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The Determinants of Efficiency and Solvency in Savings and Loans

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Abstract

The savings and loan crisis is popularly blamed on the industry's deregulation. We investigate this by comparing the performance of institutions that made extensive use of their expanded powers under deregulation and those institutions that did not. Using a nonparametric method of classifying efficient from inefficient institutions, we find that, in general, the more institutions made use of their expanded powers, the more likely they were to be inefficient. We also show that institutions that were inefficient in 1986 were more than twice as likely to become insolvent after 1986 than institutions that were efficient. Controlling for efficiency, we find that the use of expanded powers had almost no impact on insolvency. This suggests that the "problem" with these expanded powers was due to their inefficient management rather than to their inherent properties, such as greater risk. We also explore the difference between mutual institutions and stock institutions. We find little evidence that stock institutions are superior to mutual institutions; they appear similar in terms of efficiency and solvency.

JEL Classification: G21, G28, C14

The Determinants of Efficiency and Solvency in Savings and Loans*

I. Introduction

The Savings and Loan industry is currently undergoing enormous structural change and re-regulation due to the massive failures of the 1980's. During the last decade, 525 insolvent S&Ls were either closed or sold, at a cost of $47 billion dollars. Estimates suggest a further 517 institutions are unable to meet the capital requirements stipulated in the Financial Institutions Reform, Recovery, and Enforcement Act (FIRREA), 1989, and these future closures could, conservatively, cost $100 billion in present value terms over the next decade (Barth, 1991, p. 1).

What caused this carnage? The popular culprit seems to be the industry's deregulation in the early 1980's (see, e.g., Pizzo *et al.*, 1991). Like most popular answers, however, this one leaves many questions unanswered. Firstly, were the firms that failed those that pursued the new lines of business allowed under deregulation? Secondly, if so, was it because these new lines of business were riskier than traditional lines of business, or was it that firms managed these new lines in an inefficient manner, or both? This second question, in turn, raises the more fundamental question of what determines whether an S&L operates efficiently. To what extent does its lines of business affect the efficiency of its operations? To what extent do organizational factors matter? Can we, for instance, establish which of two organizational forms, mutuals (where depositors are the owners) or stock (where shareholders are the owners), is more efficient? These are among the questions we address in

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this paper.

We begin our analysis by adapting nonparametric tests derived in Varian (1984) to determine which S&Ls were efficient or inefficient relative to our sample of 1360 S&Ls. Loosely, we ask, for each S&L, whether it could have produced more output or generated greater revenues at lower cost using another S&L's input mix. If the answer is yes, the S&L is considered inefficient. Otherwise, it is considered efficient. Having identified efficient from inefficient S&Ls, we use this knowledge in two ways. First, in Section IV, we see whether an S&L's organizational form can explain whether it is efficient or inefficient. We, then, extend the analysis to see whether data on an S&L's lines of business can increase the accuracy of our predictions. Of particular interest are the lines of business allowed S&Ls by deregulation in 1982. With some exceptions, we find that engaging in these lines of business tended to reduce efficiency.

We also use our efficiency measures to predict, using our 1986 data, which S&Ls became insolvent after 1987. We find, in Section V, that our efficiency measures are highly significant predictors of future insolvency. In that section, we also identify other predictors of insolvency, including foreclosed real estate.

We are not the first to study the efficiency of S&Ls. A number of papers (discussed below) have also studied this issue, although their focus has typically been on testing the hypothesis that mutuals are less efficient than stock S&Ls (theory — see, e.g. Rasmusen, 1988 — typically predicts that mutuals will be less efficient because their ownership structure is hypothesized to lead to greater agency problems and to limit their ability to raise capital). As noted above, our work differs from these papers in that we consider a wider range of

determinants of efficiency.

A more important distinction, perhaps, is our use of nonparametric techniques to evaluate efficiency. Previous work, such as Verbrugge and Goldstein (1981), Verbrugge and Jahera (1981), Blair and Placone (1988), Akella and Greenbaum (1988), and Mester (1987, 1989, and 1991), has relied on parametric tests of efficiency. Although these papers have produced important insights into the behavior of financial intermediaries, their reliance on parametric tests creates some problems. Firstly, strong maintained hypotheses are required to test for optimizing behavior. For instance, the validity of the technique used by Verbrugge and Jahera, Verbrugge and Goldstein, and Blair and Placone relies on the maintained hypothesis that stock S&Ls are efficient. If, as our data suggests, a significant number of stock S&Ls are inefficient,[1] then their finding that mutuals (as a rule) are inefficient becomes questionable. Moreover, a parametric approach limits the researcher to comparing efficiency across broad classes of firms (e.g., stock S&Ls versus mutual S&Ls) and does not readily allow him or her to see how efficiency varies with continuous variables (e.g., proportion of assets in deregulated lines of business). In addition, a parametric approach requires that the underlying cost or production functions be specified, because the estimated parameters are needed to test for efficiency. The standard parametric tests for cost minimization, therefore, do not test whether S&L managers minimize cost but rather whether they minimize relative to the econometrician's best guess as to the firms' true production function. Hence, these tests rely on the maintained hypothesis that these approximations are essentially accurate.

[1] In our sample, 49% of the institutions that became insolvent by March 1988 were mutuals and 51% were stock firms. In contrast, 65% of the solvent institutions were mutuals and 35% were stock firms.

Moreover, as Varian (1985; 1990) notes, the "exact optimization" required in standard parametric tests typically gives no indication whether firms in the sample are nearly optimizing or grossly non-optimizing. Finally, these studies have focussed on inefficient behavior with respect to a single factor input, typically labor, so that it is difficult to determine the effects of combinations of outputs or inputs on the probability that a firm will be inefficient.

Because we wish to test which, of a wider variety of possible determinants, leads to efficiency; because we wish to avoid too many maintained hypotheses; and because we wish to treat firms individually, rather than as a member of a class, we have chosen to use nonparametric techniques for judging efficiency. Although these tests are not without their own problems — which we discuss below — they represent, at the very least, an additional set of imperfect tests. To the extent these different tests lead to conclusions that are similar to those found in previous work, these non-parametric tests complement the previously used parametric tests. To the extent they lead to conclusions that contradict those found in previous work, they raise a warning flag that indicates further research is necessary. Moreover, because our technique allows us to address questions not previously asked, we offer new insights into S&Ls that can guide regulators and future researchers.

II. An Organizing Framework

The development, solution, and comparative statics of a full model of S&L decision-making are beyond the scope of this paper. We can, however, offer a framework within which to organize the empirical analysis that follows. This framework is illustrated in

Figure 1.

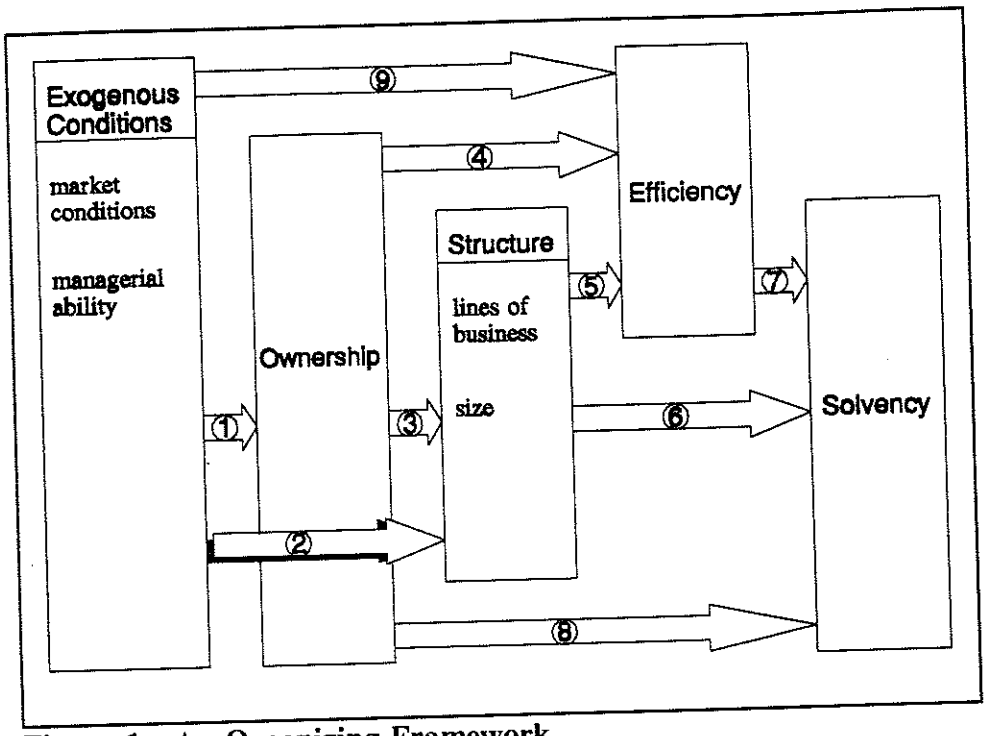

Figure 1: An Organizing Framework

In Figure 1, movement from left to right is meant to suggest temporal order and the arrows are meant to indicate causal relations.

