Further Evidence on Economies of Scale and Scope in Commercial Banking

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Abstract

The present study uses FCA data and the translog cost model to estimate economies of scale and scope for U.S. commercial banks for the years 1981, 1983, and 1985. In contrast to most bank cost studies, evidence is found that cost curves were downward sloping in these years. Moreover, the largest banks tended to have the greatest scale economies, which implies that large banks have an operating cost advantage compared to smaller banks. Tests for scope economies for different output combinations generally indicate jointness in production. Comparing the current results to those of other studies using different proxies for the price of capital, an important implication of the findings is that translog results for scale economies may be sensitive to the choice of input price proxies. Consequently, further work is recommended in the area of input price measurement in the banking industry.

Introduction

Deregulation of interest rates, asset powers, and geographic constraints have intensified the level of competition in the commercial banking industry. These changes in the competitive environment have spurred an increase in banking mergers and acquisitions, many of which are occurring across state lines. An important question is whether this consolidation process will proceed to such an extent that the banking industry eventually will become relatively concentrated, as in other industrialized countries?

Crucial to answering this question is the cost economies of producing banking services. In this regard, numerous studies (Benston, Hanweck, and Humphrey, 1982; Benston, Berger, Hanweck, and Humphrey, 1983; Gilligan and

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Smirlock, 1984; Gilligan, Smirlock, and Marshall, 1984; Kolari and Zardkoohi, 1987; Berger, Hanweck, and Humphrey, 1987; Rangan, Zardkoohi, Kolari, and Fraser, 1989)[1] have examined the cost characteristics of the banking industry using the translog cost model developed by Christensen, Jorgenson, and Lau (1973). In general, these studies have found that bank cost curves are either U-shaped or flat. This evidence is consistent for the most part with many earlier bank cost studies (e.g., see Benston, 1964, 1965; Bell and Murphy, 1967, 1969; Kalish and Gilbert, 1973; Longbrake and Haslem, 1975; Powers, 1969) using the Cobb-Douglas method of estimating cost functions. Thus, researchers have concluded that large banks do not have inherent operating cost advantages relative to smaller banks.

Extending Hunter and Timme (1986) using a comparable cost model with data for banks of various sizes rather than only for large banks, the present study finds that cost curves were downward sloping in the U.S. banking industry in the early 1980s. Based on functional cost analysis (FCA)[2] data for the years 1981, 1983, and 1985, increasing scale economies are found as banks expand output, which sharply contrasts with previous bank cost studies using the translog cost model. This means that the cost per unit output of increasing output was lower for large banking institutions relative to smaller banks. In regard to large bank operating costs, both Hunter and Timme and Noulas, Ray, and Miller (1990) have reported evidence of scale economies for billion dollar banks. Because these authors used a proxy for the price of capital that was identical or similar to the proxy used here while other studies used a dummy variable, office rental rate capital price proxy, it is inferred that translog cost results may be sensitive to the selection of input price proxies. Consequently, further study concerning measurement of bank input prices is recommended.

[1]For an excellent survey of this literature, see Clark (1988).

[2]FCA data are collected by the Federal Reserve from member banks that voluntarily submit detailed cost information. The data are unique, as noninterest expenses are allocated to specific output categories. Although there has been some concern that participating banks are not representative of the banking population due to the exclusion of billion dollar banks, it generally is recognized that this potential sampling problem is more than offset by the reliability of data.

Empirical Method

Measuring Bank Outputs and Costs

In general, banks produce intermediation services by channeling deposits into investment. Little agreement among academicians exists beyond this rather simplistic view of banking practice. According to Fama (1980), banks produce deposit services in their fundamental role as an accounting system of exchange and purveyor of portfolio services. A contradictory point of view by Sealey and Lindley (1977) is that bank deposits are an input (instead of an output) in their role as a source of loanable funds. These differing viewpoints on the nature of bank output are not surprising in light of the lack of consensus in the literature on the theory of a bank as a firm (e.g., see Baltensperger, 1980). Consequently, the present authors opt to take the common textbook approach of viewing the banking firm as a vertically integrated production process in which deposits (and other liabilities) are produced in the first stage. The outputs of the first stage then are used as inputs in the second stage to produce loans. The cost structures of these two stages are examined separately as well as simultaneously in the present paper.

Translog Cost Model

The translog cost function is used to obtain estimates of economies of scale and scope. Because the derivation of the translog cost function is intractable from corresponding translog production functions, it is obtained as a log-linear quadratic approximation and restrictions are added that are consistent with duality conditions. Given Q_i outputs and P_m input prices, the general form of the translog cost function is:

$$
\begin{aligned}
(1)\quad \ln C = {} & \alpha_0 + \sum_m \alpha_m \ln P_m + \sum_i \beta_i \ln Q_i + \\
& 1/2 \sum_m \sum_n \sigma_{mn} \ln P_m \ln P_n + 1/2 \sum_i \sum_j \theta_{ij} \ln Q_i \ln Q_j + \\
& \sum_m \sum_i \gamma_{mi} \ln P_m \ln Q_i + \lambda_1 \ln B + 1/2 \lambda_{11} (\ln B)^2 \\
& + \sum_i \omega_{1i} \ln B \ln Q_i + \rho_1 \ln A + 1/2 \rho_{11} (\ln A)^2 + \sum_i \tau_{1i} \ln A \ln Q_i,
\end{aligned}
$$

where:

C = the costs of producing outputs;
B = the number of full service and limited service banking offices; and
A = the weighted average dollar size of accounts.

