PN-ABC-717

Intermediation Costs in an Agricultural Development Bank: A Cost-Function Approach to Measuring Scale Economies

Carlos E. Cuevas

The cost-output relationships and production technology in the Agricultural Development Bank of Honduras are analyzed using a translog model. Scale economies for the average branch are not significantly different from one. They are a function of output levels reflecting U-shaped cost surfaces. Product-specific economies of scale are substantially different. Returns to scale of lending activities approach unity, whereas there are important unexploited economies to the expansion of deposit mobilization. Cost complementarities between lending and deposit mobilization indicate advantages of joint provision of financial services over the traditional specialization in lending of agricultural development banks in developing countries.

Key words: agricultural development banks, financial intermediation costs, Honduras, scale economies, translog model.

Knowledge of the production technology of financial institutions is essential for analyzing market structure and institutional performance. Many regulatory and managerial decisions are based on specific assumptions about economies of scale and other features of the cost-output relationships in these institutions. Consequently, several recent studies have addressed the measurement of scale economies and cost complementarities in the production of financial services (Benston, Hanweck, and Humphrey; Hunter and Timme; Mullineaux; Murray and White; Panzar and Willig 1977). However, few attempts have been made to analyze these cost-output relationships in development banks operating in less developed countries.

Development banks function primarily as lending institutions intermediating government funds or lines of credit established by foreign agencies and providing limited deposit services, if any, to the rural clientele. The lack of empirical evidence regarding the cost-output relationships in these banks has so far prevented the assessment of their overall performance and the evaluation of their operational strategies that emphasize lending over deposit mobilization. Furthermore, considerable regulation exists in less developed countries regarding bank branching, bank size, and loan pricing. These regulations are formulated with imperfect knowledge, if any, of the production structure of financial institutions. In particular, government subsidization of development banks should consider the cost structure of these banks to determine the magnitude of the subsidy and the expected impact of the policy on output expansion. Thus, the knowledge of the production structure of financial institutions becomes essential to assess the likely consequences of financial policy.

Studies on development banks in less developed countries by Gheen and by Nyanin have provided limited insights into the cost structure and underlying technology of these institutions because of the choice of very restrictive functional forms for the cost function. In general, the use of Cobb-Douglas or constant elasticity of substitution (CES) specifications implies the adoption of highly restrictive assumptions about the technology utilized by financial intermediaries. Under these specifications, scale economies are forced to remain constant regardless of the level of out-

Carlos E. Cuevas is an assistant professor in the Department of Agricultural Economics and Rural Sociology, Ohio State University.

The author acknowledges helpful comments and suggestions from *Journal* reviewers.

Copyright 1988 American Agricultural Economics Association

Best Available Document

put. Thus, the corresponding average cost curves are either downward or upward sloping throughout the entire output domain.

In this article, a translog cost function is used to analyze the cost-output relationships and production technology of the Agricultural Development Bank of Honduras. Emphasis is placed on the measurement of scale economies and on the sensitivity of this measure to the choice of functional form and estimation procedure. This cost function approach also allows the assessment of cost complementarities (economies of scope) in the provision of banking services. In addition, estimates of the elasticity of factor substitution and the price elasticities of factor demands are based on the estimated parameters of the translog cost function (Binswanger; Christensen, Jorgenson, and Lau; Ray). The resulting empirical evidence allows the assessment of current operational practices of the development bank and the formulation of improved expansion strategies.

The following section presents the analytical model and its main properties. Subsequent sections discuss the data and estimation procedures and present the results of different estimation techniques. The final section summarizes the main findings and implications of the study.

A Translog Cost Function

The model formulation considers banks as firms which use inputs of real resources to produce financial services (e.g., bookkeeping, loan evaluations, and deposit transactions), given a certain technology. Under this approach, financial assets as well as bank liabilities are considered bank outputs to the extent that their production causes operating expenses. The treatment of deposits as a bank output is consistent with the "real resource model" approach to modeling the banking firm (Baltensperger), and it has been accepted practice in recent empirical work (Benston, Hanweck, and Humphrey; Benston et al.; Hunter and Timme). This approach is especially relevant to analyze bank specialization in lending versus multiservice operations in development banking.