We imagine that an S&L's ownership (mutual versus stock) and other aspects of its structure (lines of business, size, etc.) are chosen in light of the exogenous conditions it faces, such as managerial ability and market conditions.[2] These are the relations indicated by arrows 1 and 2; and they are meant to reflect the outcome of a firm's optimizing in the face

[2] Of course variation in these organizational features need not be due to variation in exogenous conditions. A number of models have shown why otherwise identical firms facing identical exogenous conditions may, nevertheless, behave asymmetrically in equilibrium. Most relevant to the analysis here would be product differentiation models (see Eaton and Lipsey, 1989, for a survey), Maksimovic and Zechner's (1991) model of capital structure heterogeneity, and Hermalin's (1992) model of heterogeneity in organizational form.

of its exogenous conditions. While the details of this optimizing are clearly of interest, we will largely ignore them because our data does not permit us to control for the underlying exogenous conditions.

As noted in the introduction, an S&L's ownership structure — whether it is a mutual or a stock firm — could affect the S&L's behavior. For instance, a common hypothesis is that agency problems (e.g., managerial slacking or perquisite taking) will be worse in mutual S&Ls than in stock S&Ls because, one, the mutual ownership structure makes it harder for a mutual's depositor-owners to control management;[3] and, two, deposit insurance reduces the depositor-owners' need to exercise control. These differences could, in turn, lead to differences in the efficiency with which S&Ls are managed (arrow 4). Moreover, because the rewards available to the managers of mutuals and stock firms are different (see Rasmusen, 1988) — as are the rewards available to shareholders and depositor-owners — different ownership structure could affect which lines of business are pursued (arrow 3).

In addition to the ownership structure, we expect an S&L's choice of lines of business to have a direct effect on the efficiency of its operations (arrow 5). In particular, we expect that a firm that took advantage of their expanded powers following the Garn-St. Germain Act of 1982 would have operated less efficiently that those firms that eschewed these expanded powers. Firstly, a lack of experience using these powers could have led institutions to make costly mistakes as they worked their way up the learning curve. Secondly, these expanded powers represented new lines of business. To acquire new business, particularly against established commercial banks, an S&L might have had considerable start-up costs, which

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[3] See Rasmusen (1988) for a further discussion of this hypothesis.

makes it appear inefficient (at least in the short run).

We expect an S&L's solvency to be determined by three factors: its efficiency, its lines of business, and its ownership structure. The hypothesis that efficiency and solvency are related is well known, and requires no discussion. Variation in the riskiness of different lines of business suggests that differences in lines of business could also explain solvency. Lastly, because stock S&Ls have greater access to the capital markets, they might be better at surviving crises than mutual S&Ls.

III. Nonparametric Tests of Optimizing Behavior

Nonparametric techniques to test for cost minimization have a long history in economics: Consider, e.g., Samuelson (1938), Afriat (1972), Hanoch and Rothschild (1972), and Varian (1984). Here, we most closely follow Varian's (1984) approach. If the observed firm-level data is consistent with cost-minimizing behavior, then it must satisfy the Weak Axiom of Cost Minimization (WACM). Specifically, every firm m producing more output (y) than firm n must have greater costs than firm n evaluated at *firm* n*'s factor prices.* Otherwise, firm n could have obtained more output with lower costs by using firm m's input vector; that is, firm n is not minimizing cost.[4] Let $CMEFF_n$ indicate whether firm n "passes"

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[4] Alternatively, firm n does not have access to firm m's technology. We do not, however, believe this is an important issue in this context: S&L "technology" is essentially common knowledge; moreover, there are no patents or other restrictions that keep S&Ls from adopting whatever technology they wish. Admittedly, it could be difficult for an S&L to expand its use of core deposits rapidly; but as we find that firms that made greater use of brokered deposits tend to be more efficient than those that do not, this objection does not seem particularly critical.

Note that because all comparisons are done at firm n's factor prices, firm n's factor prices are irrelevant to whether it is found to be efficient or inefficient; in particular, n can*not* be found to be inefficient only because it faces greater factor prices than other S&Ls. Some people have suggested to us that this is a problem with the WACM test, as it allows firms that "overpay" for inputs to escape being tagged as inefficient. There are two reasons to think this is not an important issue: First, only 7% of our firms are classified as efficient by WACM, so it does not seem that being too liberal is one of the test's problems; and, second, an alternative test, which does not hold factor prices constant, yields

this test ($CMEFF_n = 1$ indicates pass, $CMEFF_n = 0$ indicates fail). Formally,

$$CMEFF_n = \begin{cases} 1, \text{ if } C_{nn} < C_{nm}, \ \forall m \text{ such that } y_n < y_m \\ 0, \text{ otherwise} \end{cases}.$$

where $C_{ij} = \mathbf{w}_i \bullet \mathbf{z}_j$, $\mathbf{w}_i$ is the vector of factor prices faced by firm i, and $\mathbf{z}_j$ is the vector of inputs used by firm j.[5]

Some obvious issues remain, for example what is an S&L's output? What inputs should we consider? Following previous studies, Sealey and Lindley (1977), Humphrey (1985), and Mester (1989), we assume that S&Ls engage in what has become known as "transformation production" (Humphrey, 1985). They produce dollar amounts of asset classes, such as mortgages, cash, and other loans, using inputs such as labor, physical capital, demand deposits, and purchased funds. Since dollars are dollars, a measure of this transformation production is an S&L's total assets. Hence, we used total assets as our "y's."

We assume that S&Ls produce assets using three inputs: labor, physical capital, and deposits. As discussed in detail in the data appendix, the price of labor, w_1, is the average wage rate per employee over four quarters. For our 1986/87 tests, the first quarter began June 1986. Similarly, for our 1987/88 tests, the first quarter began June, 1987. The unit price of physical capital, w_2, is rent, depreciation, utilities, equipment, and furniture expenses

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similar results (see footnote 5 below).

[5] An alternative test, which does not hold factor prices constant, is to test if $C_{nn} < C_{nnm} \ \forall m$ such that $y_n < y_m$. The results of this test are highly correlated with the WACM test (χ^2 tests reject the null hypothesis of independence at better than the .0001 level for both our 1986/87 and 1987/88 data sets). Not surprisingly, regression analyses that use this alternative test yield exceedingly similar results to those based on the WACM test. Therefore, for the sake of space, we do not report the regression analyses based on this alternative test.

divided by the total number of branch offices operated by the institution. The deposit price, w_3, is the interest paid on deposits in Federal Home Loan Bank Advances, fixed maturity deposits, NOW accounts, passbook accounts, and money market accounts divided by total deposits in these accounts over the relevant four quarters.

The results of our WACM tests are given in Tables 1a and 1b for our 1986/87 and 1987/88 samples, respectively. For the 1986/87 sample, 131 out of 2008 S&Ls (6.5%) were efficient. For the 1987/88 sample, 119 out of 1716 S&Ls (6.9%) were efficient.

One problem with WACM is that total assets could be an imperfect proxy for transformation production: It is reasonable to assume total assets are only positively — but not perfectly — correlated with production and, thus, with costs. For this reason, we also carried out a complementary test for efficiency using a modification of Varian's (1984) test for the Weak Axiom of Profit Maximization, WAPM:[6] Firm n is WAPM-efficient if no firm generates greater revenues using an input mix, which, at firm n's factor prices, would cost firm n less than the input mix it chose. Formally, let R_n denote the nth firm's total revenue (the data appendix describes our measure of total revenue) and let $PMEFF_n$ indicate whether firm n is efficient according to our modified WAPM test ($PMEFF_n = 1$ indicates efficient, $PMEFF_n = 0$ indicates inefficient). Then,

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[6] The modification is that we treat all S&Ls as if they faced the same output prices, whereas Varian's WAPM test requires information — unavailable to us — on firm-level output prices. Although not ideal, we feel our treatment is reasonable in this context: S&Ls compete in a national capital market, so we would not expect much variation in output prices across firms. After all, even real estate lending has a national component: For instance, S&Ls in the midwest made loans to developers in Hawaii (Pizzo *et al.*, 1991).

$$PMEFF_n = \begin{cases} 1, \text{ if } C_{nn} < C_{nm}, \forall m \text{ such that } R_n < R_m \\ 0, \text{ otherwise} \end{cases}.$$

We tested for violations of the WAPM treating the 1986/87 and 1987/88 samples separately. The results of these tests are shown in Tables 1a and 1b. From these tables it is clear that our WACM-based measure, *CMEFF*, and our WAPM-based measure, *PMEFF*, are positively correlated (χ^2 tests reject the null hypotheses of independence at better than the .0001 level in both tables).