The number of banking offices is included as a control variable because previous studies have found that bank costs are affected by the branching status of the bank and/or state branching regulations. The cost function is linearly homogeneous in prices, i.e.,

$$\sum_m \partial \ln C / \partial \ln P_m = 1,$$

such that the following restrictions on the cost function parameters must hold:

$$\sum_m \alpha_m = 1; \sum_m \gamma_{mi} = 0; \text{ and } \sum_m \sigma_{mn} = 0.$$

Furthermore, by symmetry $\gamma_{mi} = \gamma_{im}$ and $\theta_{ij} = \theta_{ji}$.

When output is measured in terms of number of accounts, C is calculated as the total noninterest expenses allocated to the outputs. Also, the weighted average dollar size of accounts was included as a control variable. When output is measured in terms of dollars, C is the sum of total noninterest costs allocated to outputs plus total interest costs.[3] Moreover, the last three terms on the right side of equation (1) relating to the average account size are dropped.

Three translog cost models are estimated with different outputs:

- Model I—real estate mortgage loans, installment loans, and commercial and other loans;
- Model II—demand deposits and time deposits; and

[3]Berger *et al.* (1987) have observed that bank output can be measured using either a production approach or intermediation approach. The former focuses on the number of physical units of service produced, while the latter is concerned with the intermediation of deposits into investment in dollar terms by the bank. In the present study both approaches are employed; however, the results are similar.

- Model III—real estate mortgage loans, installment loans, commercial and other loans, demand deposits, and time deposits.[4]

These models provide coverage of stage one's acquisition of funds, stage two's investment of funds in loans, as well as the combined tasks of acquisition and administration of loanable funds.

Two input prices are included in equation (1) that adjust for differences in labor and capital costs across banks in the samples. Like prior bank cost studies, the price of labor is estimated as the average wage rate for bank employees. Moreover, following Hunter and Timme (1986, p. 158), the price of capital is proxied by the ratio of total expenses allocated for furniture, equipment, and bank premises to the book value of these items less depreciation reserves. This measure is a plausible proxy for the depreciation rate of physical bank capital; however, it may be biased to the extent that differences exist between book and market values of physical capital and book values are not associated with market values among sample banks.[5]

Numerous authors have found that an optimal estimation procedure is to estimate jointly the translog cost function and the associated cost share equations as a multivariate regression system.[6] The cost function was estimated both with and without share equations. The former method improved statistical results. The empirical results reported here are based on the share equation approach.

Because the cost equation has two factor prices and the sum of the cost shares must add to unity, one of the cost share equations was dropped and equation (1) was estimated simultaneously with the other factor share equation. The share equation was derived by partially differentiating the translog cost function (1) with respect to P_m. That is,

[4]When measuring output in terms of numbers of accounts, the average dollar size of accounts and interaction terms for both deposits and loans are included in model III.

[5]Many bank cost studies have used the rental cost per square foot of bank and office buildings in nine regions of the United States to measure the price of capital. Dummy variables are used in equation (1) to reflect these nine regions. While it would have been instructive to test the sensitivity of the results to the use of rental cost, the state codes on the FCA tapes were suppressed by the Federal Reserve in order to protect the identity of participants. For this reason, the rental cost proxy could not be calculated. In defense of the Hunter and Timme proxy used in the present study, the price of capital is allowed to vary across banks, allowing for differences among individual banks in the samples.

[6]Share equations increase the number of degrees of freedom. For example, see Christensen and Green (1976).

$$(2)\quad \partial \ln C/\partial \ln P_m = \frac{P_m}{C} \cdot \frac{\partial C}{\partial P_m}.$$

Adopting Shephard's (1953) lemma,

$\partial C/\partial P_m = X_m$,

where X_m is the amount of the ith input employed such that equation (2) can be expressed as

$$(3)\quad S_m \equiv \frac{P_m X_m}{C},$$

with S_m representing the cost share of the mth input or

$$S_m = \alpha_m + \sum_n \sigma_{mn} \ln P_n + \sum_i \gamma_{mi} \ln Q_i.$$

The cost function and the cost share equation are estimated jointly using Zellner's iterative procedure (i.e., seemingly unrelated regression, SUR).

Economies of Scale and Scope

Equation (1) explicitly recognizes that banks produce more than one product. Accordingly, the conventional one output average cost curve cannot be estimated unless all bank products are lumped together into a single index. Because aggregation of all products into a single index ignores differences in product attributes, Baumol (1977) has suggested that bank outputs be considered as a bundle or a composite commodity containing given units of each product. This approach assumes that if one product in the bundle increases by some percentage, the remaining products increase by the same percentage.

Economies of scale in a multiproduct firm occur when the ray average cost of the composite output increases. Ray average cost can be defined as:

$RAC = C(kQ_i)/k$,

where:

C = total cost;
Q_i = a vector of outputs, or the unit bundle for a particular mix of outputs $(Q_1, \ldots, Q_n)$; and
k = the number of units in the bundle such that $Q = kQ_i$.

Economies of scale are said to exist if $C(kQ_i)/k < C(tQ_i)/t$ for $k > t$.

