



## **Firm Efficiency and the Regulatory Closure of S&Ls: An Empirical Investigation**

A. Sinan Cebenoyan, Elizabeth S. Cooperman, Charles A. Register

*The Review of Economics and Statistics*, Volume 75, Issue 3 (Aug., 1993), 540-545.

Stable URL:

<http://links.jstor.org/sici?sici=0034-6535%28199308%2975%3A3%3C540%3AFEATRC%3E2.0.CO%3B2-E>

---

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/about/terms.html>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

*The Review of Economics and Statistics* is published by The MIT Press. Please contact the publisher for further permissions regarding the use of this work. Publisher contact information may be obtained at <http://www.jstor.org/journals/mitpress.html>.

---

*The Review of Economics and Statistics*

©1993 The MIT Press

JSTOR and the JSTOR logo are trademarks of JSTOR, and are Registered in the U.S. Patent and Trademark Office. For more information on JSTOR contact [jstor-info@umich.edu](mailto:jstor-info@umich.edu).

©2002 JSTOR

FIRM EFFICIENCY AND THE REGULATORY CLOSURE OF S&LS:  
AN EMPIRICAL INVESTIGATION

A. Sinan Cebenoyan, Elizabeth S. Cooperman, and Charles A. Register\*

*Abstract*—This paper uses a two-step methodology to examine the relationship between firm inefficiency and the regulatory closure of savings and loans (S&Ls). In the first step, using multiproduct, translog stochastic cost frontiers, we estimate inefficiency scores separately for mutual and stock S&Ls operating in the southwest in 1988. We use the inefficiency scores in second step logit models to identify determinants of regulatory closure. For both mutual and stock S&Ls, we find a significant positive relationship between firm inefficiency and regulatory closure. We also find a greater probability of closure for S&Ls in economically depressed states.

### I. Introduction

Under the Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA) of 1989, higher capital requirements were imposed on savings and loans (S&Ls) and an official mandate was given to regulators to shut down the nation's capital deficient thrifts.<sup>1</sup> Until 1988, when President Bush initiated an informal policy of closing S&Ls that had negative tangible capital, the majority of these firms had been allowed to continue to operate under a policy of regulatory forbearance. The FDIC Improvement Act of 1991 similarly provides a mandate for bank regulators to seize ailing banks before they become insolvent.

Nakamura (1990, p. 16) points out that regulatory bank closures have two objectives: (1) to protect the deposit insurance fund and reduce the cost of deposit insurance; and (2) to promote efficiency in the banking industry. If capital deficient firms are economically inefficient, the new regulatory mandates should benefit

Received for publication October 9, 1991. Revision accepted for publication May 28, 1992.

\*University of Baltimore, University of Baltimore, and Mississippi State University, respectively.

The authors are particularly grateful to Robert Cooperman and Hung Gay Fung for their helpful comments and suggestions. We also wish to thank Augustien Sutjahjo for assistance in data collection and the Robert G. Merrick School of Business at the University of Baltimore for a research grant allowing the purchase of data for this study.

<sup>1</sup>S&Ls are capital deficient when their capital to asset ratios fall below a regulatory minimum. S&Ls are technically insolvent when tangible capital ratios are negative. In the mid-1980s, the minimum S&L regulatory capital ratio was 3%, with intangible items (FSLIC net worth certificates, income capital, and, goodwill, etc.) allowed as capital. Under FIRREA, intangible capital was eliminated, and capital ratios were phased in for S&Ls that were equally stringent as banks. The core capital ratio for S&Ls in 1992 was 4%, with risk-based capital requirements to be fully applied in 1993. Regulators use book values to determine solvency; although market values provide a more accurate measure of insolvency (see Barth, 1991, pp. 64–66).

the entire banking industry by reducing “deadweight” losses, leaving the most efficient firms to provide financial intermediation services. Nakamura notes, however, that although the first objective is met with a mandated closure policy, “a brush with insolvency may be due merely to bad luck, and an unlucky efficient bank may find itself closed.” In the financial press some bankers and regulators have argued that by mandating the closure of capital deficient firms, regulators may lose the flexibility to be more lenient in difficult economic times, and that efficient firms may be closed prematurely.<sup>2</sup>

This study examines the relationship between firm inefficiency and the regulatory closure of S&Ls after 1988. Based on the estimation of inefficiency scores using separate stochastic cost frontiers for 395 stock S&Ls and 156 mutuals operating in 1988, and the estimation of empirical models of the determinants of closure, we find a significantly greater likelihood of closure for relatively inefficient S&Ls, supporting the new regulatory mandates.