Both the WACM and WAPM tests are severe in the following sense. We say that firm m dominates firm n, if $m > n$ (where the ranking is by assets or revenue depending on the test) and $C_{nm} < C_{nn}$. Firm n fails WACM or WAPM if it is dominated by even just one firm. Given that data are never free from errors, such a severe test could lead to some truly efficient firms being accidently classified as inefficient. In turn, this mis-classification would adversely affect our regression analysis below, lowering the power of those statistical tests. For this reason we also examined four other measures. Let $D_{CM}(n)$ denote the set of firms that dominate firm n using the WACM test; let $D_{PM}(n)$ denote the set of firms that dominate firm n using the WAPM test; and let #(•) be the function that counts the elements of a set (note #(∅) = 0). $CMEFF1_n$ and $CMEFF5_n$ indicate whether firm n is undominated in more than 99% and 95% of its potential comparisons respectively. That is,

$$CMEFF1_n = \begin{cases} 1, \text{ if } \dfrac{\#(D_{CM}(n))}{\#(\{m \mid y_m > y_n\})} \leq .01 \\ 0, \text{ otherwise} \end{cases}.$$

$CMEFF5_n$ is defined similarly (except the cutoff is .05). $PMEFF1_n$ and $PMEFF5_n$ indicate whether firm n is undominated in more than 99% and 95% of its potential comparisons respectively. Notationally, their definitions are analogous to $CMEFF1_n$ and $CMEFF5_n$, except the ratio is $\#(D_{PM}(n))/\#(\{m \mid R_m > R_n\})$. These measures are more robust with respect to Type-I errors than $CMEFF_n$ and $PMEFF_n$; but, on the other hand, they do increase the potential for Type-II errors.

In addition to classifying firms as efficient or inefficient, we can also measure how inefficient the dominated firms were. Our measures, "maximum inefficiency," $MICM_n$ and $MIPM_n$, are calculated as

$$MI_n = \max_{j \in D(n) \cup \{n\}} \frac{C_{nn}}{C_{nj}} - 1,$$

where CM and PM have been suppressed in this general definition. This measure is the proportion by which a dominated firm's costs exceed the costs it would have had if it had chosen to produce as efficiently as possible at its factor prices; where "as efficiently as possible" means using the cost-minimizing input mix from the set of input mixes of firms that dominate it. If firm n is not dominated, then $MI = 0$ by construction. Otherwise, $MI > 0$. The larger MI is, the less optimal the firm's behavior would appear to be. Table 2

summarizes the *MI* measure by the WACM and WAPM tests for the 1986/87 sample, the 1987/88 sample, and the panel of firms that operated in both years. *MI* is greater for firms that are inefficient using the 1% cutoff than for firms that are efficient at the 1% cutoff in all six comparisons. Inefficient firms exceeded the costs of efficient firms by 37% to 145% evaluated at constant relative factor prices.

The number of firms that are classified as efficient is highly sensitive to the cutoff rule. For our panel sample, the number of WACM-efficient firms is 92, using the strict cutoff of no violations. It grows to 470 firms under the 1% cutoff and 1078 under the 5% cutoff. The pattern is similar for the WAPM test: 67 firms are classified as efficient under the strict cutoff; 407 firms under the 1% cutoff; and 956 firms under the 5% cutoff. The level of *MI* for *efficient* firms under the 5% cutoff — versus that level under the 1% cutoff — suggests that the 5% rule is too liberal.[7] For this reason, we use only the 1% cutoff and the strict cutoff in the following analyses.

Having constructed a number of measures of the efficiency of the S&Ls in our sample, the next step is to explain why some S&Ls were efficient and some were not. This analysis is conducted in the next section.

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[7] The MICM and MIPM values for the 5% rule are as follows:

Deviation Measure	Efficiency Class.	1986/87 Sample Mean (N=2,008)	1987/88 Sample Mean (N=1,716)	Panel Sample Mean (N=1,360)
MICM	CMEFF5 = 0	1.83	.56	.56
	CMEFF5 = 1	.93	.29	.30
MIPM	PMEFF5 = 0	1.69	1.82	1.62
	PMEFF5 = 1	.70	.33	.34

In all cases the value of the efficiency measure exceeds the value observed for the 1% efficiency classification. Additionally, the differences between the means for the efficient and inefficient firms is smaller than the differences observed using the 1% cutoff limit.

IV. Testing for Efficiency in S&L Production

Potentially, violations of efficiency can be explained by covariates. Econometrically, the problem is straightforward: Estimate Probits to see what explains an S&L's relative efficiency. The Log-Likelihood is

$$\mathcal{L} = \sum_{n=1}^{N} \{EFF_n \log\Phi(\beta' x_n) + (1-EFF_n)\log[1 - \Phi(\beta' x_n)]\}$$

where $EFF_n = 1$ indicates efficient and $EFF_n = 0$ indicates inefficient, β is a coefficient vector, and $\mathbf{x}_n$ is the vector of hypothesized determinants (covariates) of S&L efficiency (See Amemiya, 1985).

Figure 1 and the connected discussion suggest what the vector of determinants should be. Broadly, we expect a firm to be relatively inefficient due to unobservable costs (e.g., agency costs), a lack of access to resources (e.g., managerial ability), or simply managerial mistakes. We focus first on agency costs. Our ability to find measures of the underlying agency problems is extremely limited. As we noted above, many scholars have argued that agency problems will be worse in mutual S&Ls than in stock S&Ls; hence, we control for whether an S&L is a mutual or a stock firm (STOCK86).

In Table 3, we tested whether ownership structure predicts efficiency. We report the results from four Probits: The probability that a firm never violates the WACM (*CMEFF* = 1); the probability that a firm only violates the WACM in 1% or less of its comparisons (*CMEFF1* = 1); the probability that a firm never violates the WAPM (*PMEFF* = 1); and the probability that a firm only violates the WAPM in 1% or less of its comparisons

(*PMEFF1* = 1). In addition to ownership structure, we controlled for assets held (ASSET86) and the square of assets held (ASSET86SQ) because of their role in constructing the efficiency measures.

The results are basically inconclusive with respect to ownership structure. The STOCK86 variable is not significantly different from zero in three of the four specifications. Ownership does, however, have a negative and significant effect on *CMEFF1* efficiency. The conjecture that stock S&Ls are more efficient than mutual S&Ls does not, thus, receive much support here. The asset base, ASSET86 and ASSET86SQ, appears to have a nonlinear effect on the probability that an S&L is classified as efficient in at least 99% of all comparisons (*PMEFF1* and *CMEFF1*). The probability that a firm is efficient is falling in assets until a minimum asset size ($4.5 to $4.7 billion) is reached after which the probability is increasing in assets.

The Probit specifications reported in Table 3 are expanded in Table 4 to control for these institutions' asset portfolios. We do this, largely, to evaluate these institutions use of their expanded powers following the Garn-St. Germain Act of 1982. As discussed in Section II, inexperience with these expanded powers and competition with commercial banks are at least two reasons to expect that firms that took advantage of these expanded powers would have operated less efficiently than those firms that eschewed these expanded powers.

In Table 4, ownership structure (STOCK86) has a statistically significant and positive effect on the probability that an S&L is efficient for *CMEFF*, *PMEFF*, and *PMEFF1* efficiency. The effects of total assets (ASSET86) and total assets squared (ASSET86SQ) are consistent with Table 3.

The proportion of assets held in real estate owned (NREO86) and total plant (NPLANT86) reduce the probability an S&L will be efficient (at better than the 1% level in three of the four specifications). NREO86 is real estate to which a marketable title has been acquired by foreclosure or deed in lieu of foreclosure or real estate acquired as part of a troubled debt restructuring. NPLANT86 includes holdings in buildings, furniture, and land used in the S&L's business operations. Both these assets are known to expose S&Ls to credit and liquidity risk. To the extent that an S&L holds illiquid assets, it reduces its ability to modify its portfolio in response to changing market conditions. Additionally, managing these assets could require a specialized labor force, which would increase an institution's costs. Finally, as these assets produce little, if any, revenue, it is not surprising that firms that "specialize" in their production are WAPM-inefficient.

The proportion of assets in service corporations (NSRCRP86) decreases the probability that an institution is *CMEFF1* or *PMEFF1* efficient at better than the 1% level of statistical significance. Service corporations (NSRCRP86)[8] have been the subject of considerable debate because they were used to invest in junk bonds and hold equity in commercial real estate. Similarly, but less dramatically, the proportion of assets in commercial loans (NCOMML86) and consumer loans (NCONSL86) leads to a statistically significant reduction

[8] In March of 1985, investment by FSLIC-insured institutions in direct investments (equity securities, real estate, service corporations, and operating subsidiaries) was limited to the greater of 10% of assets or twice the institutions net worth, provided that the institution met its regulatory and special purpose net worth requirements. Some firms were, however, grandfathered and continued to hold sizeable portions of their portfolio as service corporations. For Federally chartered institutions, the limit was 3% of the portfolio. For firms hitting either the 3% limit or the 10% limit, junk bonds were typically booked as "other investments." This leads to some difficulties with our NRISK measure, which is primarily hedging instruments but includes "other investments." For some firms this variable will include holdings of junk bonds making it difficult to distinguish the effects of hedging versus the effects of investments in junk bonds.