Economies of scale are obtained as the sum of the individual cost elasticities (Brown, Caves, and Christensen, 1979; Bothwell and Cooley, 1979) or $\Sigma(\partial \ln C/\partial \ln Q_i)$. If this sum is less than, equal to, or greater than one, then there are increasing, constant, or decreasing returns to scale, respectively. To infer the shape of the cost curve, scale estimates for different ranges of output are needed. Using FCA data, the present study's sample sizes for the deposit size ranges listed below are:[7]

Deposit Size	1981	1983	1985
$0 million to $25 million	81	63	60
$25 million to $50 million	193	132	119
$50 million to $100 million	189	182	168
$100 million to $200 million	114	164	150
$200 million to $400 million	45	78	75
$400 million & over	40	69	62

It should be recognized that a declining ray average cost does not necessarily imply natural monopoly in a multiproduct industry. Even though a multiproduct firm may benefit from economies of scale, it may produce multiple products at a higher ray average cost than a group of firms producing the same products

[7]The deposit size distribution of FCA banks in the samples for 1981, 1983, and 1985 were compared with the bank population as a whole, as proxied by insured banks on the Call Report tapes distributed by NTIS. On average, comparing the FCA sample distribution versus the population (in parentheses) distribution based on Call Report data, yields:
$0 million to $25 million--10 percent (5 percent),
$25 million to $50 million--23 percent (47 percent),
$50 million to $100 million--27 percent (25 percent),
$100 million to $200 million--21 percent (15 percent),
$200 million to $400 million--10 percent (6 percent), and
$400 million and over--8 percent (2 percent).
This comparison indicates that FCA data have higher proportionate samples in the smallest deposit category as well as the largest deposit category relative to the Call Report data. Also, the $25-50 million size range is underrepresented in the FCA data on a proportionate basis. From these comparisons, it can be concluded that the FCA data are not necessarily biased toward small banks and that they are a representative of the population of banks.

separately. In this regard, a sufficient condition for the existence of natural monopoly in a multiproduct industry is for the production technology to be subadditive.[8]

As the concept of subadditivity is not easily amenable to empirical analysis, an alternative condition to test for the existence of natural monopoly is the simultaneous existence of economies of scale and scope. Economies of scope (or jointness) in production imply that the marginal cost of producing one product depends on the quantity of other product(s) produced by the firm. Jointness exists when an increase in the output level of one product reduces the marginal cost of producing the other product(s). The main source of jointness is the sharing of inputs among products of the firm. Alternatively, a production technology may be nonjoint if simultaneous production of multiple products leads to either no gains or greater costs compared to producing each product separately by different firms.

In order to test whether jointness can be rejected, a nonlinear restriction for nonjointness is imposed on the joint cost function, where the outputs are normalized by their respective means. For example, the nonlinear restriction can be imposed on the translog function shown in equation (1) is

$\beta_i \cdot \beta_j = -\theta_{ij}$ for all i, j unless i = j

where:

β's = coefficients of the outputs; and
θ_{ij} = coefficient of the interaction between the corresponding outputs.

The log-likelihood test can be stated as:

(4) $\log_e \lambda(\chi) = n/2(\log[SSE(H_0)/SSE]$,

where:

$SSE(H_0)$ = the sum of squared errors for the constrained model; and
SSE = the sum of squared errors for the unrestricted model.

[8]A production technology is subadditive if a single firm's production of the composite output $Q_i = (Q_1, \ldots, Q_n)$ is less costly than production of Q_i using any allocation of Q_i among any number of firms, *ceteris paribus*.

For a large n, it has been shown that 2 $\log_e \lambda(\chi)$ is approximately χ^2 (chi-square with one degree of freedom).[9]

Empirical Results

Tables 1, 2, and 3 contain the results of estimating the three translog cost models using both dollars and numbers of accounts for the years 1981, 1983, and 1985. The R^2 values range between 0.83 and 0.94 and indicate strong goodness of fit for all cost models. The t-statistics (shown in parentheses) associated with the estimated parameters indicate that many of the coefficients are significant.[10] Comparing the alternative use of dollars and numbers of accounts, statistically significant coefficients had the same sign and approximate magnitude in most instances. These results suggest that the estimation of cost functions is not sensitive to the denomination of output.[11]

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[9]Another way to test for jointness is to calculate the magnitude of scope economies (or diseconomies) and then examine whether the scope economies are significantly different from zero. Willig (1979) has suggested that the degree of scope economies between two products can be measured as follows:

$$(5)\quad SC = \frac{[C(Q_1,0) + C(0,Q_2) - C(Q_1,Q_2)]}{C(Q_1,Q_2)}$$

Because the translog cost function cannot be estimated when any output is zero, previous researchers arbitrarily have set output close to zero (e.g., .001) to predict $C(Q_1,0)$ and $C(0,Q_2)$. Some authors (e.g., Benston, Berger, Hanweck, and Humphrey, 1983; Kolari and Zardkoohi, 1987) have found that SC is large due to resultant extrapolation beyond the range of the data. Other authors (e.g., Gilligan and Smirlock, 1984; Gilligan, Smirlock, and Marshall, 1984) appear to obtain reasonable results but nonetheless relegate scope findings to a footnote. Due to apparent problems inherent in this technique for measuring scope economies and their secondary purpose in the present paper, tests for nonjointness are confined to equation (4).

[10]Although the coefficients on the output variables generally are not significant, their squared and interaction terms normally are highly significant, with the exception of model III. The lack of significance of output coefficients can be explained for the most part by collinearity with the respective nonlinear terms.

[11]Tests for constant returns to scale indicated that the translog model better fit the data using dollars as opposed to numbers of accounts to measure output. When using dollars, all models and years (except model III in 1985) yielded test statistics that implied nonconstant returns to scale. For number of accounts, however, nonconstant returns to scale were found for only model II in 1981.