Cost minimization subject to a production constraint yields a cost function that depends on output levels and factor prices. Development banks usually operate under objectives consistent with development policy goals. However, to the extent that cost levels are considered in evaluating a bank's performance, cost minimization is a plausible behavioral assumption for these institutions.

The translog cost function is essentially a second-order approximation to an arbitrary cost function. For two outputs and two inputs, the translog function is written as follows:

$$
\begin{aligned}
(1)\quad \ln C = {} & \alpha_0 + \alpha_1 \ln q_1 + \alpha_2 \ln q_2 + \beta_1 \ln p_1 \\
& + \beta_2 \ln p_2 + \tfrac{1}{2}\gamma_{11}(\ln q_1)^2 \\
& + \tfrac{1}{2}\gamma_{22}(\ln q_2)^2 + \gamma_{12} \ln q_1 \ln q_2 \\
& + \tfrac{1}{2}\delta_{11}(\ln p_1)^2 + \tfrac{1}{2}\delta_{22}(\ln p_2)^2 \\
& + \delta_{12} \ln p_1 \ln p_2 + \eta_{11} \ln q_1 \ln p_1 \\
& + \eta_{12} \ln q_1 \ln p_2 + \eta_{21} \ln q_2 \ln p_1 \\
& + \eta_{22} \ln q_2 \ln p_2 .
\end{aligned}
$$

where q_i is quantity of ith output with q_1 representing loans and q_2 representing deposits, and p_j is price of jth input with p_1 representing salaries and wages and p_2 representing the price of capital services.

The cost-share equations for the two inputs are derived from equation (1) as

$$
(2)\quad S_j = \beta_j + \Sigma_h \delta_{jh} \ln p_h + \Sigma_i \eta_{ij} \ln q_i, \qquad j, h = 1, 2, \quad i = 1, 2,
$$

where S_j denotes the cost share of input j.

Cost function (1) should be homogenous of degree one in input prices. This condition imposes a set of restrictions on the parameters of equation (1) that is also consistent with the requirement that the sum of the cost shares (2) must equal one:

$$
\Sigma_j \beta_j = 1,\ \Sigma_j \delta_{jh} = 0,\ \Sigma_j \eta_{ij} = 0, \qquad j, h = 1, 2, \quad i = 1, 2.
$$

Several properties of the cost structure and the underlying production function can be investigated using the translog cost function defined in equation (1). These properties are summarized as follows.

Overall economies of scale, ES, are defined as the percentage change in cost when all outputs increase by a common factor, λ. In equation (1), scale economies are measured as

$$
ES = \frac{\partial \ln C}{\partial \ln q_1} + \frac{\partial \ln C}{\partial \ln q_2};
$$

that is,

$$
\begin{aligned}
(3)\quad ES = {} & \alpha_1 + \alpha_2 + \gamma_{11} \ln q_1 + \gamma_{22} \ln q_2 \\
& + \gamma_{12}(\ln q_1 + \ln q_2) \\
& + (\eta_{11} + \eta_{21}) \ln p_1 \\
& + (\eta_{12} + \eta_{22}) \ln p_2 .
\end{aligned}
$$

Scale economies are a function of the output

levels, q_1 and q_2; therefore, the ES measure is not invariant to scale and is dependent on the output mix. If ES is less than 1, economies of scale exist since costs increase proportionately less than output. Values of ES equal to or greater than 1 imply constant returns or diseconomies of scale, respectively. Partial economies of scale, ES_i, and marginal costs of each output, MC_i, can be computed from equation (1) as

$$ES_i = \frac{\partial \ln C}{\partial \ln q_i}, \tag{4}$$

and

$$MC_i = \frac{C_i}{q_i}(ES_i),$$

where C_i is the proportion of total costs C attributed to output i. A discussion of the cost-attribution problem under joint production is found in Cuevas.