In June of 1987, the direct investment assets were further limited. These limitations will not, however, be reflected in our regressions because all our independent variables are averages from June 1986 through March 1987.

in the probability of WACM-efficiency. In contrast, the use of hedging or risk management strategies — the proportion of assets in options, futures, and residuals (NRISK86) — leads to statistically significant increases in the probability of *CMEFF1* and *PMEFF1* efficiency. Because of the difficulties in measuring hedging strategies without the confounding influence of junk bond holdings for some firms (see the appendix and footnote 8), the effects of NRISK86 on efficiency are difficult to interpret.

Surprisingly, given their bad press (e.g., Pizzo *et al.*, 1991), the proportion of brokered deposits (PROBRO86) leads to a statistically significant increase in the probability of *CMEFF*, *CMEFF1*, and *PMEFF1* efficiency. Since attracting brokered deposits would seem to require less of other inputs, such as labor and branch offices, than "traditional" deposits, it is perhaps not surprising, ultimately, that firms that made greater use of brokered deposits appear more efficient.[9]

Mortgages on one-to-four (NA14DWL86) and five plus (NA5DWL86) dwelling units increase *PMEFF* and *PMEFF1* efficiency.[10] In contrast, the holdings of riskier commercial real estate mortgages and land for development (NHRISK86) reduces the probability that a firm will be classified as *CMEFF1* efficient.

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[9] Indeed, in theory at least, an S&L could consist of one person, a computer, some phone lines and modems. Such an S&L would take in brokered deposits and invest in mortgage-backed securities and other paper.

[10] Admittedly, we have a problem with mortgages for the following reason. As long as there is no default, a mortgage is counted in a measure such as NA14DWL. If there is a default, however, it "ends up" in NREO. In other words, our mortgage measures count only "good" mortgages, and, thus, only imperfectly reflect total mortgage-writing activity. We could find no way around this problem, since, one, NREO does not distinguish among the different types of real estate; and, two, NREO represents the market value of the real estate, while our mortgage measures are the book value of the mortgages. This limits us to "one-sided" tests for the impact of different mortgage-writing activities: A finding that good mortgages reduce efficiency (or increase the probability of insolvency) is evidence that the associated mortgage-writing activities are suspect; however, a finding that these mortgages increase efficiency (or decrease the probability of insolvency) is not necessarily evidence that the associated mortgage-writing activities are beneficial.

To a large extent, NSRCRP, NCOMML, NCONSL, NHRISK and NRISK represent "post-regulation" assets; i.e., assets that reflect lines of business allowed or expanded following the Garn-St. Germain Depository Institutions Act of 1982. With the notable exception of NRISK, these post-regulation assets appear to lead to inefficiency. A number of explanations are consistent with this finding: First, different lines of business likely require different production processes, and some processes appear inefficient relative to others. For instance, some lines could be more labor intensive; this, in particular, could be true of commercial mortgages and other lending because these activities require the S&L to do more monitoring. Although this explanation points out that the WACM and WAPM tests potentially compare "apples to oranges," it does not exonerate a WACM-inefficient or, especially, a WAPM-inefficient firm from the charge of not profit maximizing: Lines of business represent an endogenous decision, so higher costs and lower revenues (or output), even if due to differences in lines of business, remain evidence of inefficient behavior.

A second explanation for the relation between post-regulation assets and inefficiency is that many of the post-regulation assets represent new lines of business. As noted above, S&Ls entering these lines of business could appear inefficient due to start-up costs (e.g., becoming established against incumbent commercial banks). Moreover, managerial inexperience with these lines of business could lead to inefficient operations while managers acquired the necessary experience.

This second explanation suggests that our findings may not reflect the long-run relation between post-regulation assets and efficiency. Our panel is too short for us to evaluate fully whether we are capturing a long-run or short-run phenomenon. An indirect

piece of evidence against our measuring only a short-run phenomenon is that, were we capturing only the short run, our efficiency measures (e.g., *CMEFF1* and *PMEFF1*) would not reflect long-run efficiency. As such, they should not have much predictive power for the long-run survivability of an S&L. Our findings below (Table 7), however, indicate that they have strong predictive power: A by-our-measures inefficient firm is around 2½ times more likely to become insolvent than a by-our-measures efficient firm. This suggests that many S&Ls that made use of their expanded powers either never learned to make efficient use of them or were unable to recoup their start-up costs in sufficient time to avoid insolvency.

The preceding discussion does not, however, explain why some S&Ls invested in post-regulation assets, while others did not. The reasons for this variation could be important for how we interpret causality in our regressions: If the variation is due to factors that also directly determine efficiency, then the correlations reported above could be, in part, spurious. As discussed in Section II, ownership structure is plausibly one factor that directly affects both investment in post-regulation assets and efficiency. However, as we can control for this factor, we can rule it out as a source of spurious correlation. More troubling is the suggestion that exogenous factors beyond our control, such as managerial ability, could influence both an S&L's efficiency and which lines of business it pursued (the possible link between such exogenous factors and efficiency is represented by arrow 9 in Figure 1). Although plausible, the direction in which managerial ability would influence lines of business is unclear: On the one hand, abler managers could feel more confident about pursuing new lines of business, while on the other hand, less able managers could feel desperate enough to pursue new lines of business. Moreover, it is not clear to us that managerial ability would be an important

determinant of lines of business: Cognitive dissonance or managerial hubris could prevent less able managers from recognizing their limitations; in addition, we are suspicious of a model in which "bad" managers choose a different course of action than "good" managers, because, if they did, they would reveal that they knew they were bad, which would have adverse consequences for their careers.

Ultimately, this question is an empirical one. It is also one that is not easily answered given the shortness of our panel. We did, however, devise an imperfect test — we divided an S&L's business into seven lines: service corporations (NSRCRP); mortgage-backed securities (NMBS); mortgages on vacant land and commercial real estate (NHRISK); assets in options, futures, and other hedging instruments (NRISK); commercial and consumer lending (NCOMML + NCONSL); mortgages on residential real estate (NA14DWL + NA5DWL); and all other activities. We, then, regressed the change in the proportion of assets in each line from 1986/87 to 1987/88 on 1986/87 *CMEFF* — a proxy for managerial ability.[11] If managerial ability affects the lines of business chosen, we would expect to find some systematic relation between changes in lines of business and 1986/87 efficiency. The results are shown in Table 5. We found no significant relation between *CMEFF* and changes in lines of business.[12] Hence, based on this test, as well as the theoretical reasons discussed above, we find spurious correlation to be, at best, a weak explanation for our results. In any

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[11] Formally, we estimated the system of equations

$$\Delta p_{in} = \alpha_i \times CMEFF_n + \varepsilon_{in} ,$$

where Δp_{in} is the change in the proportion of assets in the ith line by the nth firm, α_i is a coefficient, ε_{in} is an error term, and where we imposed the restriction that $\alpha_1 + \ldots + \alpha_7 = 0$.

[12] The results were similar with the other three measures of efficiency, so, for the sake of space, we have chosen not to report them.

case, even if our results are, in part, due to spurious correlation, this does not imply that our results are not also, in part, due to the causal relations discussed above.

To consider further the degree to which S&Ls are non-optimizing, we studied the impact of ownership structure and portfolio structure on *MI*, our measure of how far dominated firms are from optimizing. This measure is non-negative by construction. Consequently, a linear specification for *MI* would be inappropriate. Instead, suppose that

$$MI_n = \max(0, \mathbf{x}_n'\beta + \varepsilon_n) ,$$

where $\mathbf{x}_n$ is a vector of the independent variables for the *n*th firm, β is a coefficient vector, and ε_n is an i.i.d. normally distributed error term. Under this assumption, the appropriate method of estimation is a Tobit, which yields the log-likelihood function

$$\mathcal{L} = \sum_{\{n \mid MI_n<0\}} \log\left[\Phi\left(\frac{-\mathbf{x}_n'\beta}{\sigma}\right)\right] + \sum_{\{n \mid MI_n\geq 0\}} \log\left[\phi\left(\frac{MI_n - \mathbf{x}_n'\beta}{\sigma}\right)\right],$$

where $\Phi(\bullet)$ and $\phi(\bullet)$ are the distribution and density functions of a standard-normal variate and σ is the standard deviation of ε_n (see Amemiya, 1985, pp. 361-364).

Two specifications are compared in Table 6. The Tobit is estimated for both *MICM* and *MIPM* using the Panel sample. The output factors that increase the degree to which a firm is nonoptimizing include the proportion of assets held in service corporations (NSCRP86), in real estate owned (NREO86), and in buildings, furniture, and land used in operations (NPLANT86). These results are consistent with the Probit analyses in Table 4. The proportion of deposits that are brokered (PROBRO86) decreases the amount by which dominated firms deviate from efficiency. Again, this is consistent with Table 4. Also

consistent with Table 4 are that mortgages on five plus dwelling unit mortgages (NA5DWL86) and investments in risk management instruments (NRISK86) reduce the amount of inefficiency. The results concerning commercial loans (NCOMML86) are, however, somewhat inconsistent with the results of Table 4: Whereas greater commercial lending increased the probability of WACM-inefficiency, it appears, in Table 6, to decrease the amount of WAPM-inefficiency.