Table 4 shows the scale estimates derived from the bank cost functions. The t-statistics are normally significant, which implies that they are different from one. In general, the results suggest that commercial banks have downward sloping long-run average cost curves. Little variation from this general cost curve shape is evident across different models. Results for years 1981 and 1985 are similar to one another and, contrary to past studies, indicate increasing scale economies as output increases. No clear trend in scale economies as output increases is evident from the 1983 results. It is not known why the 1983 results differ from those in 1981 and 1985. Apparently, changes in exogeneous conditions in the banking industry that may be attributable to economic and regulatory factors are responsible.

These scale findings stand in sharp contrast to other bank cost studies that use FCA data. Studies by Benston, Hanweck, and Humphrey (1982) and Gilligan, Smirlock, and Marshall (1984) used FCA data in the latter part of the 1970s in a translog model with the price of capital measured as the rental cost per square foot of office space in nine regions of the U.S. These studies generally found U-shaped cost curves with minimum cost levels in the range of $25 million to $100 million in deposits. Kolari and Zardkoohi (1987) employed FCA data from the latter 1970s and early 1980s in a translog model with the price of capital proxied by the interest rate on Treasury securities held by banks (as an opportunity cost). They reported U-shaped, flat, and L-shaped cost curves, but no instances of declining cost curves throughout the entire range of output examined. Unlike these studies using a similar data source and econometric technique, the present study finds downward sloping cost curves.

In explaining the divergence of the current findings from those of prior studies, it is important to keep in mind that a different proxy for the price of capital is used. Hunter and Timme's depreciation rate for physical capital is employed to proxy the price of capital. In this regard, based on pooled 1972-1982 Call Report data, Hunter and Timme also reported evidence of scale economies for large banks. They obtained average scale estimates using noninterest costs of 0.80 for one bank holding companies (OBHCs) and 0.84 for multibank holding companies (MBHCs). Using total costs, average scale estimates were 1.05 and 0.97 for OBHCs and MBHCs, respectively. The current scale estimates for banks with deposits in excess of $400 million varied from 0.70 to 0.96, with most of the estimates in the range of 0.70 to 0.80. Unfortunately, Hunter and Timme did not attempt to estimate scale economies for banks of different size and, in turn, make inferences concerning the shape of the cost curve.

It should be recognized that the average bank size in Hunter and Timme's study exceeded that of the largest bank size category in the present paper. Their results apply to large holding companies with asset sizes in excess of $1 billion of assets, while the current large bank results include both nonaffiliated and affiliated banks with assets in the range of $400 million to $1 billion in general. Although the results are comparable to Hunter and Timme's estimates for larger banks, which may be interpreted to mean that scale estimates do not drop further beyond $1 billion of assets, further evidence for billion dollar banks is needed before reliable inferences can be made.

A recently published study by Noulas, Ray, and Miller (1990) focusing on scale economies among billion dollar banks also has found scale economies among banks with assets between $1 billion and $3 billion (while mild diseconomies were found for banks with assets between $3 billion and $6 billion). A translog model was estimated based on 1986 Call Reports for 330 billion dollar banks. The average cost of premises and fixed assets was employed as a proxy for the price of capital. This price is similar, but not identical, to that used by both Hunter and Timme and the present study in which these items are divided by their book value less depreciation reserves.

Taken as a whole, these comparisons to previous bank cost literature imply that the translog model may be sensitive to input price measurement. Recent studies, including the present work, that have proxied the price of capital using bank accounting data obtain greater scale economies at high output levels than reported by earlier studies using a dummy variable, office rental rate. In view of these differences, further work is recommended in order to gain insight into the potential influence of different proxies for various input prices on translog-based estimates of scale economies in the banking industry.

Last, scope economies were tested using the nonjointness test shown in equation (4). As discussed above, the existence of scale economies is not sufficient to infer natural monopoly. A sufficient condition for natural monopoly is to have both economies of scale and economies of scope. As shown in Table 5, chi-square tests for nonjointness for all possible combinations of outputs for each cost model and year in all cases generally failed to accept the null hypothesis of nonjointness. In combination with the scale findings, these results imply that natural monopoly conditions may exist in the banking industry.

Conclusions and Implications

The main conclusion to be drawn from these empirical findings is that, based on a variety of cost models estimated for the years 1981, 1983, and 1985 using FCA data, cost curves in the banking industry were downward sloping. Scale economies tended to increase as bank size increased. Also, jointness in the production of different combinations of outputs generally was found. Thus, natural monopoly conditions may exist in the banking industry.

The scale findings of this study contrast sharply with prior bank cost studies that generally find flat or U-shaped cost curves. Only Hunter and Timme and Noulas *et al.* have reported evidence of scale economies for large banks. Because a proxy was used for the price of capital that was identical or similar to these authors, it seems reasonable to infer that the current results diverged from those of most other studies, with the exceptions of Hunter and Timme and Noulas *et al.*, due to this different proxy. Thus, an important implication of this study is that further research is needed concerning the sensitivity of translog cost model results to different proxies for input prices and the appropriateness of such proxies.

