beta_{QQ}$ | -0.0180 | -0.0119 | 0.0131 | 0.0178 |
| | (0.005) | (0.006) | (0.004) | (0.004) |
| $\beta_{BB}$ | -0.0038 | -0.0052 | 0.0104 | 0.0174 |
| | (0.001) | (0.009) | (0.008) | (0.007) |
| $\beta_{BQ}$ | 0.0112 | 0.0086 | -0.0110 | -0.0159 |
| | (0.004) | (0.007) | (0.005) | (0.005) |
| $\beta_{SAV}$ | 0.0315 | 0.0296 | 0.0380 | -0.0128 |
| | (0.005) | (0.005) | (0.004) | (0.004) |
| SERFO | 0.0011 | 0.0006 | 0.0011 | 0.0009 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $\beta_{SERBY}$ | 0.0007 | 0.0008 | 0.0005 | 0.0009 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $\beta_{OTH}$ | 0.0040 | 0.0040 | 0.0014 | 0.0047 |
| | (0.001) | (0.001) | (0.001) | (0.001) |
| $\beta_{BOR}$ | -0.0000 | -0.0008 | -0.0007 | 0.0000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $\beta_{SERV}$ | 0.0004 | 0.0004 | 0.0005 | 0.0007 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $\beta_{SM}$ | -0.0017 | 0.0011 | -0.0152 | -0.0081 |
| | (0.005) | (0.004) | (0.004) | (0.004) |
| $\beta_{ACF}$ | 0.9139 | 0.8541 | 0.9581 | 0.8594 |
| | (0.023) | (0.032) | (0.029) | (0.027) |
| $\beta_{WAGE}$ | 0.0549 | 0.0789 | 0.0744 | 0.0706 |
| | (0.007) | (0.007) | (0.007) | (0.007) |
| $\beta_{PCAP}$ | 0.0372 | 0.0541 | 0.0684 | 0.0796 |
| | (0.006) | (0.006) | (0.006) | (0.005) |
| $\beta_{INV}$ | 0.0009 | -0.0008 | -0.0065 | -0.0009 |
| | (0.003) | (0.003) | (0.003) | (0.003) |
| N | 2285 | 2285 | 2285 | 2285 |

The numbers in parenthesis are the standard errors of the regression coefficients. The data are described in Table I

## Table A2—Total Cost Equations, 1986 to 1989

| | 1986 | 1987 | 1988 | 1989 |
|---|---|---|---|---|
| $\beta_0$ | -1.1275 | 0.7585 | 0.8299 | 1.9556 |
| | (0.609) | (0.588) | (0.476) | (0.506) |
| $\beta_Q$ | 0.9548 | 0.7920 | 0.7499 | 0.6608 |
| | (0.114) | (0.110) | (0.088) | (0.093) |
| $\beta_B$ | 0.0230 | 0.1452 | 0.1952 | 0.3814 |
| | (0.877) | (0.120) | (0.096) | (0.099) |
| $\beta_{QQ}$ | -0.0076 | 0.0074 | 0.0114 | 0.0279 |
| | (0.010) | (0.010) | (0.008) | (0.008) |
| $\beta_{BB}$ | 0.0029 | 0.0173 | 0.0255 | 0.0467 |
| | (0.003) | (0.017) | (0.014) | (0.014) |
| $\beta_{BQ}$ | 0.0023 | -0.0104 | -0.0157 | -0.0341 |
| | (0.008) | (0.012) | (0.009) | (0.010) |
| $\beta_{SAV}$ | 0.0548 | 0.0515 | 0.0555 | -0.0204 |
| | (0.010) | (0.008) | (0.008) | (0.008) |
| $\beta_{SERFO}$ | 0.0027 | 0.0015 | 0.0018 | 0.0011 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $\beta_{SERBY}$ | 0.0010 | 0.0009 | 0.0008 | 0.0014 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $\beta_{OTH}$ | 0.0036 | 0.0051 | 0.0032 | 0.0043 |
| | (0.002) | (0.002) | (0.002) | (0.002) |
| $\beta_{BOR}$ | -0.0004 | -0.0014 | -0.0022 | -0.0017 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $\beta_{SERV}$ | 0.0006 | 0.0011 | 0.0009 | 0.0014 |
| | (0.001) | (0.000) | (0.000) | (0.000) |
| $\beta_{SM}$ | 0.0435 | 0.0445 | 0.0321 | 0.0358 |
| | (0.009) | (0.008) | (0.008) | (0.008) |
| $\beta_{ACF}$ | 0.2208 | -0.0596 | 0.0914 | -0.0809 |
| | (0.047) | (0.056) | (0.053) | (0.056) |
| $\beta_{WAGE}$ | 0.3916 | 0.4548 | 0.4603 | 0.4805 |
| | (0.014) | (0.013) | (0.013) | (0.013) |
| $\beta_{PCAP}$ | 0.1851 | 0.1994 | 0.2186 | 0.2297 |
| | (0.012) | (0.010) | (0.010) | (0.110) |
| $\beta_{INV}$ | -0.0121 | -0.0121 | -0.0170 | -0.0072 |
| | (0.007) | (0.005) | (0.005) | (0.006) |
| N | 2285 | 2285 | 2285 | 2285 |

The numbers in parenthesis are the standard errors of the regression coefficients. The data are described in Table 1