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Changes in the Cost of Intermediation: The Case of Savings and Loans

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ABSTRACT

The minimum cost output configuration for a firm may change as the result of a variety of factors, including changes in market structure. In this paper we test this structural change hypothesis with savings and loan data. We find support for the hypothesis that separable, constant returns to scale production functions characterize the average savings and loan in our sample in 1983. This is in contrast to the cost complementarities found in 1978. We argue that this result may be the result of regulatory changes that allowed savings and loans to alter their production mix to fully capture the benefits of joint production.

IT SEEMS REASONABLE TO assume that the cost minimizing configuration of a multiproduct firm is potentially subject to nonstationarity during periods of structural change in input and/or output markets. The late 1970s and early 1980s represent such a period of turbulence for many markets in the financial services industry. Volatile interest rates, combined with technological and regulatory changes, may have caused firms in this industry to alter their output mixes in an effort to capture cost complementarities from joint production. The purpose of this paper is to test this hypothesis of structural change in the savings and loan industry using both a translog and minflex Laurent translog (MLT) specification of the production function.

We have chosen to investigate savings and loans (S&Ls) during the late 1970s and early 1980s for two reasons. First, S&Ls provide an ideal vehicle for testing our hypothesis because they were restricted almost exclusively to mortgages and securities as outputs before the passage of the Depository Institutions Deregulation and Monetary Control Act of 1980 and the Garn-St. Germain Act of 1982. Moreover, there were also market changes with respect to both the pricing and mix of inputs (i.e., deposits). Our second rationale involves the fact that there is a large and growing body of literature in the area of what is now called the

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financial services industry.[1] This extensive background work allows us a point of reference from which to check the impact of other factors (e.g., choice of inputs, output definitions, statistical methodology, etc.) on our results.

The remainder of the paper has four sections. In Section I we consider issues in model specification. We specifically discuss the traditional translog cost equation (see, e.g., Murray and White (1983); Gilligan, Smirlock, and Marshall (1984); and Mester (1987)) and the minflex Laurent translog (see Barnett and Lee (1985)). Section II provides a brief discussion of data definitions and a rationale for the specific years used in the study (1978 and 1983). The results are contained in Section III and indicate that the S&L is faced with the traditional U-shaped cost curve. The finding of economies of scale for small S&Ls and diseconomies of scale for large S&Ls coincides with the findings of Gilligan, Smirlock, and Marshall (1984) and Benston, Hanweck, and Humphrey (1982) for commercial banks. Our results also suggest the presence of nonseparability in production during 1978. However, the results are quite different in 1983. We find, like Mester (1987), that the average S&L in our sample possesses a production technology that is essentially separable and displays constant returns to scale. Overall these results provide evidence against the hypothesis that the average S&L in our sample exhibits the same cost characteristics across competitive environments. Section IV provides a summary and some concluding remarks.

I. Models

The cost functions to be estimated in this study are derived from approximations to an arbitrary function of output quantities and input prices. The S&L is assumed to minimize costs subject to a given level of output, where costs are given by

$$C(Y_i, P_j) = f(Y_1, \cdots, Y_n; P_1, \cdots, P_m), \tag{1}$$

for n outputs and m inputs where Y_i is the output level and P_j is the input price. We assume that equation (1) is the unique dual of a general production transformation that has a strictly convex input structure (McFadden (1978)). The convex input structure is equivalent to the cost function, equation (1), being homogeneous of degree one, nondecreasing, and concave in input prices. For an empirical study, an explicit functional form of equation (1) is required. An acceptable cost function should contain a manageable number of unknown parameters to be estimated and be easily estimable. It should also be from the class of flexible functional forms in that it does not restrict the second-order properties of the cost structure being studied. Both the translog and the MLT meet these standards. Furthermore, their multiproduct design allows for the estimation of interproduct cost complementarities. The translog model, which is a second-order

[1] See Lawrence and Shay (1986), Mester (1987), and Hunter and Timme (1986) for recent contributions to this literature.