Cost complementarities (economies of scope) exist in multi-output production when the marginal cost of producing one output declines with increases in production of another output (Murray and White, Panzar and Willig 1981). In terms of the parameters of the cost function (1), Murray and White indicate that a necessary condition for cost complementarity between loans and deposits is

$$\gamma_{12} + \alpha_1\alpha_2 < 0. \tag{5}$$

For elasticity of substitution and elasticities of input demand, Uzawa has shown that the Allen partial elasticity of substitution between factors of production, σ_{jh}, can be written in terms of the (dual) cost function as

$$\sigma_{jh} = \left(\frac{\partial^2 \ln C}{\partial p_j \partial p_h} \Big/ \frac{\partial \ln C}{\partial p_j}\,\frac{\partial \ln C}{\partial p_h}\right) + 1. \tag{6}$$

In terms of the parameters of the translog cost function (1) and the factor shares (S_j), the Allen partial elasticities of substitution are computed as

$$\begin{aligned} \sigma_{jh} &= (\delta_{jh} + S_jS_h)/S_jS_h, \\ \sigma_{jj} &= (\delta_{jj} + S_j(S_j - 1))/S_j^2, \quad j, h = 1, 2. \end{aligned} \tag{7}$$

In addition, the price elasticities of demand for inputs, e_{jh}, are obtained using the estimated value of σ_{ij} and the factor shares (see Binswanger).

$$e_{jh} = \sigma_{jh}S_h,\ e_{jj} = \sigma_{jj}S_j, \qquad j, h = 1, 2. \tag{8}$$

It is clear from (7) that if all $\delta_{jh} = 0$, then the elasticities of substitution are independent of factor prices and equal to one for $j \neq h$. Furthermore, if all $\gamma_{ik} = 0$, $\delta_{jh} = 0$, and $\eta_{ij} = 0$, the cost function (1) reduces to a Cobb–Douglas-type cost function:

$$\ln C = \alpha_0 + \alpha_1 \ln q_1 + \alpha_2 \ln q_2 + \beta_1 \ln p_1 + \beta_2 \ln p_2, \tag{9}$$

with scale economies equal to $(\alpha_1 + \alpha_2)$ and unitary elasticity of substitution.

Data Sources and Estimation Procedures

Data utilized in this study come from twenty-eight branches of the Agricultural Development Bank of Honduras over the twelve-year period 1971–1982. For the most part these branches were independently managed under a set of rules and targets determined by the central office of the bank. Except for very large loans, which were handled directly by the central office, lending decisions occurred at the branch level. Similarly, branches acted independently in the servicing of deposits. All variables were expressed in real terms (lempiras of 1966 where 1 lempira equals 0.5 U.S. dollars) using the country's implicit GDP deflator. These variables are defined as follows:

(*a*) *Costs*. Total nonfinancial operating expenses net of depreciation and provisions for bad debt.

(*b*) *Outputs*. Total value of loans granted during the year (q_1) and total amount of deposit balances outstanding as of 31 December of each year (q_2). Output definition has been a matter of concern in cost studies of financial institutions. Recent research suggests that the scale of economies results are invariant to the definition of output (Benston, Hanwek, and Humphrey; Hunter and Timme). In this study, two other output definitions were used: (*i*) number of loans and number of deposit accounts and (*ii*) aggregate output (i.e., value of loans plus deposit balances). The scale economies estimates obtained with these alternative definitions were similar to those reported below (see Cuevas). However, the definition of q_1 as total value of loans and q_2 as total deposit balances provided consistently better fits than any of the alternative definitions. These results are presented in the following section.

(*c*) *Factor Prices*. The price of labor services (p_1) is measured as total personnel costs

including benefits and social security payments divided by the total number of employees. A unit price of capital services (p_2) is proxied by the ratio of depreciation plus rents paid over the total value of loans plus deposit balances. This ratio was considered an acceptable proxy for the price of capital, even though depreciation was based on historical accounting values of capital goods (thus was not included in the measurement of costs).

(*d*) *Loan size* (*LS*) *and deposit size* (*DS*). These variables are included in the model to account for the heterogeneity of loans and deposit transactions. Average loan size is measured as the total amount of loans granted during the year (q_1) divided by the number of loans. Average deposit size results from dividing outstanding balances by the number of deposit accounts. The variables are included in the cost function in interactive form with the output levels,

$$\theta_1 \ln q_1 \ln LS + \theta_2 \ln q_2 \ln DS.$$

Thus, both the scale-economies indicator and the marginal costs of production depend on the average size of loans and deposits.