### II. Previous Studies

Previous studies by Altman (1977); Barth, Brumbaugh, Sauerhaft, and Wang (1985); and Benston (1985) examining S&Ls in the mid-1960s to mid-1980s have focused on financial ratios as predictors of problem S&Ls or S&L failures. Although results have differed, in general these studies have found capital and earnings ratios to be significant predictors of problem firms.

In a recent review Demircuc-Kunt (1989) faults previous studies. First, they fail to distinguish between regulatory closure and economic insolvency, since regulatory closures are partly a function of political factors. For instance, Kane (1990) points out that regulators have an incentive to close small versus large S&Ls to delay the recognition of insurance losses.<sup>3</sup> Second, these studies use financial ratios which are poor prox-

<sup>2</sup>For instance, a banker of a seized S&L that became insolvent overnight under FIRREA states that the problems faced by the firm were temporary and could have been resolved had regulators been more flexible (*Wall Street Journal*, November 11, 1991, p. A20).

<sup>3</sup>Kane (1990, p. 758) points out that by March 21, 1990 only 35% of all capital deficient S&Ls had been put into conservatorship, suggesting that smaller S&Ls have been taken over by regulators more rapidly than larger ones. Barth et al. (1990) found the discount rate and regulatory liquidity to be determinants of S&L resolution costs during 1980–1988.

ies for fraud and management competence. Ratios based on book values are inaccurate and also incorporate external factors that may be beyond a manager's control, such as disparities in economic conditions across geographical regions. Bovenzi and Nejezchleb (1985) point out, for example, a concentration of bank failures during 1982–1984 in a few states which had undergone significant economic hardship.

The role of fraud and mismanagement in failures has been difficult to evaluate, since evidence on these relationships has been largely anecdotal. Barth (1991, p. 44) notes that about half of the S&Ls resolved in 1988 were associated with fraud; however, he also points out that some Office of Thrift Supervision officials state that fraud was probably directly involved in the failure of only a small percentage of S&Ls.

S&Ls are also prone to a moral hazard problem under a federal deposit insurance system. Depositors do not have an incentive to impose discipline on S&Ls. Consequently, S&Ls may be operated less efficiently, and managers may have a tendency to invest in risky assets. Capital deficient S&Ls may be particularly subject to moral hazard problems, since there is less of owners' equity at risk (see Barth, 1991, p. 47).

In contrast to previous studies, we examine directly the relationship between managerial inefficiency and S&L closure by calculating inefficiency scores for S&Ls, utilizing a stochastic frontier approach. Previous studies using a frontier approach for banks (Rangan, Grabowski, Aly, and Pasurka, 1988; Aly, Grabowski, Pasurka, and Rangan, 1990; Ferrier and Lovell, 1990; Berger and Humphrey, 1991; and Elyasiani and Mehdiian, 1990) and for S & Ls (Cebenoyan, Cooperman, Register, and Hudgins, 1993) with different data, time periods, estimation techniques, and input and output variables have found fairly consistent mean inefficiency scores ranging from 16% to 35%. The mean scores suggest that, on average, depository institutions could produce the same output with 65%–84% of the inputs actually used.

### III. Data

The data for this study are taken from the annual balance sheets and income statement reports for S&Ls in the eleventh and ninth Federal Home Loan Bank Board (FHLBB) districts in 1988. This includes 551 thrifts with sufficient data operating in Arizona, Arkansas, California, Louisiana, Mississippi, Nevada, New Mexico, and Texas. Our sample includes 395 stock and 156 mutual S&Ls. We selected 1988 as it is the most recent year with complete data for S&Ls, and also as a year prior to regulatory changes associated with FIRREA. This district was selected since it encompassed a large number of technically insolvent S&Ls, many of which were closed after 1988. Of the

551 firms in our sample, 202 (37%) were closed between 1989–1991. Since our sample represents a subset of S&Ls in the southwestern region of the United States, it is important to recognize that our results could reflect characteristics of S&Ls that are peculiar to this region.