A potential limitation of our data is that we use the book value of assets. Therefore, we cannot control for interest rate changes on the market value of S&L assets. Although not reported here, we also considered several specifications that included the proportion of assets held in fixed and adjustable rate mortgages. These specifications were intended to determine whether assets with different durations affected the relative probability of being classified as efficient. We found that neither mortgage type was a statistically significant determinant of efficiency. To the extent that NRISK86 measures the hedging strategies of institutions (see the appendix and footnote 8 for a caveat), it appears to increase the probability that an institution is efficient.

Although the results are somewhat mixed, stock ownership does appear to increase the probability that an institution is classified as efficient and, moreover, to reduce the amount by which firms are inefficient. As such, these results are consistent with earlier studies (exceptions are Mester, 1989 and 1991, which find no difference in efficiency between mutuals and stock S&Ls). On the other hand, for the panel sample 73% (71%) of the stock firms were *CMEFF1* (*PMEFF1*) inefficient and 95% (96%) of the stock firms were *CMEFF* (*PMEFF*) inefficient. Hence, it would be grossly overstating our results to conclude that

stock S&Ls are efficient.

In summary, the results from the Probit, and to a lesser extent the Tobit, analyses suggest a negative relation between the relative efficiency of S&L institutions and the many asset investments that were deregulated by the Garn-St. Germain Depository Institutions Act.

V. S&L Failure

In this section, we test whether the insolvency of an S&L in the period 1987 to 1990 can be explained by the output mix (structure), ownership structure, and efficiency ranking of the firm in 1986. Previous studies have explored, in various ways, how the output mix affects insolvency, but they have ignored the relation between the efficiency of the input mix and insolvency.[13] From Figure 1, however, this relation is important for understanding how the output mix and the ownership structure affect insolvency. If, as seems plausible, insolvency is negatively correlated with efficiency (arrow 7), then the output mix and the ownership structure will affect insolvency through their effects on efficiency (arrows 4 and 5). Consequently, if one does not control for efficiency, the interpretation of the effect of the output mix and the ownership structure on insolvency becomes muddled. For instance, suppose emphasizing commercial mortgages increased the probability of insolvency, would this be because commercial mortgages are inefficiently managed (the arrows-5-and-7 route) or because commercial mortgages expose S&Ls to too much risk (arrow 6)? Similarly, suppose stock S&Ls were less likely to become insolvent, would this be because they are more likely

[13] A partial list of previous studies includes Benston (1985; 1989), Barth *et al.* (1985), Rudolf and Topping (1988), Barth and Bradley (1989), Carhill and Mauldin (1989), and Benston *et al.* (1991).

to be efficiently managed (the arrows-4-and-7 route) or because they have better access to the capital market in a crisis (arrow 8)? In addition to providing a clearer picture of the effect of the output mix and ownership structure on solvency, controlling for efficiency also allows us to see whether the effects of the output mix and the ownership structure differ between efficient and inefficient firms.

For this analysis, the dependent variable is whether the S&L became insolvent (was unable to meet the FIRREA capital requirement) by 7 December 1989 or had been taken over by the Resolution Trust Corporation by 7 December 1989. Since this is a binary variable, Probits are the appropriate method of analysis. The results are reported in Table 7.

The more illiquid assets, the proportion of assets held as real estate owned (NREO86) and in business assets (NPLANT86), are statistically significant and positive predictors of S&L insolvency. This is not surprising, as the illiquid nature of these assets could leave an S&L vulnerable to sudden changes in its environment. Indeed, it would be surprising if a portfolio heavy on defaulted loans did not lead to insolvency. As such, this finding is consistent with previous studies. The findings for NPLANT86 are consistent with recent exposes (e.g., Pizzo *et al.*, 1991) concerning excessive investments in luxurious corporate facilities by S&L managers.

On the whole the deregulated assets had little direct impact on insolvency; suggesting that the link represented by arrow 6 in Figure 1 is a weak one for these assets. Two exceptions, however, are assets held in service corporations (NSRCRP86) and hedging instruments (NRISK86), which have a statistically significant and negative effect on the probability of default. We are not surprised that the use of hedging instruments (even if

contaminated by junk bonds, see footnote 8) reduces the probability of default, but we are puzzled by the sign of the coefficient on service corporations. In contrast, traditional mortgage lending does have a direct effect on insolvency: One-to-four-unit dwellings (NA14DWL86) and five-plus-unit dwellings (NA5DWL86) appear to reduce the likelihood of insolvency.

The proportion of deposits that are brokered (PROBRO86) has no significant effect on insolvency (the coefficients are, however, positive). Combined with their positive effect on efficiency , the overall effect of brokered deposits on solvency appears to be positive. This is a surprising result, which corroborates neither the thrust of re-regulation (e.g., FIRREA), nor several recent analyses (Barth and Bradley, 1989; Pizzo, et al., 1991; and Benston et al., 1991).

Total assets (ASSET86 and ASSET86SQ) has a nonlinear effect on the probability of insolvency. The results indicate that the probability of insolvency increases for larger firms until a maximum asset base ($5.3 to $5.5 billion) has been reached at which point the probability of insolvency falls with increased asset size.

The WAPM and WACM efficiency measures have statistically significant and negative effects on the probability of insolvency. To assess the effects of efficiency on the probability of insolvency, we computed the probabilities of insolvency for *CMEFF1* and *PMEFF1* efficient and inefficient firms evaluated at the sample means. For WAPM efficiency, the probability of insolvency for efficient firms (*PMEFF1* = 1) was .067, whereas, the probability of insolvency for inefficient firms (*PMEFF1* = 0) was .200. For WACM efficiency, the probability of insolvency for efficient firms (*CMEFF1* = 1) was .089, whereas, the probability

of insolvency for inefficient firms (*CMEFF1* = 0) was .205. These large differences between efficient and inefficient firms suggest that our efficiency measures provide an important indication of S&L performance.

Overall, Table 7 suggests that a leading cause of S&L failure in the 1980's was inefficient management (i.e., arrow 7 represents an important relation). Moreover, the pursuit of deregulated lines of business appears not to have been, *per se*, a cause of S&L failure (beyond the fact that many of these deregulated lines seem to have been inefficiently managed). That is, their effect on insolvency is through the impact on efficiency (the arrows-5-and-7 route) rather than insolvency. Hence, there is little to suggest that their inherent properties — such as greater risk — directly caused S&L insolvency.

In Table 8, we compute the arc elasticities for the assets and liabilities that had a statistically significant effect on the probability of insolvency. We evaluated the elasticities at the sample mean for efficient and inefficient firms. Although none of the elasticities are absolutely large, the relative differences between efficient and inefficient firms is apparent. For example, a one percent increase in the proportion of foreclosed real estate (NREO86) held by an inefficient firm increased the probability of insolvency by more than one and a half times as much as it did for an efficient firm (.18 percent versus .10 percent for WAPM efficiency and .19 percent versus .12 percent for WACM efficiency). One-to-four family residential mortgages (NA14DWL86), five-plus residential mortgages (NA5DWL86), and hedging instruments (NRISK86) decrease the probability of insolvency more for efficient firms than for inefficient firms. The elasticity findings for the proportion of assets held in plant and equipment (NPLANT86) suggest that, the greater the magnitude of these holdings,

the greater the effects of untoward credit or interest rate surprises regardless of whether a firm is efficient.

The elasticity results for total assets are very revealing. A one percent increase in the asset base of inefficient firms increases the probability of insolvency, whereas it decreases the probability of insolvency for efficient firms. Firms that do not operate efficiently are unlikely to grow out of their problems by increasing their asset and liability base. On the other hand, firms that are operated efficiently can expand their asset base and realize reductions in the likelihood of insolvency. Thus, growth in asset base is not, *per se*, harmful to an S&L's well-being, however, growth without efficiency will have serious consequences.

VI. Conclusions

In this paper we used nonparametric techniques to evaluate the relative efficiency of S&L institutions. These techniques allowed us to exploit the data to a far greater extent then we could have had we used parametric techniques. In particular, for each *individual* thrift we assessed whether it was efficient relative to our sample of thrifts; moreover, when it was inefficient we measured how far it was from being efficient. Consequently, we were able to test hypotheses concerning the efficiency of S&L behavior directly, without relying on our ability to specify the S&Ls' production function correctly. In addition, we showed that our measures of relative efficiency are powerful predictors of future insolvency.

We studied two questions. What determines whether an S&L is relatively efficient or inefficient? And what determines whether an S&L will become insolvent?

We found that organizational form — whether the S&L is a mutual or a stock firm —

played a small role in determining efficiency, but had no direct bearing on future insolvency. Moreover, although we tended to find that the probability that an S&L was efficient was greater if it were a stock firm rather than a mutual, this is not the same as finding that stock S&Ls are efficient. Indeed, most of them were not (at least using our more stringent measures of efficiency). As such, this finding raises doubts about the methodology used by some researchers that relies on the maintained hypothesis that stock S&Ls are efficient. This finding also raises doubts about the benefit of the recent spate of conversions from mutuals to stock firms on the long-run health of the thrift industry (see, e.g., "Street Seeks the Winners as IPO Fever Spreads to Thrifts, Including One in Class of '88 Rescue," *The Wall Street Journal*, 20 March 1992).