Taylor series expansion in output quantities and input prices, is given by[2]

$$\ln \text{total cost} = A_0 + \sum_j B_j \ln P_j + \sum_i C_i \ln Y_i + 1/2 \sum_i \sum_k D_{ik} \ln Y_i \ln Y_k + 1/2 \sum_j \sum_h E_{jh} \ln P_j \ln P_h + \sum_i \sum_j F_{ij} \ln Y_i \ln P_j, \quad i, k = 1, \cdots, n \quad \text{and} \quad j, h = 1, \cdots, m. \tag{2}$$

where total cost = total operating costs plus interest expenses; P_j = unit price of factor input j; Y_i = quantity of output i, measured by the dollar volume of i; and ln is the natural logarithm.

The translog function presented above has been, and continues to be, the major functional form employed when testing for scale and scope economies. However, the translog has a number of shortcomings. First, recent evidence indicates that the remainder term of the translog may be poorly behaved away from the point of approximation (see, e.g., Barnett and Lee (1985), Barnett (1983), Gallant (1981), Wales (1977), and Christensen and Caves (1980)). Essentially, this introduces heteroskedasticity in the error term, which biases the standard error estimates and causes the point estimates to be inefficient. Another criticism of the translog is that the approximation region may be "small".

For these reasons we also estimate the MLT model. To our knowledge, the only prior applications of the Laurent specification have been in the analysis of consumer demand systems by Barnett (1983) and manufacturing data by Diewert and Wales (1985).[3] The MLT is also a more general model and contains the translog as a special case.

The generalized Laurent specification is obtained by imposing certain parametric restrictions on a second-order Laurent series expansion of equation (1). The second-order expansion is given by

$$\begin{aligned} \ln \text{total cost} = {} & A_0 + \sum_j B_j \ln P_j + \sum_i C_i \ln Y_i + 1/2 \sum_i D_{ii} (\ln Y_i)^2 \\ & + 1/2 \sum_j E_{jj} (\ln P_j)^2 + 1/2 \sum\sum_{i \neq k} D_{ik}^2 \ln Y_i \ln Y_k \\ & + 1/2 \sum\sum_{j \neq h} E_{jh}^2 \ln P_j \ln P_h + \sum_i \sum_j F_{ij}^2 \ln Y_i \ln P_j \\ & - 1/2 \sum\sum_{i \neq k} G_{ik}^2 (\ln Y_i)^{-1} (\ln Y_k)^{-1} \\ & - 1/2 \sum\sum_{j \neq h} H_{jh}^2 (\ln P_j)^{-1} (\ln P_h)^{-1} \\ & - \sum_i \sum_j I_{ij}^2 (\ln Y_i)^{-1} (\ln P_j)^{-1}, \\ & i, k = 1, \cdots, n; \quad \text{and} \quad j, h = 1, \cdots, m. \end{aligned} \tag{3}$$

[2] We impose the standard homogeneity and symmetry conditions on equation (2). See Denny and Pinto (1978).

[3] Diewert and Wales (1985) actually use a generalized Laurent specification rather than the MLT.

The MLT is obtained by imposing the following constraints.[4]

$$D_{ik} * G_{ik} = 0, \quad E_{jh} * H_{jh} = 0, \quad F_{ij} * I_{ij} = 0, \quad \text{and} \quad D_{ik} = D_{ki}.$$

$$G_{ik} = G_{ki}, \quad E_{jh} = E_{hj}, \quad H_{jh} = H_{hj}.$$

Although the MLT is clearly a more general specification, both models allow for the investigation of scale economies and cost complementarities.