Other data sources used for our independent variables and information on S&L closures include: (1) *U.S. Department of Commerce Bureau of the Census County and City Data Book*; (2) *County Business Patterns*; (3) the *Rand and McNally Savings and Loan Directory*, and (4) the *Sheshunoff S&L Quarterly Rating and Analysis Reports*. To examine the effect of fraud on S&L performance, we obtained the 1991 Department of Justice report on fraud convictions for S&Ls.

## IV. Methodology

### A. Estimating Inefficiency Scores

We use a two-step empirical methodology. In the first step, we employ a stochastic cost frontier methodology (see Aigner, Lovell and Schmidt, 1977, and Meeusen and Van Den Broeck, 1977) based on a multiproduct translog cost function to calculate inefficiency scores for the 551 thrifts in our sample. The stochastic frontier methodology is described in detail in the studies cited above and in Jondrow et al., (1982); and the translog cost function for savings and loans, in LeCompte and Smith (1990) and Mester (1987). For the sake of brevity, we refer interested readers to these studies.<sup>4</sup>

The stochastic cost frontier methodology incorporates a two-component error structure. One component represents random, uncontrollable factors, and the second component, individual firm deviation caused by factors within a manager's control, such as technical and allocative efficiency. By estimating the ratio of the variability for these two factors, we can calculate an overall measure of controllable firm inefficiency (see Jondrow et al., 1982). By focusing only on controllable factors, our study excludes from efficiency scores exogenous events that may affect all S&Ls or thrifts in a particular area.

We use a financial intermediation approach, following the arguments of Sealey and Lindley (1977) to specify S&L inputs and outputs in our translog function. In contrast to a production approach, in which banks produce a total number of deposit and loan accounts, the financial intermediation approach considers the transformation of deposits and other borrowings into loans measured in dollar values (see Aly et al., 1990). The outputs used in the multiproduct cost

<sup>4</sup> See Cebenoyan et al. (1993) for a detailed description of the methodology, which this section draws from.

TABLE 1.—SAMPLE STATISTICS FOR STOCK AND MUTUAL S&amp;L SUBSAMPLES

Variable	Closed S&Ls	Nonclosed S&Ls	<i>t</i> -statistic
<b>Stock Sample (<i>N</i> = 395) Means of Variables</b>			
Inefficiency Score	0.5217	0.3020	6.41 <sup>a</sup>
Per Capita Income	\$18,269	\$19,717	3.39 <sup>a</sup>
Fraud	0.1060	0.0902	1.97 <sup>b</sup>
Louisiana/Texas	0.6225	0.3115	6.24 <sup>a</sup>
Assets (thous.)	\$622,250	\$1,320,400	1.59
	<i>N</i> = 151	<i>N</i> = 244	
<b>Mutual Sample (<i>N</i> = 156) Means of Variables</b>			
Inefficiency	0.2889	0.2059	2.08 <sup>b</sup>
Per Capita Income	\$17,498	\$17,669	0.32
Fraud	0.0392	0.0095	1.00
Louisiana/Texas	0.8039	0.5619	3.24 <sup>a</sup>
Assets (thous.)	\$206,240	\$210,110	0.07
	<i>N</i> = 51	<i>N</i> = 105	

<sup>a</sup> Significant at the 0.01 level for a difference in means test.

<sup>b</sup> Significant at the 0.10 level for a difference in means test.

function include: (1) mortgage lending of all types; (2) nonmortgage loans, which include commercial loans, consumer loans, and lease financing; and (3) other investments, including U.S. Government and Agency Securities, and other securities. The inputs include: (1) the price of physical capital, proxied by taking the total expenditures on premises and fixed assets divided by the book value of premises and fixed assets; (2) the price of deposits, total interest expenses divided by total deposits and other borrowings; and (3) the price of labor, total expenditures on employees divided by the number of full-time equivalent employees at the end of the year.