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Table 1
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Loans, Installment Loans, and Commercial and Other Loans
1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
α_0	-5.61	-1.77	4.91	-13.95	6.66	6.98
	(-1.72)*	(-0.52)	(2.94)***	(-4.05)***	(1.59)	(2.46)**
α_1	0.14	-0.23	-0.09	0.00	-0.32	-0.23
	(1.04)	(-1.57)	(-0.76)	(0.04)	(-2.66)***	(-2.21)**
α_2	0.86	1.23	1.09	1.00	1.32	1.23
	(6.31)***	(8.49)***	(8.98)***	(8.89)***	(10.85)***	(11.62)***
β_1	0.13	0.08	-0.07	-0.23	0.58	0.21
	(0.48)	(0.34)	(-0.30)	(-0.88)	(1.81)*	(0.62)
β_2	-0.12	0.77	0.32	0.85	0.66	-0.24
	(-0.39)	(2.19)**	(0.89)	(2.41)**	(1.45)	(-0.50)
β_3	1.10	0.11	-0.20	1.20	-0.06	0.11
	(4.98)***	(0.54)	(-0.76)	(4.69)***	(-0.21)	(0.32)
σ_{11}	0.06	0.08	0.06	0.06	0.08	0.06
	(7.29)***	(8.90)***	(7.76)***	(7.27)***	(8.64)***	(7.88)***
σ_{22}	0.06	0.08	0.06	0.06	0.08	0.06
	(7.29)***	(8.90)***	(7.76)***	(7.27)***	(8.64)***	(7.88)***
σ_{12}	-0.06	-0.08	-0.06	-0.06	-0.08	-0.06
	(-7.29)***	(-8.90)***	(-7.76)***	(-7.27)***	(-8.64)***	(-7.88)***
θ_{11}	0.06	0.08	0.07	-0.00	0.05	0.02
	(4.36)***	(6.22)***	(4.71)***	(-0.01)	(3.42)***	(1.34)
θ_{22}	0.10	0.05	-0.00	0.14	0.10	0.14
	(5.08)***	(1.69)*	(-0.10)	(7.37)***	(2.89)***	(5.61)***
θ_{33}	0.05	0.10	0.13	0.05	0.05	0.08
	(4.08)***	(13.55)***	(8.64)***	(4.04)***	(5.72)***	(4.89)***
θ_{12}	-0.03	-0.05	-0.01	-0.01	-0.06	-0.04
	(-1.51)	(-3.26)***	(-0.46)	(-0.59)	(-3.39)***	(-2.31)**
θ_{13}	-0.04	-0.03	-0.05	0.00	-0.03	-0.02
	(-3.16)***	(-3.18)***	(-3.91)***	(0.20)	(-2.64)***	(-1.38)
θ_{23}	-0.04	-0.03	-0.01	-0.08	0.00	-0.03
	(-2.81)***	(-2.49)**	(-0.69)	(-4.97)***	(-0.13)	(-1.74)*

Table 1 (continued)
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Loans, Installment Loans, and Commercial and Other Loans
1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
γ_{11}	0.00	0.01	0.01	0.00	0.01	0.01
	(0.40)	(2.52)••	(1.78)•	(0.25)	(2.56)•••	(1.76)•
γ_{12}	0.00	0.00	0.02	-0.00	-0.01	0.01
	(0.06)	(0.25)	(2.39)••	(-0.33)	(-0.70)	(0.65)
γ_{13}	-0.02	-0.03	-0.04	-0.02	-0.02	0.01
	(-3.11)•••	(-5.61)•••	(-5.83)•••	(-3.11)••	(-3.65)•••	(-2.68)•••
γ_{21}	-0.00	-0.01	-0.01	-0.00	-0.01	-0.01
	(-0.40)	(-2.52)••	(-1.78)•	(-0.25)	(-2.56)••	(-1.76)•
γ_{22}	-0.00	-0.00	-0.02	0.00	0.01	-0.01
	(-0.06)	(-0.25)	(-2.39)••	(0.33)	(0.70)	(-0.65)
γ_{23}	0.02	0.03	0.04	0.02	0.02	0.02
	(3.11)•••	(5.61)•••	(5.83)•••	(3.11)•••	(3.65)•••	(2.68)•••
λ_1	0.62	-0.21	1.55	0.32	0.02	0.39
	(1.77)•	(-0.68)	(4.89)•••	(1.77)•	(0.13)	(1.51)
λ_{11}	0.12	0.00	0.19	0.13	0.02	0.13
	(3.57)•••	(0.19)	(4.42)•••	(3.30)•••	(0.97)	(2.58)••
ω_{11}	-0.02	0.00	-0.01	-0.00	0.05	0.05
	(-1.35)	(0.25)	(-0.39)	(-0.01)	(3.63)•••	(1.69)•
ω_{12}	-0.02	0.05	0.03	-0.07	-0.02	-0.07
	(-0.71)	(2.27)••	(0.83)	(-2.82)•••	(-0.86)	(-1.99)••
ω_{13}	-0.00	-0.04	-0.12	0.02	-0.03	-0.03
	(-0.03)	(-2.51)••	(-5.20)•••	(1.36)	(-1.70•*	(-1.26)
ρ_1				2.63	-0.85	-0.08
				(4.85)•••	(-1.18)	(-0.25)
ρ_{11}				-0.13	0.20	0.04
				(-2.79)•••	(2.83)•••	(2.56)••
τ_{11}				0.03	-0.05	0.00
				(1.12)	(-1.53)	(0.07)
τ_{12}				-0.07	-0.03	0.02
				(-1.95)•	(-0.81)	(0.57)

Table 1 (continued)
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Loans, Installment Loans, and Commercial and Other Loans 1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
τ_{13}				-0.06 (-2.86)***	0.04 (1.85)*	0.03 (0.95)
R^2	.88	.88	.84	.88	.88	.83

[a] Asterisks indicate significance at the following levels: .01—***, .05—**, and .10—*