Economies of scale (EOS) measures are obtained by differentiating equations (2) and (3) with respect to all Y_i, where Γ is the proportional change in the production of all outputs of the firm. For the translog we have

$$EOS_T = \frac{d \ln TC}{\Gamma} = \sum_i \frac{\delta \ln TC}{\delta \ln Y_i}$$

$$= \sum_i C_i + \sum_i \sum_k D_{ik} \ln Y_k + \sum_i \sum_j F_{ij} \ln P_j. \tag{4}$$

The measure of economies of scale for the MLT, obtained by differentiating equation (3), is given by

$$EOS_M = \sum_i C_i + \sum_i \sum_k D_{ik}^2 (\ln Y_k) + \sum_i \sum_j F_{ij}^2 \ln P_j$$

$$- \sum_{i \neq k} \sum G_{ik}^2 (\ln Y_i)^{-2} (\ln Y_k)^{-1} - \sum_i \sum_j I_{ij}^2 (\ln Y_i)^{-2} (\ln P_j)^{-1}. \tag{5}$$

If EOS is greater (less) than one, the firm will experience diseconomies (economies) of scale. A value of EOS that is not significantly different from one indicates constant returns to scale.

Cost complementarity between different outputs can be measured with a condition derived by Baumol, Panzar, and Willig (1982). A sufficient condition for the existence of economies of scope in the production of outputs, Y_i and Y_k is

$$\frac{\delta^2 \ln TC}{\delta \ln Y_i \delta \ln Y_k} < 0, \qquad i \neq k; \quad i, k = 1, \cdots, n. \tag{6}$$

One test condition for this inequality (Denny and Pinto (1978)) is given by

$$C_i * C_k + D_{ik} < 0, \tag{7}$$

where the Y_i and Y_k output variables have been normalized about their sample means, and TC is the measure of total cost.[5] The results from these tests are discussed in Section III. The next section contains a description of the data and definitions of the variables used in the estimation procedure.

[4] See Barnett and Lee (1985) and Barnett (1983) for further details.

[5] Mester (1987) has argued that this approach provides a poor approximation when using OLS. However, our qualitative conclusions do not appear to be sensitive to this specification because our 1983 results are consistent with those obtained by Mester using a more general test statistic.

II. Data and Definitions

The data were taken from the semiannual reports of the S&Ls operating in the Ninth District of the Federal Home Loan Bank Board during the years 1978 and 1983. We chose to look at 1978 and 1983 because we wanted the earlier data to be relatively uncontaminated by market and/or regulatory changes. Although 1979 would have technically met this specification, we felt that by this time significant changes were taking place in financial markets and regulatory bodies. Moreover, 1983 is the first full year of operation after the bulk of regulatory changes were in place. The 431 S&Ls studied were in operation for the entire period; from the beginning of 1978 until the end of 1983. Table I reports descriptive statistics from these institutions that are located in Texas, Mississippi, Arkansas, New Mexico, and Louisiana.

A. Costs

Total cost (TC) is defined as operating plus interest expenses. Operating expenses are defined as labor and real capital payments, whereas total cost also includes interest payments. The estimation procedure utilizes a model of S&Ls having three outputs (mortgages, consumer loans, and investments) and three input prices (labor, capital, and interest expense).[6] Note that changes in the deposit mix have possibly changed both operating costs (e.g., start-up costs for new types of accounts) and input prices (through rate deregulation and brokered deposits). Both the operating cost and deposit input price measures (as well as total costs) reflect these changes in 1983. We also recognize that our cost and output measures are influenced by changes in the price level over this period. Therefore, the 1983 data are adjusted so that all the variables are measured in constant dollars with 1978 as the base year.

B. Output and Input Measures

We follow the arguments developed by Sealey and Lindley (1977) and use the dollar volume of earning assets as our measure of output. Moreover, deposits are defined as one of the factor inputs.[7] The outputs are broken down into three categories of earning assets. Y_1 is mortgage lending of all types (VA, FHA, and conventional). Y_2 is defined as consumer loans, which is one of the areas where S&Ls were allowed to expand their concentration of assets. Y_3 is classified as investments and includes the newly allowed commercial lending, as well as real estate investments and liquid investments such as treasury bills. Cash and other nonearning assets are excluded from all three categories. We utilized this rather unconventional breakdown in an effort to capture any cost dependencies between

[6] We also estimated a three-output, two-input model (excluding interest expenses). The results were similar to those reported.