Summary statistics of the data are reported in table 1. The translog cost function (1) is estimated as a single equation [by ordinary least squares (OLS)] and as a cost system with the cost share equations (2). Because cost shares must add to 1, one of these equations is redundant and thus is dropped from the system. The remaining equations, the cost function and the labor share equation, are seemingly unrelated. Hence, the estimation of this two-equation system utilizes a generalized least squares procedure. As shown later, aside from efficiency gains important differences may occur in the magnitude of the estimated parameters resulting from different estimation procedures. Thus, the scale economies measure (and other parameters) will differ depending on the estimation technique.

Table 1. Summary Statistics of Branch-Level Data for the Agricultural Development Bank of Honduras, 1971–82

Variable	Mean	Standard Deviation
Costs (lp. 000)	270.46	324.74
Loans, amount (lp. 000)	2,166.36	3,281.95
number of loans	2,085	2,022
Deposits, balances (lp. 000)	779.46	1,727.56
number of accounts	1,160	855
Price of labor (lempiras per man-month)	199.27	64.42
Price of capital (lempiras per thousand lempira of output)	3.09	3.89

Note: N = 292. See text for variable definitions. Values in constant lempiras of 1966 (1 lempira = 0.5 U.S. dollars).

Empirical Results

This section reports results of the estimation procedures. Their presentation highlights the importance of the choice of functional form and of estimation technique on the levels of the scale economies estimates, the effects on costs of loan size and deposit size, and the estimates of cost complementarities and elasticities.

Functional Form and Scale Economies

The measures of scale economies generated by the Cobb-Douglas functional form (9) underestimated the cost-increasing effects of output expansion, compared to the estimates obtained with the translog functional form. The translog form resulted in a significantly better fit over the Cobb-Douglas form, according to the F-ratios obtained when testing for equality of the two regressions. Furthermore, F-tests conducted on the parameters of the (unrestricted) system of equations formed by the cost function and the labor share equation rejected the hypothesis of a simplified (Cobb-Douglas-type) functional form (9) with unitary elasticity of substitution. Loan size and deposit size were not statistically significant in the Cobb-Douglas estimation; however, including these variables affected the estimated magnitude of economies of scale in the translog specification.

Single Equation and System Estimation

A detailed comparison of the results obtained with single-equation (OLS) and system estimation (GLS) procedures is presented in table 2. System estimation improved the overall goodness of fit and especially the statistical significance of individual coefficients. More important, scale economies measures obtained with the cost system estimation differ

Table 2. Estimated Parameters of the Translog Cost Function, Single Equation versus System Estimation

Parameter (Variable)	(1) Single Equation (OLS) Estimate	(1) Single Equation (OLS) t-ratio	(2) System of Equations (GLS) Estimate	(2) System of Equations (GLS) t-Ratio (Asymptotic)
α_0 (intercept)	5.3210	9.817**	4.7545	14.219*
α_1 ($\ln q_1$, loans)	0.1439	1.153	0.3434	4.890*
α_2 ($\ln q_2$, deposits)	0.0163	0.101	−0.1037	−1.188
β_1 ($\ln p_1$, labor)	0.5439	3.399*	0.5776	8.265*
β_2 ($\ln p_2$, capital)	0.4561	2.851*	0.4224	14.385*
γ_{11} ($\ln q_1$)^2	0.0931	3.388*	0.1351	10.518*
γ_{22} ($\ln q_2$)^2	−0.0429	−1.211	0.0967	4.756*
γ_{12} ($\ln q_1 \ln q_2$)	−0.0063	−0.257	−0.0113	−0.723
δ_{11} ($\ln p_1$)^2	0.0003	0.007	0.1022	13.729*
δ_{22} ($\ln p_2$)^2	0.0003	0.007	0.1022	13.729*
δ_{12} ($\ln p_1 \ln p_2$)	−0.0003	−0.007	−0.1022	−13.729*
η_{11} ($\ln q_1 \ln p_1$)	−0.0426	−1.255	−0.0954	−14.914*
η_{12} ($\ln q_1 \ln p_2$)	0.0426	1.255	0.0954	14.914*
η_{21} ($\ln q_2 \ln p_1$)	0.0922	2.786*	−0.0169	−2.029°
η_{22} ($\ln q_2 \ln p_2$)	−0.0922	−2.786*	0.0169	2.029°
R^2	0.8491	173.86[b]	0.8586	117.51[b]
Weighted R^2			0.7331[c]	
Economies of scale (ES)	0.71		1.08	