Table 2
Estimates of Multiproduct Cost Functions for Demand Deposits and Time Deposits: 1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
α_0	-4.78	5.10	3.13	12.47	9.61	2.25
	(-1.23)	(1.41)	(2.10)*	(3.04)**	(2.46)*	(0.74)
α_1	0.41	0.33	0.54	0.23	0.06	0.37
	(3.69)***	(3.10)**	(5.70)***	(2.55)*	(0.63)	(4.40)***
α_2	0.59	0.67	0.46	0.77	0.94	0.63
	(5.33)***	(6.16)***	(4.89)***	(*.32)***	(10.36)***	(7.42)***
β_1	1.78	-0.64	-0.14	-0.51	-0.61	-0.02
	(5.12)***	(-2.15)*	(-0.40)	(-0.89)	(-1.34)	(-0.05)
β_2	-0.93	0.28	-0.17	0.02	0.87	0.09
	(-2.28)*	(0.76)	(-0.58)	(0.04)	(2.17)*	(0.19)
σ_{11}	0.05	0.05	0.03	0.05	0.06	0.03
	(6.62)***	(7.21)***	(5.35)***	(6.94)***	(8.75)***	(4.37)***
σ_{22}	0.05	0.05	0.03	0.05	0.06	0.03
	(6.62)***	(7.21)***	(5.35)***	(6.94)***	(8.75)***	(4.37)***
σ_{12}	-0.05	-0.05	-0.03	-0.05	-0.06	-0.03
	(-6.62)***	(-7.21)***	(-5.35)***	(-6.94)***	(-8.75)***	(-4.37)***
θ_{11}	0.06	0.16	0.07	0.15	0.21	0.14
	(2.92)**	(8.84)***	(3.04)**	(3.62)***	(5.58)***	(14.38)***
θ_{22}	0.19	0.10	0.07	0.19	0.09	0.12
	(6.64)***	(3.68)***	(2.36)*	(3.73)***	(2.59)**	(3.00)**
θ_{12}	-0.12	-0.09	-0.02	-0.16	-0.12	-0.08
	(-6.15)***	(-4.96)***	(-1.35)	(-4.20)***	(-3.89)***	(-4.34)***
γ_{11}	-0.01	0.00	-0.00	-0.02	0.01	0.00
	(-2.09)*	(0.64)	(-0.40)	(-1.60)	(0.76)	(0.35)
γ_{12}	-0.01	-0.02	-0.02	-0.00	-0.02	-0.01
	(-0.98)	(-4.44)***	(-3.14)**	(-0.53)	(-3.53)***	(-2.87)**
γ_{21}	0.01	-0.00	0.00	0.02	-0.01	-0.00
	(2.09)*	(-0.64)	(0.40)	(1.60)	(-0.76)	(-0.35)
γ_{22}	0.01	0.02	0.02	0.00	0.02	0.01
	(0.98	(4.44)***	(3.14)**	(0.53)	(3.53)***	(2.87)**

Table 2 (continued)
Estimates of Multiproduct Cost Functions for Demand Deposits and Time Deposits: 1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
λ_1	0.84	0.94	2.39	0.87	0.50	1.25
	(2.18)*	(3.22)**	(8.50)***	(3.27)**	(3.00)**	(3.88)***
λ_{11}	0.08	-0.01	0.19	0.16	0.00	0.16
	(2.39)*	(-0.60)	(5.50)***	(3.84)***	(0.09)	(3.42)***
ω_{11}	0.01	-0.05	-0.11	-0.05	-0.09	-0.07
	(0.28)	(-2.77)**	(-5.43)***	(-1.53)	(-3.21)**	(-3.41)***
ω_{12}	-0.05	0.00	-0.03	-0.04	0.04	-0.08
	(-1.86)	(0.16)	(-1.22)	(-1.27)	(1.57)	(-2.04)*
ρ_1				-1.53	-1.49	-0.09
				(-1.90)	(-1.95)	(-0.29)
ρ_{11}				0.04	0.19	0.07
				(0.48)	(2.14)*	(4.05)***
τ_{11}				0.20	0.08	0.02
				(3.39)***	(1.88)	(0.51)
τ_{12}				-0.02	-0.03	0.01
				(-0.29)	(-0.63)	(0.13)
R^2	.92	.92	.91	.92	.92	.91

[a] Asterisks indicate significance at the following levels: .01—***, .05—**, and .10—*

Table 3
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Mortgage Loans, Installment Loans, Commercial and Other Loans Demand Deposits, and Time Deposits: 1981, 1983, 1985[a]