[7] Our brevity in dealing with these measurement issues is not meant to suggest that questions concerning what is an appropriate definition of intermediary output have been answered. Space limitations preclude us from discussing these topics in more detail. See Berger, Hanweck, and Humphrey (1987) for an extended analysis of this issue.

Table I

Descriptive Variables for 431 S&Ls Operating in the Ninth District of the Federal Home Loan Bank Board during 1978 and 1983

Total cost is defined as operating costs (labor and capital payments) plus interest payments. Mortgages are the dollar holdings of all mortgages (VA, FHA, and conventional). Consumer loans are the dollar holdings of consumer loans. Investments include the dollar holdings of commercial loans and investment securities. The price of labor is the sum of total labor expenses divided by the dollar volume of transaction deposits. The price of capital is the sum of capital expenses (i.e., rent, office occupancy expense, utilities, depreciation, etc.) divided by the total fixed assets of the S&L. The price of deposits is the sum of dividend and interest charges divided by total deposits. Total earning assets are the total dollar volume of assets less cash and due from other institutions and fixed assets.

Variable	Minimum Value	Mean	Maximum Value
	Data for 1978[a]		
Total cost	$ 106,100	$ 5,199,900	$ 149,850,200
Mortgages	574,522	60,579,300	1,971,266,200
Consumer loans	6,972	2,889,400	113,971,100
Investments	147,848	5,984,700	227,003,200
Price of labor	0.0036	0.0095	0.0435
Price of capital	0.0355	0.3040	11.5516
Price of deposits	0.0392	0.0687	0.0855
Total earning assets	1,230,500	69,453,300	2,223,007,700
Number of offices	1	3.434	57
	Data for 1983[b]		
Total cost	$ 185,300	$ 11,844,400	$ 289,109,967
Mortgages	1,111,100	81,447,687	1,745,895,500
Consumer loans	5,192	6,515,700	143,591,200
Investments	1,792	13,518,000	777,679,400
Price of labor	0.0020	0.0090	0.0325
Price of capital	0.0307	0.4530	16.2686
Price of deposits	0.0505	0.0924	0.1665
Total earning assets	1,599,500	101,481,400	2,537,784,100
Number of offices	1	5.422	85

[a] In dollars, except for number of offices.
[b] In constant 1978 dollars, except for number of offices.

the major new lending areas (consumer and commercial), as well as those between mortgage lending and new lending instruments.

C. Input Prices

The three factor inputs we consider in this study are labor, fixed capital, and deposits. The price of labor, P_1, is defined as the sum of the total labor expenses divided by the dollar volume of transaction deposits. The unit cost of capital, P_2, is calculated by dividing the sum of capital expenses (i.e., rent, office occupancy expense, utilities, depreciation, etc.) by total fixed assets. Interest expense, P_3, is obtained by dividing the sum of dividend and interest charges by total deposits. Finally, we include a variable, the natural logarithm of the number of offices, to account for the possible impact of branching on the cost function.

III. Empirical Results

Table I presents descriptive statistics for the variables used in the empirical work. Although the percentage changes in the asset mix are not dramatic, we note that S&Ls moved, on average, from holding ≈10% of their assets in consumer loans and investments in 1978 to 20% in 1983. With few exceptions, the parameter estimates for the MLT and translog models have the expected influence on costs.[8]

Table IIA provides point estimates of the degree of scale economies by asset size and type of estimation.[9] The results for the translog model are obtained from simultaneously estimating a system of cost share equations and equation (2). The cost shares are derived by differentiating equation (2) with respect to each of the input prices (the *Pj*s) and employing Shephard's lemma. Results obtained from both the translog and MLT indicate the presence of a traditional U-shaped cost curve for these firms.

One notable difference in estimation results, however, involves the fact that MLT-based estimates possess higher standard errors than those obtained when using the translog.[10,11] Despite these differences, both models provide support for the result that one finds economies of scale for depository firms of less than $50 million in earning assets (or deposits—see Gilbert (1984)). The wider range of MLT estimates also provides evidence of significant diseconomies of scale for some of the largest institutions in the sample.