Note: Factor-price homogeneity restrictions imposed on all estimated functions. Cross-equation restrictions imposed on system estimation.
** is significant at .01 level; * is significant at .05 level.
[b] F-ratio.
[c] R^2 of labor share equation: 0.2886, F-ratio = 28.50.

significantly from those resulting from the corresponding single-equation estimations.

Table 3 shows the partial and overall economies of scale obtained using the system estimation procedure. In this case, the overall ES value is not significantly different from one. However, the values reported in table 3 are not independent of scale effects and output mix. To analyze this result, it is useful to recall equation (3):

$$(3') \quad ES = A + \gamma_{11}\ln q_1 + \gamma_{22}\ln q_2 + \gamma_{12}(\ln q_1 + \ln q_2),$$

where A summarizes all parameters and variables in equation (3) that do not involve output quantities.

Scale economies tend to disappear (ES approaches 1) as output increases, since both $\hat{\gamma}_{11}$ and $\hat{\gamma}_{22}$ are positive. However, an offsetting effect is due to joint production of q_1 and q_2, since $\hat{\gamma}_{12} < 0$. The overall result is a U-shaped average cost surface, represented by the two branch-size cases reported in table 3. The "small" branch is represented by a point on the downward-sloping portion of the average cost surface, whereas the "large" branch represents a point on the upward-sloping portion of the surface. The values of the partial scale economy measures reported in table 3 indicate that substantial economies of scale exist in the bank's deposit activity. On the other hand, loan activity approaches constant returns to

Table 3. Economies-of-Scale Estimates at Different Branch Sizes Under Cost System Estimation

	Sample Mean	"Small" Branch Case	"Large" Branch Case
Partial ES ($\partial \ln C/\partial \ln q_i$)			
q_1, loans	0.77	0.66	1.14
q_2, deposits	0.31	0.30	0.40
Overall ES ($\Sigma_i \partial \ln C/\partial \ln q_i$)	1.08	0.96	1.54

Note: Computed from column (2) of table 2. Branch size cases were selected on the basis of loan activity, 1982.

scale for the average-branch size (i.e., a hypothetical branch represented by the sample means of all variables). Furthermore, the lending activity displays diseconomies of scale in branches with large amounts of loans.

Effects of Loan Size and Deposit Size

The addition of both loan size and deposit size interactions to the cost system improved the overall statistical performance of the estimation (see table 4). Both estimated coefficients, θ_1 and θ_2, showed a negative sign meaning that the scale economies measure decreases as the average size of loans and/or deposits increases.

The effects of loan size and deposit size becomes more meaningful when the marginal costs of lending and the marginal costs of mobilizing deposits are considered. Equation (4) is written in terms of the parameters of the cost function as follows:

$$(10)\quad MC_i = \frac{C_i}{q_i}(B_i + \gamma_{ii}\ln q_i + \gamma_{ik}\ln q_k + \theta_i \ln SZ),$$

where

$$B_i = \alpha_i + \Sigma_j \eta_{ij}\ln p_j, \quad i = 1, 2,$$

$SZ = LS$ (loan size) for $i = 1$, and $SZ = DS$ (deposit size) for $i = 2$.