	Output in Dollars			Output in Dollars of Accounts		
	of Accounts					
Coefs	1981	1983	1985	1981	1983	1985
α_0	-2.96	3.41	4.68	0.68	9.96	5.09
	(-0.85)	(0.85)	(3.20)•••	(0.17)	(1.92)•	(1.59)
α_1	0.15	-0.45	0.13	0.02	-0.36	-0.12
	(1.34)	(-2.46)••	(1.210	(0.16)	(-2.26)••	(-1.22)
α_2	0.85	1.45	0.87	0.98	1.36	1.12
	(7.53)•••	(7.91)•••	(8.36)•••	(10.36)•••	(8.57)•••	(11.52)•••
β_1	-0.17	0.48	0.39	0.00	0.34	0.29
	(-0.44)	(1.11)	(0.90)	(0.02)	(1.01)	(0.92)
β_2	0.09	0.96	-0.31	0.28	0.83	-0.94
	(0.21)	(2.27)••	(-0.71)	(0.62)	(1.45)	(-1.97)••
β_3	0.54	0.52	0.12	0.69	-0.13	0.07
	(1.66)•	(1.85)•	(0.29)	(2.66)•••	(-0.53)	(0.27)
β_4	1.12	-1.20	0.01	0.07	-0.72	2.22
	(2.06)••	(-2.36)••	(0.02)	(0.09)	(-0.81)	(2.76)•••
β_5	-0.69	-0.19	-0.27	0.05	0.70	-1.37
	(-1.10)	(-0.27)	(-0.46)	(0.07)	(0.92)	(-1.79)•
σ_{11}	0.07	0.11	0.05	0.06	0.10	0.05
	(9.81)•••	(9.61)•••	(7.80)•••	(8.93)•••	(8.38)•••	(8.01)•••
σ_{22}	0.07	0.11	0.05	0.06	0.10	0.05
	(9.81)•••	(9.61)•••	(7.80)•••	(8.93)•••	(8.38)•••	(8.01)•••
σ_{12}	-0.07	-0.11	-0.05	-0.06	-0.10	-0.05
	(9.81)•••	(-9.61)•••	(-7.80)•••	(-8.93)•••	(-8.38)•••	(-8.01)•••
θ_{11}	0.03	0.08	0.08	-0.01	0.05	-0.02
	(1.25)	(3.41)•••	(2.55)••	(-0.98)	(2.51)••	(-1.52)
θ_{22}	0.11	-0.04	0.00	0.05	-0.04	0.17
	(3.90)•••	(-1.22)	(0.16)	(1.50)	(-0.65)	(3.83)•••
θ_{33}	0.02	0.05	0.01	-0.00	0.00	0.00
	(1.35)	(4.01)•••	(0.58)	(-0.44)	(0.01)	(0.13)
θ_{44}	0.08	0.18	-0.16	0.03	0.14	0.14
	(1.70)•	(4.15)•••	(-3.24)•••	(0.47)	(1.74)•	(1.44)

Table 3 (continued)
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Mortgage Loans, Installment Loans, Commercial and Other Loans Demand Deposits, and Time Deposits: 1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
θ_{55}	-0.05	0.13	0.07	0.31	0.13	-0.04
	(-0.53)	(1.55)	(0.73)	(3.27)***	(1.62)	(-0.37)
γ_{24}	0.01	-0.02	0.00	0.02	0.01	0.02
	(1.06)	(-1.85)*	(-0.48)	(1.86)*	(0.70)	(1.15)
γ_{25}	-0.00	-0.00	0.01	-0.02	0.01	-0.03
	(-0.19)	(-0.28)	(1.15)	(-2.05)*	(0.40)	(-2.20)**
λ_1	0.75	-0.05	1.79	0.38	0.13	1.00
	(2.27)**	(-0.16)	(5.97)***	(1.62)	(0.70)	(3.30)***
λ_{11}	0.10	-0.01	0.19	0.13	0.01	0.18
	(3.51)***	(-0.42)	(4.81)***	(3.76)***	(0.80)	(4.00)***
ω_{11}	-0.01	-0.01	0.02	-0.02	0.03	0.02
	(-0.56)	(-0.58)	(0.85)	(-1.15)	(1.55)	(1.00)
ω_{12}	-0.03	0.01	-0.01	-0.06	-0.07	0.02
	(-1.47)	(0.30)	(-0.37)	(-2.06)**	(-2.32)**	(0.59)
ω_{13}	0.04	-0.01	-0.01	-0.00	-0.02	0.02
	(1.96)	(-0.79)	(-0.44)	(-0.17)	(-1.56)	(0.98)
ω_{14}	-0.02	-0.04	-0.09	0.01	0.01	-0.20
	(-0.67)	(-1.35)	(-2.15)**	(0.35)	(0.28)	(-4.25)***
ω_5	-0.02	0.06	-0.02	0.01	0.03	0.02
	(-0.58)	(1.86)*	(-0.63)	(0.24)	(0.96)	(0.49)
ρ_1				1.12	-0.55	-0.28
				(1.67)*	(-0.71)	(-0.37)
ρ_{11}				-0.01	0.13	0.01
				(-0.16)	(1.89)*	(0.18)
τ_{11}				-0.01	0.01	-0.04
				(-0.51)	(0.34)	(-1.40)
τ_{12}				-0.02	-0.07	0.09
				(-0.58)	(-1.72)*	(2.43)**
τ_{13}				-0.07	0.05	0.02
				(-2.70)***	(2.20)**	(0.72)

Table 3 (continued)
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Mortgage Loans, Installment Loans, Commercial and Other Loans Demand Deposits, and Time Deposits: 1981, 1983, 1985[a]