Table IIB provides our results concerning cost complementarity. The estimates for 1978 show that there were cost disadvantages associated with the joint production of consumer loans and investments (which includes commercial loans). Alternatively, mortgages displayed positive cost complementarity with both of these other asset categories. These results imply that a strategy of looking like a traditional commercial bank (i.e., focusing solely on investments, commercial lending, and consumer lending) provided significant cost disadvantages for savings and loans that attempted to follow this path in 1978. However, there were cost benefits to S&Ls that combined these functions with their traditional mortgage lending operation for which they had significant inputs in place (e.g., credit processing and collection procedures as well as the necessary equipment and human resources).

The complementarity estimates from 1983 are, however, quite different. We cannot reject the hypothesis that there were no cost complementarities present

[8] These results are available on request.

[9] Note that under the standard assumption of normality of the individual parameters, the exact standard erors can be calculated by using results for the products of correlated normal random variables (see Stevens 1971)).

[10] Two structural variables were also tested. One test showed the origin of charter, state or federal, to have no significant effect on costs. The other showed that the form of organization, stock or mutual, did exert a statistically significant influence on costs, with the stock form of organization being higher cost.

[11] Although the standard errors of the scale estimates for the MLT are larger then those for the translog, the standard errors for the cost complementarity estimates are roughly comparable. This apparent inconsistency results from the elimination of several "high" variance parameters in the derivation of the test conditions for measuring cost complementarity for both models.

Table II

Translog and MLT Cost Efficiency Measures for S&Ls in 1978 and 1983

The estimates of S&L scale economies and output cost complementarity are obtained from the translog and minflex Laurent translog cost functions for S&Ls operating in the Ninth District of the Federal Home Loan Bank Board for 1978 and 1983. The two cost functions estimated, the translog and minflex Laurent, are both derived from the second-order approximation of a general cost function relating the firms' output quantities and factor input prices (both in natural logarithms). The translog is derived from a second-order Taylor series expansion whereas the minflex Laurent is obtained by imposing certain parametric restrictions on a second-order Laurent expansion. Total cost, the dependent variable in both functional models tested, is defined as operating costs, labor, and fixed capital expenses plus interest payments. S&L output is defined as the total dollar value of earning assets and is divided into three categories for estimation purposes: mortgages, consumer loans, and investments. Mortgages are defined as the dollar value of all mortgages: VA, FHA, and conventional. Consumer loans are the dollar holdings of consumer loans, and investments are the dollar value of commercial loans and investment securities held by the firm. The factor input prices specified for the models are the expenses associated with labor, fixed capital, and the acquisition of deposits. The price of labor is the sum of total labor expenses divided by the dollar volume of transaction deposits, whereas the price of fixed capital is the sum of capital expenses, rent, office occupancy expense, utilities, depreciation, et cetera divided by the total fixed assets of the S&L. The price of acquiring and holding deposits is the sum of dividend and interest payments divided by total deposits.

Panel A

Economies of scale estimates classified by the dollar value of the S&Ls' total earning assets for the translog and the minflex Laurent translog are obtained by differentiating the cost functions with respect to all earning assets and summing these derivatives. Under the null hypothesis of no scale economies, the parameter values should equal unity. Economies of scale are represented by parameter values <1, whereas diseconomies of scale are obtained for parameter values >1.