Since production technology may depend on form of ownership, as noted by Mester (1989), it is improper to pool the mutual and stock S&L subsamples without first determining whether the two groups of firms share the same cost structure. An *F*-test for pooling the subsample data indicated that the stock and mutual S&Ls in our sample had significantly different cost functions. Consequently, translog cost functions and inefficiency scores were estimated separately for the respective stock and mutual samples (shown in appendix 1).<sup>5</sup>

#### B. Cross-sectional Regression Analysis

In the second stage, we use a maximum likelihood (MLE) logit model to examine the relationship between regulatory closure of S&Ls and firm inefficiency. The MLE logit model permits an analysis of the binary

dependent variable of regulatory closure versus nonclosure for an S&L. The independent variables include the estimated inefficiency scores, along with other factors discussed previously, including *FRAUD*, a dummy variable equal to one if an S&L was associated with a fraud conviction between 1988 and 1990, 0, if otherwise; *SIZE*, measured as the natural logarithm of assets; *PER CAPITA*, the average annual per capita income in the PMSA or non-PMSA county in which an S&L operates; and *TXLA*, a dummy variable with a value of one for S&Ls operating in Texas or Louisiana, states suffering unusual economic distress because of oil-related industry problems in the 1980s, 0, if otherwise.

## V. Empirical Results

### A. Descriptive Statistics

Descriptive statistics for the stock and mutual S&L samples are shown in table 1. For the stock sample, the mean inefficiency score is 0.52 for closed S&Ls versus 0.30 for the nonclosed thrifts, a difference which is significant at the 0.01 level. Closed S&Ls also appear to be located on average in areas with significantly lower per capita incomes (\$18,269 vs. \$19,717), and in Texas and Louisiana. Ninety-four (62.25%) of the 151 closed stock S&Ls are in Texas and Louisiana. The mean statistics are consistent with the view that closures are higher in areas of economic distress. The mean fraud variable is significantly higher for the closed S&Ls (0.11 vs. 0.09). About 11% of the closed stock S&Ls are associated with fraud, compared to only 9% of the nonclosed stock firms. Although the mean asset size is larger for the nonclosed stock S&Ls, the difference in the means is not significant.

<sup>5</sup> Beard, Caudill, and Gropper (1991) performed a finite mixture estimation of multiproduct cost functions for a sample of 2,092 S&Ls with positive regulatory capital in 1988 and similarly found significant differences in cost functions across S&Ls.

TABLE 2.—LOGIT MODEL ESTIMATES  
DEPENDENT VARIABLE: 1 = CLOSURE; 0 = NONCLOSURE

Independent Variables	Coefficient	t-statistic	Mean
<u>Stock Subsample Results</u>			
INTERCEPT	-2.286	-2.367 <sup>a</sup>	1.000
INEFFICIENCY	0.030	6.275 <sup>b</sup>	38.602%
PER CAPITA	-0.0001	-4.010 <sup>b</sup>	\$19,263
SIZE	0.213	2.570 <sup>b</sup>	11.920
TXLA	1.291	5.235 <sup>b</sup>	0.430
FRAUD	0.021	0.005	0.096
Log-Likelihood = -213.21; % correctly predicted = 74.18%			
<u>Mutual Subsample Results</u>			
INTERCEPT	-1.902	-0.941	1.000
INEFFICIENCY	0.018	2.042 <sup>a</sup>	23.303%
PERCAPITA	-0.00001	-0.183	\$17,613
SIZE	0.007	0.039	11.511
TXLA	1.210	2.898 <sup>b</sup>	0.641
FRAUD	0.131	0.945	0.019
Log-Likelihood = -90.848; % correctly predicted = 68.59%			

Note: *SIZE* is measured by the natural logarithm of assets (thous.). *TXLA* is a dummy variable for S&Ls in Texas and Louisiana.

<sup>a</sup> Significant at the 0.05 level.

<sup>b</sup> Significant at the 0.01 level.

The means for the mutual S&Ls shown in the lower panel of table 1 indicate a significantly higher mean inefficiency score for the closed S&Ls, but only at a 10% level (0.29 vs. 0.21). There are also significantly more closed versus nonclosed mutual S&Ls in Louisiana and Texas. The mean dummy variable for Louisiana/Texas is significantly higher for the mutual sample. Forty-one (80.39%) of the 51 closed mutual S&Ls are in Louisiana or Texas versus only 59 (56.19%) of the 105 nonclosed mutuals. The means for the other variables are not significantly different.

### B. Logit Model Results

The results of the logit regression for the stock sample are shown in the top panel of table 2. The log likelihood ratio of -213.21 and the percentage of predicted to actual outcomes of 74.18% indicate that the model has a good fit. The highly significant, positive coefficient on *INEFFICIENCY* implies that more inefficient firms are likely to be closed by regulators. The implied marginal probability for inefficiency based on a mean value of 38.60% is 0.0071, indicating that with a 10% increase in a firm's inefficiency score, the probability of the S&L's closure increases by approximately 7.10%.