We found that an S&L's portfolio of assets had a direct effect on efficiency and, to a much lesser extent, on insolvency. On the whole, a portfolio with a high proportion of "post-regulation" assets — assets reflecting lines of business allowed following the Garn-St. Germain Depository Institutions Act — was a significant predictor of *in*efficiency. On the other hand, we did not find that these post-regulation assets directly led to insolvency (there was, however, an indirect effect through their impact on efficiency). If anything, some of them, such as investments in hedging instruments, seemed to lower the probability of insolvency. Loosely, it would seem that these post-regulation assets were not, themselves, responsible for S&L insolvency, rather their mis-management was. S&Ls which favored their traditional line of business, residential lending, without acquiring too much real estate through foreclosure, were likely both to be more efficient and to have a smaller probability of insolvency. The "trouble" assets were those with little liquidity, such as foreclosed real estate

and holdings in buildings used in business operations, which led an S&L to be inefficient and which directly raised its probability of becoming insolvent.

Brokered deposits, which have been the source of much controversy, looked surprisingly good. S&Ls with a higher proportion of brokered deposits appeared to be more efficient (which, indirectly, lowered their probability of insolvency). Moreover, a higher proportion of brokered deposits did not directly increase the probability of insolvency.

Admittedly, due to limitations in the data and methods, our analyses provide only a partial picture of S&L efficiency and solvency. On the other hand, given the consistency of this picture over different measures and methods, what we have shown is suggestive, both for future research and for future policy decisions.

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TABLE 1a
Comparison of the Weak Axiom of Cost Minimization (WACM) and the Weak Axiom of Profit Maximization (WAPM)
1986 Sample (N=2008)

(Null Hypothesis: WACM and WAPM are independent)

PMEFF86	CMEFF86		TOTALS
	0	1	
0	1,841	83	1,924
1	36	48	84
TOTALS	1,877	131	2,008

$\chi^2 = 368.346$, Prob. = .000

TABLE 1b
Comparison of the Weak Axiom of Cost Minimization (WACM) and the Weak Axiom of Profit Maximization (WAPM)
1987 Sample (N=1716)

(Null Hypothesis: WACM and WAPM are independent)

PMEFF87	CMEFF87		TOTALS
	0	1	
0	1,565	61	1,626
1	32	58	90
TOTALS	1,597	119	1,716

$\chi^2 = 486.748$, Prob. = .000

TABLE 2
Comparison of MICM and MIPM
for Firms Classified by Efficiency Measures

	1986/87 Sample (N=2,008)			1987/88 Sample (N=1,716)			Panel Sample 1986 - 1988 (N=1,360)		
	MICM86			**MICM87**			**MICM87**		
Efficiency Classification	Mean	Std. Dev.	Number of Firms	Mean	St. Dev.	Number of Firms	Mean	Std. Dev.	Number of Firms
CMEFF[a] = 0	1.15	1.57	1,877	.37	.33	1,597	.38	.33	1,268
CMEFF1[b] = 0	1.45	1.72	1,237	.45	.33	1,090	.45	.33	890
CMEFF1 = 1	.46	.92	771	.17	.24	626	.16	.24	470
	MIPM86			**MIPM87**			**MIPM87**		
Efficiency Classification		Std. Dev.	Number of Firms	Mean	Std. Dev.	Number of Firms	Mean	Std. Dev.	Number of Firms
PMEFF[c] = 0	1.02	2.27	1,924	.81	4.60	1,626	.76	4.33	1,293
PMEFF1[d] = 0	1.24	2.60	1,411	1.03	5.35	1,188	.95	5.03	953
PMEFF1 = 1	.36	.499	597	.18	.20	528	.19	.20	407

[a] Equals 1 if S&L never violates the Weak Axiom of Cost Minimization.
[b] Equals 1 if S&L violates the Weak Axiom of Cost Minimization in 1% or less of the comparisons.
[c] Equals 1 if S&L never violates the modified Weak Axiom of Profit Maximization.
[d] Equals 1 if S&L violates the modified Weak Axiom of Profit Maximization in 1% or less of the comparisons.

TABLE 3
Probit Analysis of the Probability that an S&L Is Efficient in 1987/88
(Panel Sample N = 1360)

	WACM		WAPM	
INDEPENDENT INVARIABLE	CMEFF[a]	CMEFF1[b]	PMEFF[c]	PMEFF1[d]
Constant	-1.631*** (-22.231)	-.159*** (-3.319)	-1.881*** (-22.098)	-.411*** (-8.501)
Stock Charter in 1986 (STOCK86)	.126 (1.093)	-.222*** (-2.855)	.176 (1.360)	.065 (.832)
Total Assets (ASSET86)	.007 (.738)	-.070*** (-6.847)	.020** (2.447)	-.059*** (-6.059)
Total Assets Squared (ASSET86SQ)	.0001 (1.067)	.0008*** (6.403)	-.000005 (-.067)	.0006*** (5.778)
LOG-LIKELIHOOD	-313.92	-832.49	-239.37	-803.19
χ^2 (3) =	45.39	88.54	55.314	53.48

* Significant at better than the 10% level.
** Significant at better than the 5% level.
*** Significant at better than the 1% level.
( ) t Statistics.
[a] Equals 1 if S&L never violates the Weak Axiom of Cost Minimization.
[b] Equals 1 if S&L violates the Weak Axiom of Cost Minimization in 1% or less of the comparisons.
[c] Equals 1 if S&L never violates the modified Weak Axiom of Profit Maximization.
[d] Equals 1 if S&L violates the modified Weak Axiom of Profit Maximization in 1% or less of the comparisons.

TABLE 4
Probit Analysis of the Probability that an S&L Is Efficient in 1987/88
(Panel Sample N = 1360)

	WACM		WAPM	
INDEPENDENT VARIABLES	CMEFF[a]	CMEFF1[b]	PMEFF[c]	PMEFF1[d]
Constant	-.717 (-1.192)	.631 (1.477)	-3.052*** (-3.792)	-.710* (-1.668)
Stock Charter in 1986 (STOCK86)	.377*** (2.702)	.143 (1.472)	.371** (2.339)	.387*** (4.066)
Proportion of assets in service corporations (NSRCRP86)	-4.667 (-1.073)	-10.571*** (-2.968)	-.489 (-.113)	-12.180*** (-3.493)
Proportion of assets in Real Estate Owned (Foreclosed Real Estate) (NREO86)	-3.031 (-.917)	-9.826*** (-3.565)	-18.272** (-2.150)	-22.886*** (-5.750)
Proportion of assets in Commercial loans (NCOMML86)	-7.535* (-1.665)	-4.653* (-1.897)	-.876 (-.222)	-1.843 (-.836)
Proportion of assets in consumer loans (NCONSL86)	-4.559** (-2.106)	-5.086*** (-4.060)	-.469 (-.238)	.298 (.278)
Proportion of assets in insured and uninsured mortgage backed securities (NMBS86)	.109 (.130)	1.050 (1.627)	1.918* (1.779)	.431 (.688)
Proportion of assets in plant and equipment (NPLANT86)	-32.860*** (-3.451)	-39.407*** (-7.404)	-1.555 (-.193)	-22.063*** (-4.426)
Proportion of assets in options, futures and other hedging instruments (NRISK86)	.886 (1.060)	2.018** (3.134)	.738 (.643)	1.111* (1.774)
Proportion of assets in cash (NACASH86)	-7.526 (-1.238)	-7.150** (-2.018)	-9.901 (-1.324)	.259 (.080)
Proportion of assets in mortgages on 5+ unit dwellings (NA5DWL86)	-.807 (-.669)	-.846 (-.998)	4.063*** (3.161)	1.523* (1.855)
Proportion of assets in mortgages on 1-4 unit dwellings (NA14DWL86)	-.600 (-.862)	-.177 (-.362)	1.883** (2.068)	1.079** (2.215)
Total dollar value of loans and participations sold (SALES86)	-.032 (-.842)	-.006 (-.183)	-.024 (-.653)	-.011 (-.312)
Total dollar value of mortgage servicing (SERVICE86)	-.00002 (-.039)	-.008 (-1.216)	-.0001 (-.029)	-.004 (-.643)

	WACM		WAPM	
INDEPENDENT VARIABLES	CMEFF[a]	CMEFF1[b]	PMEFF[c]	PMEFF1[d]
Proportion of assets in mortgages on vacant land and Commercial Real Estate (NHRISK86)	-2.374 (-1.311)	-2.757** (-2.143)	-.461 (-.208)	-.477 (-.374)
Total assets (ASSET86)	.009 (.745)	-.086*** (-6.280)	.021** (2.485)	-.0575*** (-4.613)
Total assets squared (ASSET86SQ)	.0001 (.931)	.001*** (6.092)	-.00002 (-.363)	.0066*** (4.713)
Proportion of deposits that are brokered (PROBRO86)	.515* (1.700)	1.417*** (5.085)	.421 (1.345)	1.361*** (5.166)
LOG-LIKELIHOOD	-278.46	-685.63	-218.23	-712.57
$\chi^2(20)$ =	116.30	382.25	97.59	234.71

* Significant at better than the 10% level.
** Significant at better than the 5% level.
*** Significant at better than the 1% level.
( ) t Statistics.
[a] Equals 1 if S&L never violates the Weak Axiom of Cost Minimization.
[b] Equals 1 if S&L violates the Weak Axiom of Cost Minimization in 1% or less of the comparisons.
[c] Equals 1 if S&L never violates the modified Weak Axiom of Profit Maximization.
[d] Equals 1 if S&L violates the modified Weak Axiom of Profit Maximization in 1% or less of the comparisons.