The signs of the estimates reported in table 4 indicate that the marginal cost of lending is an increasing function of the total amount lent ($\hat{\gamma}_{11} > 0$). It is reduced by increases in total deposits mobilized ($\hat{\gamma}_{12} < 0$) and decreases as the average loan size increases ($\hat{\theta}_1 < 0$). Similarly, the marginal cost of mobilizing deposits increases as the total value of deposits increases ($\hat{\gamma}_{22} > 0$). It benefits from economies of joint production ($\hat{\gamma}_{12} < 0$) and shifts downward with increases in the average size of deposit balances ($\hat{\theta}_2 < 0$).

Table 4. The Translog Cost Function, Including Loan Size and Deposit Size Effects, Single-Equation versus System Estimation

Parameter (Variable)	(1) Single Equation (OLS) Estimate	(1) Single Equation (OLS) t-ratio	(2) System of Equations (GLS) Estimate	(2) System of Equations (GLS) t-Ratio (Asymptotic)
α_0 (intercept)	5.1313	5.652**[a]	6.0005	11.489*
α_1 ($\ln q_1$, loans)	0.0574	0.297	0.5814	5.787*
α_2 ($\ln q_2$, deposits)	0.0768	0.212	−0.6449	−3.203*
β_1 ($\ln p_1$, labor)	0.7055	3.233*	0.5585	10.192*
β_2 ($\ln p_2$, capital)	0.2945	1.350	0.4415	8.056*
γ_{11} $(\ln q_1)^2$	0.0887	2.362*	0.1463	8.835*
γ_{22} $(\ln q_2)^2$	0.0368	0.375	0.2619	4.799*
γ_{12} $(\ln q_1 \ln q_2)$	0.0256	0.601	−0.0646	−2.693*
δ_{11} $(\ln p_1)^2$	0.1191	1.257	0.0756	8.041*
δ_{22} $(\ln p_2)^2$	0.1191	1.257	0.0756	8.041*
δ_{12} $(\ln p_1 \ln p_2)$	−0.1191	−1.257	−0.0756	−8.041*
η_{11} $(\ln q_1 \ln p_1)$	−0.0452	−1.007	−0.0766	−9.542*
η_{12} $(\ln q_1 \ln p_2)$	0.0452	1.007	0.0766	9.542*
η_{21} $(\ln q_2 \ln p_1)$	−0.0284	−0.394	−0.0103	−0.858
η_{22} $(\ln q_2 \ln p_2)$	0.0284	0.394	0.0103	0.858
θ_1 ($\ln q_1 \ln LS$, loan size interaction)	−0.0068	−1.059	−0.0091	2.332*
θ_2 ($\ln q_2 \ln DS$, deposit size interaction)	−0.0143	−0.974	−0.0180	−1.950*
R^2	0.8786	97.37[b]	0.8858	68.86[b]
Weighted R^2			0.8168[c]	
Economies of scale (ES)	0.79		1.07	

Note: Factor-price homogeneity restrictions imposed on all estimated functions. Cross-equation restrictions imposed on system estimation.

[a] ** is significant at .01 level; * is significant at .05 level.

[b] F-ratio.

[c] R^2 of labor share equation: 0.3116, F-ratio = 17.42.

Cost Complementarities and Elasticities

The estimates of the cost function parameters indicate cost complementarities between loans and deposits. The evaluation of the necessary conditions for cost complementarity as indicated in expression (5) using the results in column 2 of table 4 gives $\gamma_{12} + \alpha_1\alpha_2 = -0.4393$. Therefore, the necessary condition (5) is satisfied by these results. The price elasticities of factor demand reported in table 5, as well as the estimated value of the elasticity of substitution between capital and labor, $\sigma_{12} = 0.63$, seem relatively low even though no appropriate points of reference for development banks were found in the literature.

Concluding Comments

This article analyzed the cost-output relationships and production technology in the Agricultural Development Bank of Honduras. The main results and implications are summarized as follows.

The hypothesis of a simplified Cobb-Douglas function with unitary elasticity of factor substitution is rejected by the statistical tests performed in this study. The use of a Cobb-Douglas cost function underestimates the cost increases resulting from increases in production.

The estimates of scale economies obtained using the (preferred) GLS procedure on the translog cost system differ from those obtained with single-equation (OLS) estimation. The translog specification of the cost function was estimated as a seemingly unrelated system with the labor share equation. It gave consistently better estimates than other specifications and estimation procedures.