Total Earning Assets (in millions)	1978			1983		
	Translog	Minflex	Firms	Translog	Minflex	Firms
$0–10	0.968[a]	0.819[a]	76	0.947[a]	0.916[a]	15
$10–25	0.974[a]	0.870[a]	113	0.956[a]	0.888[a]	72
$25–50	0.974[a]	0.932	99	0.969[a]	0.918[a]	102
$50–75	0.976[a]	0.976	56	0.973	0.935	52
$75–100	0.976	1.019	27	0.976	0.935	34
$100–200	0.982	1.032	39	0.975	0.954	77
$200–300	0.981	1.090	13	0.998	0.981	35
$300–400	0.979	1.157[a]	1	0.981	0.988	12
$400–1000	0.982	1.188[a]	6	1.000	1.027	25
Over $1000	0.981	1.218[a]	1	1.004	1.082[a]	7

Panel B

Interproduct (i.e., pair-wise) cost complementarity measures are obtained, for each output pair, by adding the cross-partial coefficient of the cost function (with respect to these outputs) to the product of the coefficients on the linear component of the series expansion in the outputs. Under the null hypothesis of no cost complementarity in the joint production of any output pair, the expected parameter value is zero. Cost complementarity is present (absent) in joint production when the pair-wise parameter is less than (greater than) zero.

	1978		1983	
	Translog	Minflex	Translog	Minflex
Mortgages and consumer loans	−0.320[b]	−0.170[b]	−0.0746	0.033
	(0.123)	(0.0604)	(0.0579)	(0.216)
Mortgages and investments	−1.489[b]	−0.731[b]	−0.092	−0.119
	(0.412)	(0.204)	(0.071)	(0.308)
Investments and consumer loans	0.338[b]	0.147[b]	−0.022	−0.032
	(0.117)	(0.025)	(0.016)	(0.020)

[a] Significantly different from 1 at the 5% significance level using a two-tailed test.

[b] Significantly different from 0 at the 5% significance level using a two-tailed test. Numbers in parentheses are standard errors.

for any of the output combinations in 1983 when using either estimation technique.[12,13] All of the estimates of cost complementarity are uniformly closer to zero, implying a more separable cost function. This implies that in this new environment a savings and loan could be chartered and find no cost disadvantages to looking like a commercial bank. Our data also suggest that the economies associated with the joint production of mortgages and other assets were fully exploited in 1983. Indeed, by combining these results with the economies of scale estimates discussed earlier, one cannot reject the hypothesis that, in 1983, the *average* S&L possessed a separable cost function with constant returns to scale. This is consistent with the results Mester (1987) obtained using 1982 California S&L data.

Our view is that these results are the result of the removal of regulatory restrictions on the output mix of the S&Ls in our sample. This hypothesis implies that the original nonseparabilities were the result of the constrained choice set facing these firms in 1978. However, we recognize that there are a number of alternative hypotheses (e.g., technological change, changes in ownership form, etc.) that could also be used to explain these changes. Additional empirical work will hopefully sharpen our understanding of this issue.

IV. Summary

This study has investigated the degree of scale and scope economies at savings and loan associations both before (1978) and after (1983) recent changes that have altered the structure of the financial services industry. In many respects our results are similar to those found by Murray and White (1983) for credit unions and Gilligan, Smirlock, and Marshall (1984) for commercial banks. In particular, economies of scale estimates indicate the traditional U-shaped cost curves. In addition, we find that although there were significant cost complementarities in the production process during 1978, they do not exist in the more unconstrained environment of 1983. We suggest that one cause of the original (1978) results may have been regulatory restrictions, rather than the natural cost complementarity of outputs when evaluated at their unconstrained optimal values.

The paper also employs a new estimation technique, the minflex Laurent translog, which corrects for certain empirical irregularities associated with the traditional translog specification. In contrast to the translog model, one cannot reject the hypothesis of constant returns to scale in either time period when using the MLT model. Moreover, the MLT specification, unlike the translog, shows significant diseconomies of scale for the largest firms in the sample.

Additional research efforts in this area are needed if we are to determine the public policy and managerial implications of market structure changes that alter the input and output configurations of multiproduct firms. For example, tests

[12] We do not calculate global economies of scope estimates because our interest is in the possibility of any pairs of cost complementarities between any pairs of outputs.

[13] This result is also invariant to the definition of costs. See footnote 6.

such as those contained in this paper could be applied to other industries that have experienced significant changes in market structure. An analysis of changes in the risk profiles of these firms would also be of interest because this factor may either augment or negate the production cost changes reported here.

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