The other variables for the stock S&L model, with the exception of *FRAUD*, are also significant at the 0.01 level. In contrast to the smaller mean asset size for closed firms reported in table 1, the coefficient on *SIZE* is positive, indicating a greater likelihood of closure for larger firms. This may reflect the fact that

larger stock S&Ls expanded too rapidly in the mid-1980s. To test this proposition, we substituted the average annual growth rate as an independent variable in the model in lieu of size. This variable, however, was insignificant. We suggest two alternative explanations. First, smaller firms could have an advantage in terms of closer customer relationships and, hence, better credit assessment and monitoring abilities relative to their larger counterparts. In addition, small firms, because of their more tenuous position in the thrift industry, may be forced to be more conservatively managed.

We also incorporated other risk measures, including the percentage of brokered deposits held by S&Ls, the percentage of real estate construction loans, and a federal vs. state charter dummy variable. These variables were each insignificant and did not qualitatively affect the results.<sup>6</sup>

The *TXLA* and the *PER CAPITA* variables are significant, indicating a greater likelihood of closure for stock S&Ls in lower income areas and regions suffering unusual economic distress. This is consistent with Bovenzi and Nejezchleb's (1985) study, in which a large number of bank failures occurred in regions suffering industry-related problems.

The *FRAUD* variable was positive but insignificant in the stock subsample, which suggests that although

<sup>6</sup> We used the average annual growth rate for S&Ls from 1984-1988. Since balance-sheet composition variables are implicitly reflected in inefficiency scores, technically they should not be included in the logit model and are not included in the reported results.

fraud has been associated with a number of S&L failures, it is not a primary determinant of closure. On a note of caution, however, our fraud variable includes only convictions reported by the U.S. Department of Justice and does not incorporate undetected cases of fraud or nonconvictions.

As shown in the lower panel of table 2, the log-likelihood for the mutual sample was not quite as robust as the stock sample, with a log-likelihood ratio of 90.848, and a percentage of S&Ls correctly predicted of 68.59%, possibly reflecting the smaller size of this sample. Similar to the stock sample, the inefficiency variable and the *TXLA* variables are positive and significant. The implied marginal probability for inefficiency of 0.0032 based on the mean value for mutuals of 23.30% indicates that the average mutual's probability of closure would increase by about 3.2%, with a 10% rise in inefficiency. The other variables *FRAUD*, *PER CAPITA*, and *SIZE* are insignificant.

## VI. Conclusion

In this study we find inefficiency as a highly significant determinant of S&L closure. This outcome suggests that the current regulatory policy of mandating closures of capital deficient S&Ls is an economically justifiable strategy to pursue in attempting to improve the thrift industry, and by extension the mandate to close capital deficient banks before they fail under the FDIC Improvement Act (FDICIA) of 1991. Another provision of this act that prevents poorly capitalized banks from offering brokered deposits, however, is not supported, since we do not find a significant relationship between S&L closures and brokered deposits. We do find a relationship between closures and S&Ls in states undergoing unusual economic distress. This result suggests that an interstate banking provision, which was omitted in FDICIA, could reduce the number of depository institution failures by allowing geographic diversification. It should be noted, however, that our results apply only to S&Ls in the Southwest region, so generalizations to S&Ls in other regions or to commercial banks must be made with extreme caution.