TABLE 5
Change in Lines of Business from 1986 to 1987 as a Function of 1986 Efficiency (Panel Sample N = 1360)

DEPENDENT VARIABLE	α — COEFFICIENT ON 1986 EFFICIENCY (*CMEFF*)[a]	MEAN OF DEPENDENT VARIABLE
Change in proportion of assets in service corporations, 1986 to 1987	.0005 (.46)	-.00024
Change in proportion of assets in mortgage-backed securities, 1986 to 1987	.009 (1.61)	.014854
Change in proportion of assets in mortages on vacant land and commercial real estate, 1986 to 1987	-.002 (-.7551)	-.0034
Change in proportion of assets in options, futures, and other hedging instruments, 1986 to 1987	.003 (.61)	.0016
Change in proportion of assets in mortgages on residential real estate, 1986 to 1987	-.002 (-.359)	.0049
Change in proportion of assets in consumer and commercial loans, 1986 to 1987	.0009 (.44)	-.0089
Change in proportion of assets in all other lines of business, 1986 to 1987	-.013 (-1.427)	-.0088

*** Significant at better than the 1% level

( ) t-statistics

[a] See footnote 10 for the specification. By construction, these coefficients sum to zero.

TABLE 6
Tobit Analysis of the Measure of Maximum Inefficiency
(MICM and MIPM)
(Panel Sample N = 1360)

INDEPENDENT VARIABLES	MICM	MIPM
CONSTANT	.233*** (3.329)	-.131 (-.477)
Proportion of assets in service corporations (NSRCRP86)	.766** (2.133)	30.535*** (21.668)
Proportion of assets in Real Estate Owned (Foreclosed Real Estate) (NREO86)	.914*** (3.158)	8.515*** (7.501)
Proportion of assets in consumer loans (NCONSL86)	.121 (.693)	-.021 (-.030)
Proportion of assets in Commercial loans (NCOMML86)	.187 (.557)	-2.468* (1.868)
Proportion of assets in insured and uninsured mortgage backed securities (NMBS86)	-.021 (-.020)	.335 (.809)
Proportion of assets in mortgages on 5+ unit dwellings (NA5DWL86)	.034 (.246)	-.442 (-.802)
Proportion of assets in mortgages on 1-4 unit dwellings (NA14DWL86)	-.020 (-.244)	.260 (.822)
Total dollar value of loans and participations sold (SALES86)	.0003 (.054)	-.0005 (.024)
Total dollar value of mortgage servicing (SERVICE86)	.0005 (.794)	.0005 (.165)
Proportion of assets in plant and equipment (NPLANT86)	2.294*** (3.016)	-1.915 (-.637)
Proportion of assets in cash (NACASH86)	-.543 (-.999)	4.608** (2.152)
Proportion of assets in mortgages on vacant land and Commercial Real Estate (NHRISK86)	.028 (.169)	1.881*** (2.850)
Proportion of deposits that are brokered (PROBRO86)	-.060 (-1.551)	-1.030*** (-6.522)
Proportion of assets in options, futures and other hedging instruments (NRISK86)	-.316*** (-2.967)	-.144 (-.348)
Total assets (ASSET86)	-.0006 (-.374)	-.015*** (-3.126)

INDEPENDENT VARIABLES	MICM	MIPM
Total assets squared (ASSET86SQ)	-.00003 (-1.550)	.00003 (.957)
Stock Charter in 1986 (STOCK86)	-.042*** (-2.748)	-.153*** (-2.541)
LOG-LIKELIHOOD	-19.134	-1747.5
χ^2 (17)	188.45	560.4

* Significant at better than the 10% level.
** Significant at better than the 5% level.
*** Significant at better than the 1% level.
( ) t Statistics

TABLE 7
Probit Analysis of the Probability an S&L Failed or Was Taken over by the Resolution Trust Corporation (Panel Sample N = 1360)

	INSOLVENT[c]	INSOLVENT
Constant	.801* (.766)	.670 (1.493)
Proportion of assets in service corporations (NSRCRP86)	-5.946** (-2.234)	-5.886** (-2.205)
Proportion of assets in Real Estate Owned (Foreclosed Real Estate) (NREO86)	9.158*** (4.554)	8.800*** (4.386)
Proportion of assets in Commercial loans (NCOMML86)	-.106 (-.052)	-.040 (-.020)
Proportion of assets in consumer loans (NCONSL86)	.591 (.543)	.850 (.776)
Proportion of assets in insured and uninsured mortgage backed securities (NMBS86)	-.904 (-1.376)	-.889 (-1.349)
Proportion of assets in mortgages on 5+ unit dwellings (NA5DWL86)	-2.273** (-2.554)	-1.910** (-2.136)
Proportion of assets in mortgages on 1-4 unit dwellings (NA14DWL86)	-3.087*** (-5.716)	-2.906*** (-5.377)
Total dollar value of loans and participations sold (SALES86)	.040 (1.406)	.046 (1.610)
Total dollar value of mortgage servicing (SERVICE86)	-.004 (-.951)	-.004 (-1.100)
Proportion of assets in plant and equipment (NPLANT86)	16.216*** (3.291)	16.945*** (3.458)
Proportion of assets in cash (NACASH86)	-4.145 (-1.061)	-3.932 (-1.002)
Proportion of assets in mortgages on vacant land and Commercial Real Estate (NHRISK86)	-1.391 (-1.387)	-1.217 (-1.215)
Proportion of deposits that are brokered (PROBRO86)	.293 (1.232)	.340 (1.422)
Proportion of assets in options, futures and other hedging instruments (NRISK86)	-3.635*** (-4.365)	-3.690*** (-4.429)
Total assets (ASSET86)	.032*** (3.412)	.033*** (3.485)

	INSOLVENT[c]	INSOLVENT
Total assets squared (ASSET86SQ)	-.0003*** (-2.593)	-.0003*** (-2.642)
Stock Charter in 1986 (STOCK)	.148 (1.441)	.136 (1.312)
CMEFF1[a]	-.218** (-2.187)	
PMEFF1[b]		-.317*** (-3.145)
LOG-LIKELIHOOD	-552.49	-549.29
χ_2 (16) =	242.14	245.70

* Significant at better than the 10% level.
** Significant at better than the 5% level.
*** Significant at better than the 1% level.
( ) t Statistics.
[a] Equals 1 if S&L violates 1 if S&L violates the Weak Axiom of Cost Minimization in 1% or less of the comparisons.
[b] Equals 1 if S&L violates the modified Weak Axiom of Profit Maximization in 1% or less of the comparisons.
[c] Equals 1 if the S&L was unable to meet its capital requirements or was taken over by the RTC in 1988/89.

TABLE 8
Elasticity Estimates for Statistically Significant Determinants of S&L Insolvency: By Efficient and Inefficient Firms

	WAPM Elasticity Estimates		WACM Elasticity Estimates	
Variables	PMEFF1=0	PMEFF1=1[a]	CTEFF1=0	CTEFF1=1[b]
Proportion of assets in service corporations (NSRCRP86)	-.00075	-.00081	-.00083	-.00066
Proportion of assets in Real Estate Owned (Foreclosed Real Estate) (NREO86)	.0018	.00102	.0019	.0012
Total assets (ASSET86)	.0012	-.0022	.0007	-.00046
Proportion of assets in mortgages on 5+ unit dwellings (NA5DWL86)	-.00126	-.00201	-.00168	-.00179
Proportion of assets in mortgages on 1-4 unit dwellings (NA14DWL86)	-.01811	-.02744	-.01948	-.02579
Proportion of assets in options, futures and other hedging instruments (NRISK86)	-.0053	-.00776	-.00455	-.00827
Proportion of assets in plant and equipment (NPLANT86)	.0034	.00395	.0034	.0033

[a] Equals 1 if S&L violates the modified Weak Axiom of Profit Maximization in 1% or less of the comparisons.
[b] Equals 1 if S&L violates the Weak Axiom of Cost Minimization in 1% or less of the comparisons.

APPENDIX

The accounting balances used in this study were obtained from the Federal Home Loan Bank Board quarterly financial reports from June, 1986 through March, 1988. The asset and liability data were computed as average holding over four quarters June, 1986 through March, 1987 and June, 1987 through March, 1988. The mean, maximum, and minimum values for all the continuous variables are reported in Tables A.1 and A.2. The summary statistics for the Panel data set are reported in Table A.1. The Panel data set includes S&Ls that operated for the eight quarters June 1986 through March 1988, for whom we could obtain complete balance sheet and input information. The summary statistics used in the efficiency analysis are reported in Table A.2 for the 1986/87 and 1987/88 samples.