	Output in Dollars of Accounts			Output in Dollars of Accounts		
Coefs	1981	1983	1985	1981	1983	1985
ρ_2				-1.03	-0.87	0.39
				(-1.13)	(-0.74)	(0.52)
ρ_{22}				0.02	0.12	0.02
				(0.28)	(1.00)	(0.23)
θ_{12}	-0.04	-0.03	-0.02	-0.01	0.02	-0.10
	(-1.87)*	(-1.28)	(-0.93)	(-0.38)	(0.66)	(-3.98)***
θ_{13}	-0.01	0.03	0.04	0.03	-0.01	-0.00
	(-0.43)	(1.03)	(1.24)	(2.15)**	(-0.57)	(-0.14)
θ_{14}	-0.04	-0.02	-0.06	0.05	-0.03	0.07
	(-1.06)	(-0.50)	(-1.63)	(1.20)	(-0.83)	(1.48)
θ_{15}	0.08	-0.07	-0.06	-0.03	-0.06	0.05
	(1.55)	(-1.50)	(-0.97)	(-1.04)	(-1.58)	(1.31)
θ_{23}	0.02	0.02	0.03	-0.07	0.04	0.05
	(0.89)	(0.93)	(1.43)	(-2.68)***	(2.18)**	(2.37)**
θ_{24}	-0.09	-0.02	-0.02	0.06	0.01	-0.09
	(-2.74)***	(-0.77)	(-0.44)	(1.23)	(0.17)	(-1.51)
θ_{25}	0.01	0.03	0.02	-0.01	-0.00	0.02
	(0.32)	(0.69)	(0.55)	(-0.26)	(-0.02)	(0.44)
θ_{34}	-0.02	-0.03	0.11	0.08	-0.01	0.03
	(-0.79)	(-1.46)	(4.51)***	(2.30)**	(-0.59)	(1.08)
θ_{35}	-0.03	-0.06	-0.15	-0.02	-0.03	-0.08
	(-0.58)	(-1.42)	(-3.14)***	(-0.70)	(-1.21)	(-2.56)**
θ_{45}	0.03	-0.03	0.14	-0.25	-0.05	-0.04
	(0.59)	(-0.54)	(2.40)**	(-3.78)***	(-0.69)	(-0.46)
γ_{11}	-0.00	-0.01	0.01	-0.01	0.00	-0.01
	(-0.24)	(-0.76)	(1.23)	(-1.50)	(0.37)	(-0.76)
γ_{12}	0.00	-0.01	0.01	-0.00	0.01	-0.01
	(0.03)	(-0.55)	(1.34)	(-0.41)	(0.41)	(-0.71)
γ_{13}	-0.01	-0.03	-0.02	-0.01	-0.01	-0.00
	(-1.26)	(-3.33)***	(-3.02)***	(-1.85)*	(-0.86)	(-0.43)

Table 3 (continued)
Estimates of Multiproduct Cost Functions for Real Estate Mortgage Mortgage Loans, Installment Loans, Commercial and Other Loans Demand Deposits, and Time Deposits: 1981, 1983, 1985[a]

	Output in Dollars	of Accounts		Output in Dollars	of Accounts	
Coefs	1981	1983	1985	1981	1983	1985
γ_{14}	-0.01	0.02	0.00	-0.02	-0.01	-0.02
	(-1.06)	(1.85)*	(0.48)	(-1.86)*	(-0.70)	(-1.15)
γ_{15}	0.00	0.00	-0.01	0.02	-0.01	0.03
	(0.19)	(0.28)	(-1.15)	(2.05)**	(-0.40)	(2.20)**
γ_{21}	0.00	0.01	-0.01	0.01	-0.00	0.01
	(0.24)	(0.76)	(-1.23)	(1.50)	(-0.37)	(0.76)
γ_{22}	-0.00	0.01	-0.01	0.00	-0.01	0.01
	(-0.03)	(0.55)	(-1.34)	(0.41)	(-0.41)	(0.71)
γ_{23}	0.01	0.03	0.02	0.01	0.01	0.00
	(1.26)	(3.33)***	(3.02)***	(1.85)*	(0.86)	(0.43)
τ_{24}				0.19	0.10	-0.26
τ_{25}				-0.06	-0.09	0.21
				(-0.93)	(-1.18)	(3.06)***
R^2	.93	.93	.92	.94	.93	.92

[a] Asterisks indicate significance at the following levels: .01—***, .05—**, and .10—*

Table 4
Estimates of Scale Economies for the Bank Cost Models
1981, 1983, 1985[a]
(Bank Size in $ Millions Deposits)

	Model I Loans		Model II Deposits		Model III Loans and Deposits	
Bank Size	Dollars of Accts	Numbers of Accts	Dollars of Accts	Numbers of Accts	Dollars of Accts	Numbers of Accts
			1981			
0-25	.87***	.86***	.84***	.91***	.84***	.87***
25-50	.85***	.86***	.84***	.92***	.85***	.88***
50-100	.83***	.85***	.83***	.93***	.84***	.87***
100-200	.81***	.83***	.82***	.93***	.82***	.85***
200-400	.79***	.81***	.79***	.85***	.80***	.78***
≥ 400	.74***	.77***	.77***	.79***	.78***	.74***
			1983			
0-25	.86***	.91***	.75***	.90***	.83***	.94***
25-50	.88***	.89***	.82***	.94***	.87***	.92***
50-100	.88***	.88***	.86***	.96***	.88***	.91***
100-200	.90***	.89***	.89***	.97*	.89***	.91***
200-400	.89***	.87***	.91***	.97	.89***	.89***
≥ 400	.91***	.87***	.92***	.96	.91***	.87***
			1985			
0-25	.79***	.88***	.80***	.84***	.82***	.88***
25-50	.83***	.89***	.85***	.89***	.85***	.90***
50-100	.83***	.88***	.86***	.89***	.85***	.89***
100-200	.81***	.86***	.82***	.85***	.82***	.85***
200-400	.78***	.84***	.80***	.82***	.80***	.82***
≥ 400	.70***	.77***	.72***	.76***	.72***	.73***

[a] Asterisks indicate significance of the following levels: .01—***, .05—**, and .10—*

Table 5
Chi-Square Tests of Jointness for the Bank Cost Models
1981, 1983, 1985[a]

Year	Model I Loans Dollars of Accts	Model I Loans Numbers of Accts	Model II Deposits Dollars of Accts	Model II Deposits Numbers of Accts	Model III Loans and Deposits Dollars of Accts	Model III Loans and Deposits Numbers of Accts
1981	9.77***	5.96**	7.71***	3.41*	7.25***	5.17**
1983	9.96***	6.84***	9.50***	2.74*	3.89**	2.67
1985	2.47	3.41*	0.10	3.33*	6.31**	5.00**

[a] Asterisks indicate significance at the following levels: .01—***, .05—**, and .10—*