## REFERENCES

- Aigner, Dennis, C. A. Knox Lovell, and Peter Schmidt, "Formulation and Estimation of Stochastic Frontier Production Function Models," *Journal of Econometrics* 6 (July 1977), 21-37.
- Altman, Edward I., "Predicting Performance in the Savings and Loan Association Industry," *Journal of Monetary Economics* 3 (Oct. 1977), 443-466.
- Aly, H. R., R. Grabowski, C. Pasurka, N. Rangan, "Technical, Scale, and Allocative Efficiencies in U.S. Banking: An Empirical Investigation," this REVIEW 72 (May 1990), 211-218.
- Barth, James R., Dan R. Brumbaugh, Jr., Daniel Sauerhaft, and George H. K. Wang, "Thrift Institution Failures: Causes and Policy Issues," *Bank Structure and Competition, Conference Proceedings*, Federal Reserve Bank of Chicago, 1985.
- Barth, James R., Philip F. Bartholomew, and Michael G. Bradley, "Determinants of Thrift Institution Resolution Costs," *Journal of Finance* 45 (July 1990), 731-754.
- Barth, James R., *The Great Savings and Loan Debacle* (Washington, D.C.: American Enterprise Institute, 1991).
- Beard, T. Randolph, Steven B. Caudill, and Daniel M. Groppe, "Finite Mixture Estimation of Multiproduct Cost Functions," this REVIEW 73 (Nov. 1991), 654-664.
- Benston, George J., *An Analysis of the Causes of Savings and Loan Association Failures*, Salomon Brothers Center for the Study of Financial Institutions Monograph Series (1985-4/5), Graduate School of Business, New York University.
- Berger, A. N., and D. B. Humphrey, "The Dominance of Inefficiencies Over Scale and Product Mix Economies in Banking," *Journal of Monetary Economics* (Aug. 1991), 117-148.
- Bovenzi, John, and Lynn Nejezchleb, "Bank Failures: Why Are There So Many?" *Issues in Bank Regulation* (Winter 1985), 54-68.
- Cebenoyan, A. Sinan, Elizabeth S. Cooperman, Charles A. Register, and Sylvia Hudgins, "The Relative Efficiency of Stock vs. Mutual S&Ls: A Stochastic Cost Frontier Approach," *Journal of Financial Services Research* 7 (June 1993), 151-170.
- Demircuc-Kunt, Asli, "Deposit-Institution Failures: A Review of Empirical Literature," *Federal Reserve Bank of Cleveland Economic Review* (1989, Quarter 4), 2-16.
- Elyasiani, E., and S. M. Mehdi, "A Nonparametric Approach to Measurement of Efficiency and Technological Change: The Case of Large U.S. Commercial Banks," *Journal of Financial Services Research* 4 (July 1990), 157-168.
- Ferrier, Gary D., and C. A. Knox Lovell, "Measuring Cost Efficiency in Banking: Econometric and Linear Programming Evidence," *Journal of Econometrics* 46 (Oct./Nov. 1990), 229-245.
- Jondrow, James, C. A. Knox Lovell, I. S. Materov, and Peter Schmidt, "On Estimation of Technical Inefficiency in the Stochastic Frontier Production Function Model," *Journal of Econometrics* 19 (July 1982), 233-238.
- Kane, Edward J., "Principal-Agent Problems in S&L Salvage," *Journal of Finance* 45 (July 1990), 755-764.
- LeCompte, Richard L. B., and Stephen D. Smith, "Changes in the Cost of Intermediation: The Case of Savings and Loans," *Journal of Finance* 45 (Sept. 1990), 1337-1346.
- Meeusen, W., and J. Broeck, "Efficiency Estimation from Cobb-Douglas Production Function with Composed Error," *International Economic Review* 18 (June 1977), 435-444.
- Mester, Loretta, "A Multiproduct Cost Study of Savings and Loans," *Journal of Finance* 42 (June 1987), 423-445.
- \_\_\_\_\_, "Testing for Expense Preference Behavior: Mutual versus Stock Savings and Loans," *Rand Journal of Economics* 20 (Winter 1989), 483-499.
- Nakamura, Leonard I., "Closing Troubled Financial Institutions: What Are the Issues?" *Federal Reserve Bank of Philadelphia Business Review* (May/June 1990), 15-24.
- Rangan, N., R. Grabowski, H. Y. Aly, and C. Pasurka, "The Technical Efficiency of U.S. Banks," *Economic Letters* 28 (1988), 169-175.
- Sealey, C. W., and James T. Lindley, "Inputs, Outputs, and a Theory of Production and Cost of Depository Financial Institutions," *Journal of Finance* 32 (Nov. 1977), 1251-1266.