The scale economies measure for the average branch is not significantly different from one. However, the measures of scale economies reflect U-shaped average cost curves. Important differences occur between the magnitudes of the partial economies of scale. While the returns to scale of lending activities approach unity, important unexploited economies of scale are associated with the expansion of deposit mobilization. This result implies that the bank could attain important cost economies by engaging in "unbalanced" expansion, emphasizing growth in deposit mobilization over the expansion of lending activities. These cost advantages should be taken into account when designing and evaluating policy strategies which require development bank participation. The expansion strategy suggested above would represent a substantial change in the predominant operational mode of agricultural development banks, which tend to specialize in lending and neglect deposit mobilization activities.

Cost complementarities between loans and deposits suggest that the marginal cost of lending will decrease with increases in the amount of deposits mobilized, and vice versa. This finding highlights the advantages of joint production of banking services compared to specialization in lending, a feature that characterizes most agricultural development institutions in less developed economies. The provision of multiple financial services by agricultural development banks will not only foster financial intermediation and access to financial services by the rural population but will yield significant cost advantages for the financial institution as well.

Table 5. Price Elasticities of Demand for Factors of Production, Derived from Cost Function Estimates

	Labor	Capital
Labor	−0.4493	0.4493
Capital	0.1835	−0.1835

Note: Based on cost system estimates, column (2) of table 4.

[*Received October 1985; final revision received August 1987.*]

References

Baltensperger, Ernst. "Alternative Approaches to the Theory of the Banking Firm." *J. Monetary Econ.* 6(1980):1–37.

Benston, George J. "Economies of Scale of Financial Institutions." *J. Money, Credit, and Banking* 4 (1972):312–41.

Benston, George J., Allen N. Berger, Gerald A. Hanweck, and David B. Humphrey. "Economies of Scale and Scope in Banking." Washington DC: Board of Governors of the Federal Reserve System, 1983.

Benston, George J., Gerald A. Hanweck, and David B. Humphrey. "Scale Economies in Banking. A Restructuring and Reassessment." *J. Money, Credit, and Banking* 14(1982):435–56.

Binswanger, Hans P. "A Cost Function Approach to the Measurement of Factor Demand and Elasticities of Substitution." *Amer. J. Agr. Econ.* 56(1974):377–86.

Christensen, L. R., D. W. Jorgenson, and L. J. Lau. "Transcendental Logarithmic Production Frontiers." *Rev. Econ. and Statist.* 55(1973):28–45.

Cuevas, Carlos E., "Intermediation Costs and Scale Economies of Banking Under Regulations in Honduras." Ph.D. thesis, Ohio State University, 1984.

Gheen, William E. "Development Banks: Empirical Derivation of the Loan Administration Cost Curve." Ph.D. thesis, University of Maryland, 1976.

Hunter, William C., and Stephen G. Timme. "Technical Change, Organizational Form, and the Structure of Bank Production." *J. Money, Credit, and Banking* 18(1986):152–66.

Mullineaux, Donald J. "Economies of Scale and Organizational Efficiency in Banking: A Profit-Function Approach." *J. Finance* 33(1978):259–80.

Murray, John D., and Robert W. White. "Economies of Scale and Economies of Scope in Multiproduct Financial Institutions: A Study of British Columbia Credit Unions." *J. Finance* 38(1983):887–902.

Nyanin, Ohene O. "Costs of Agricultural Lending, Institutional Viability, and Lender Behavior in Jamaica." Ph.D. thesis, Ohio State University, 1982.

Panzar, John C., and Robert D. Willig. "Economies of Scale in Multi-Output Production." *Quart. J. Econ.* 91(1977):482–93.

———. "Economies of Scope." *Amer. Econ. Rev.* 71(1981):268–72.

Ray, Subhash C. "A Translog Cost Function Analysis of U.S. Agriculture, 1939–77." *Amer. J. Agr. Econ.* 64(1982):490–98.

Uzawa, Hirofumi. "Production Functions with Constant Elasticities of Substitution." *Rev. Econ. Stud.* 29 (1962):291–99.