Total assets:

> ASSET86, total assets. Two forms of total assets were used in the analysis. Our first measure of total assets adjusts, in some sense, for credit problems in an S&Ls portfolio and treats the "performing" assets as our measure of total output. For the tests of the Weak Axiom of Cost Minimization (WACM) and Weak Axiom of Profit Maximization (WAPM), valuation allowances for mortgage loans, non-mortgage loans, real estate owned, service corporations, investment securities, fixed assets, and other assets were subtracted from the total book value of assets held. These valuations are the original issue discount or premium on purchased assets and adjustments in valuation to recognize credit losses. Our second measure of total assets was computed as the book value of total assets before netting out the valuation allowances. The computed asset proportions listed below (e.g. NSRCRP) reflect an S&L's total activity in a given asset class without valuation adjustments for the relative performance of that class. Our second measure of total assets was required, because deducting valuation allowances would artificially increase the apparent share of all asset classes for firms with large reserves held against nonperforming assets. Because firms with large reserves were likely to be inefficient and insolvent, the use of the first measure of total assets could introduce negative bias on estimated coefficients. Total assets were scaled by 100 million in the Probit and Tobit analyses.

The portfolio is described by proportions of total assets. The asset classes used are:

> NSRCRP86, service corporations and subsidiaries. The included assets are subsidiary corporations in which the primary assets are junk bonds or equity participations in real estate. Wholly owned finance subsidiaries are not included in this variable.
>
> NREO86, real estate obtained through foreclosure, from deed in lieu of foreclosure, or real estate acquired from a debt restructuring.
>
> NCONSL86, consumer loans. These include loans on deposits, home improvement loans, education loans, auto loans, retail mobile home loans, revolving loans secured

by one to four family dwelling units, credit cards and other open ended credit extended to consumers.

NCOMML86, commercial loans. These include secured loans for farming operations, for commercial properties nonmortgage, retail auto loans for commercial use, loans to service corporations. It also includes unsecured loans such as unsecured construction loans to builders for new residential property, loans for the improvement of multifamily properties, commercial lines of credit, and for farming operations.

NMBS86, insured and uninsured mortgage backed securities. Includes securities issued by Federal National Mortgage Association (FNMA), the Federal Home Loan Mortgage Corporation, (FHLMC), the Government National Mortgage Association, (GNMA) and private issuers.

NA5DWL86, mortgages on five plus dwelling units. where a dwelling unit is defined as a unit designed for the residence by one family.

NA14DWL86, mortgages on one to four dwelling units.

NPLANT86, for-business real property. This includes office buildings and land, leasehold improvements, furniture, fixtures, parking lots, automobile purchase or lease, and equipment.

NACASH86, cash and noninterest earning deposits.

NHRISK86, non-residential real estate mortgages and mortgages on unimproved land.

NRISK86, Options and futures and other investments. This includes the total amount of cash and securities deposited with brokers as initial and maintenance margins for all outstanding futures and options contracts. Other investments include CMO's, residuals, and interest only (IO) and principal only (PO) strips from mortgage pools. Some institutions also book junk bonds as other investments. Unfortunately, RISK86, does not capture the most common hedging strategy involving the use of interest rate swaps and caps. GAAP accounting only required footnote reporting of interest rate swaps so this information could not be included. For this reason, RISK86, only provides an indication of market activity in hedging instruments rather than a true measure of hedging activity.

Two flow lines of business were also included in the analysis. These were computed as the total flow over four quarters. These are:

SALES86, Dollar value of all mortgage sales including sales to federal agencies and sales to trusts issuing MBS. This variable was also divided by 100,000,000.

SERVICE86, Dollar value of mortgage loans serviced for others. This variable was also divide by 100,000,000.

The liabilities are:

PROBRO86, the proportion of deposits that were received from brokers, dealers, or agents for the accounts of others.

The input quantities and average input prices used in the efficiency analysis include:

FUNDS, Federal Home Loan Bank Advances, fixed maturity deposits, money market accounts, NOW, super NOW, and other transaction accounts, and passbook accounts. The Federal Home Loan Bank quarterly financial statements no longer distinguish the interest rates paid on term and demand deposits. Thus, we were unable to treat term and demand deposits as separate inputs as in previous papers (Mester, 1989; 1990)

FNDRATE, the average unit interest rate paid on the funds as defined above.

Two other factor inputs were included labor and physical capital. The number of full time employees were obtained from the Dun and Bradstreet, *Million Dollar Directory*. Obtaining good employment data was a major obstacle and many S&Ls were excluded because of lack of available information. Average expenditure on labor (AVWAGE) was computed as total labor expenditures divided by total number of employees. We recognize that the employment data probably over estimates average expenditures because we were unable to obtain information on part-time employees in the institutions. The number of branches was obtained from the Rand McNally, *U.S. Savings and Loan Directory*. The average expenditure per branch was computed as total office occupancy expenses divided by number of branches.

Total income was measured as the sum of the total operating income over the four quarters.

Insolvent institutions were identified as S&Ls in operation in June of 1986 that were either taken over by the RTC or were unable to meet their capital requirements as of December 7, 1989. The capital requirements mandated by FIRREA and regulators went into effect on December 7, 1989. The requirements under FIRREA were that an S&L must have tangible capital equal to at least 1.5 percent of assets. Tangible capital is real assets minus liabilities. They were required to have core capital (mainly common equity, retained earnings, a certain amount of good will, and non-cumulative preferred stocks) equal to at least 3% of assets. Insolvent firms were identified using lists obtained from the Resolution Trust Corporation. All of the institutions that were treated as insolvent in our sample because of capital inadequacy, have since been taken over by the RTC. In the 1986/87, 15% of the firms were insolvent as of December 7, 1989. In the 1987/88 sample, 20% of the firms were insolvent as of December 7, 1989.

In the 1986/87 sample, 65.6% of the institutions operated as mutuals and 34.4% as stock firms. In the 1987/88 sample, 55.4% of the institutions operated as mutuals and 44.6% as stock firms. 18% of the firms had their main headquarters in California, Florida, or Texas (CFTSTATE86 = 1), whereas 21% of the 1987/88 sample were located in these states.

TABLE A.1
Summary Statistics for the Panel Sample
(N = 1360)

VARIABLES	MEAN	MAXIMUM	MINIMUM
Proportion of assets in service corporations (NSRCRP86)	.009	.447	0
Proportion of assets in Real Estate Owned (Foreclosed Real Estate) (NREO86)	.012	.385	0
Proportion of assets in consumer loans (NCONSL86)	.040	.356	0
Proportion of assets in Commercial loans (NCOMML86)	.010	.227	0
Proportion of assets in insured and uninsured mortgage backed securities (NMBS86)	.079	.817	0
Proportion of assets in mortgages on 5+ unit dwellings (NA5DWL86)	.050	.560	0
Proportion of assets in mortgages on 1-4 unit dwellings (NA14DWL86)	.461	.852	.008
Proportion of assets in plant and equipment (NPLANT86)	.014	.072	0
Proportion of assets in cash (NACASH86)	.014	.149	.0002
Proportion of assets in mortgages on vacant land and Commercial Real Estate (NHRISK86)	.042	.574	0
Proportion of assets in options, futures and other hedging instruments (NRISK86)	.104	.679	0
Total assets (ASSET86)	472,770,660	27,545,195,760	5,345,529
Total dollar value of loans and participations sold (SALES86)	64,750,100	71,374,746,650	0
Total dollar value of mortgage servicing (SERVICE86)	497,442,250	62,142,206,560	0

VARIABLES	MEAN	MAXIMUM	MINIMUM
Proportion of assets in service corporations (NSRCRP86)	.009	.447	0
Proportion of deposits that are brokered (PROBRO86)	.034	.492	0

A.2
Summary Statistics for WACM and WAPM Analysis

	1986/87 SAMPLE (N = 2008)			1987/87 SAMPLE (N = 1716)		
VARIABLES	MEAN	MAXIMUM	MINIMUM	MEAN	MAXIMUM	MINIMUM
TOTAL ASSETS	448,967,970	32,698,449,580	3,917,890	470,804,780	28,480,385,220	5,759,590
TOTAL INCOME	41,957,470	2,844,317,650	-271,531,270	41,279,060	2,446,433,470	-22,063,700
FUNDS	381,067,210	22,930,453,730	3,387,040	392,934,570	22,905,308,290	4,881,080
AVERAGE FUND RATE	.0749	.1043	.0416	.0694	.0987	.0465
EMPLOYEES	129.54	6,000	3	149.11	6,000	10
AVERAGE WAGE	28,663	96,697	13,386	27,027	97,083	10,108
TOTAL BRANCHES	8.2	289	1	8.4	294	1
AVERAGE BRANCH EXPENDITURE	200,681	1,908,021	28,144	189,571	1,956,600	23,045

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