## APPENDIX

TABLE A-1.—TRANSLOG FRONTIER COST FUNCTIONS DEPENDENT VARIABLE: NATURAL LOG OF (TOTAL COSTS / PRICE OF LABOR) (*t*-STATISTICS IN PARENTHESES)

Variable	Stock Sample	Mutual Sample	Variable	Stock Sample	Mutual Sample
Constant	2.312 <sup>a</sup> (2.785)	0.1383 (0.370)	ln(P2/P3)	0.025 <sup>b</sup> (1.871)	-0.059 <sup>a</sup> (-2.475)
ln(Y1)	0.306 <sup>a</sup> (2.788)	0.608 (1.013)	ln(P1/P3)ln(P1/P3)	0.002 (0.096)	0.097 (1.650)
ln(Y2)	0.104 (1.172)	0.585 <sup>b</sup> (1.685)	ln(P2/P3)ln(P2/P3)	0.013 (0.738)	0.031 (0.757)
ln(Y3)	0.454 <sup>a</sup> (5.076)	-0.230 (-0.575)	ln(P1/P3)ln(P2/P3)	-0.024 (-0.967)	-0.065 (-0.755)
ln(Y1)ln(Y1)	-0.284 (-1.390)	0.319 (0.495)	ln(Y1)ln(P1/P3)	-0.001 (-0.035)	0.074 (0.698)
ln(Y2)ln(Y2)	1.302 <sup>a</sup> (5.552)	0.717 (0.737)	ln(Y1)ln(P2/P3)	0.114 <sup>a</sup> (11.904)	0.126 (1.182)
ln(Y3)ln(Y3)	-0.034 <sup>a</sup> (-3.600)	-0.044 (-1.238)	ln(Y2)ln(P1/P3)	0.048 <sup>a</sup> (3.392)	0.039 <sup>b</sup> (1.911)
ln(Y1)ln(Y2)	-0.074 <sup>a</sup> (-8.249)	0.092 (-1.465)	ln(Y2)ln(P2/P3)	0.034 <sup>a</sup> (3.437)	0.115 <sup>a</sup> (2.655)
ln(Y1)ln(Y3)	0.011 (0.592)	0.014 (0.239)	ln(Y3)ln(P1/P3)	0.030 (0.877)	0.019 (-0.318)
ln(Y2)ln(Y3)	-0.030 (-1.455)	-0.009 (-0.082)	ln(Y3)ln(P2/P3)	-0.032 (-0.551)	0.108 (-0.541)
ln(P1/P3)	0.009 (0.724)	-0.0001 (-0.003)			

Note: (Log-Likelihood: -192.724 Stock Sample; 164.110, Mutual Sample) The appropriate linear homogeneity in input price restrictions were imposed by normalizing total costs and other input prices by the price of labor. Y1 = Mortgage assets; Y2 = Other loans; Y3 = Securities; P1 = Price of Capital; P2 = Price of Loanable Funds; and P3 = Price of Labor.

<sup>a</sup> Significant at the 0.01 level.

<sup>b</sup> Significant at the 0.10 level.

## INEQUALITY DECOMPOSITION BY INCOME SOURCE: A NOTE

Jacques Silber\*

*Abstract*—A new decomposition of the Gini Index by income source is proposed. It distinguishes between three components: the true Gini Index of the source, a permutation and an aggregation component.

Following earlier work by Fei, Ranis and Kuo (1979), Kakwani (1980), and others, two recent studies have proposed new methods for decomposing the Gini coefficient by income source: Lerman and Yitzhaki (1985) showed that each source's contribution could be viewed as the product of the source's own Gini coefficient, its share in total income and its correlation with the rank of total income, whereas Silber (1989) indicated that

the breakdown of the Gini Index by factor component (income source) could be handled very easily if one introduced what he called the *G*-matrix, a square matrix in which the elements  $g_{ij}$  are equal to -1 when  $j > i$ , to +1 when  $i > j$  and to 0 when  $i = j$ .

The purpose of this note is to extend Silber's (1989) result by proving that the contribution of each income source could be broken down in an additive way into three components: the Gini Index of the source, a permutation component which arises because the ranking of the individuals by size of the income source may be different from the one based on total income, and an aggregation component which may occur when individuals do not receive every source of income.

Using Silber's (1989) notations, let us define an  $n$  by  $(k + 1)$  matrix  $S$  in which the first column is the vector of the shares  $s_{j.}$  of each of the  $n$  income classes in total income and in which the  $(i + 1)$ <sup>th</sup> column is the vector  $s_{.i}$  of the shares  $s_{ji}$  of source  $i$  ( $i = 1$  to  $k$ ) of income class  $j$  in total income.

Received for publication October 5, 1989. Revision accepted for publication May 28, 1992.

\* Bar-Ilan University.

The author wishes to thank an anonymous referee for pointing out the connection between this note and Jenkins' (1988) paper.