Problem Loans at New England Banks, 1989 to 1992: Evidence of Aggressive Loan Policies

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The New England banking industry experienced serious problems between 1989 and 1992. As the region's economy deteriorated, banks failed at an unprecedented rate and many others barely survived. But even though banking problems were widespread, they were not uniform. For example, in 1991, the ratio of nonperforming loans to total loans was in excess of 10 percent for some New England banks, while for others this ratio was below 1 percent. Why such disparity in the quality of these loan portfolios? Can it be explained by differences in the underwriting skills of managers, or is it better explained by differences in the loan policies chosen by managers?

This study attempts to determine whether a 'skills' hypothesis or a 'policies' hypothesis better explains differences in the severity of loan problems. The 'skills' hypothesis posits that banks with the greatest loan problems were those that employed managers with deficient skills. The 'policies' hypothesis posits that banks with the greatest loan problems were those that chose higher loan/asset ratios, held a greater concentration of riskier types of loans, or accepted riskier loan customers.[1] An analysis of bank efficiency is used here to help identify which of these two hypotheses better explains the disparity in the problems experienced by New England banks.

It is important to differentiate between these two hypotheses because they imply different policy prescriptions for bank regulators. If deficient managerial skills are the driving force behind loan problems, supervisors attempting to predict which banks will soon be troubled might use efficiency measures as a way to identify potential problem lenders. In contrast, if differences in managerial loan policies drive problem loans, it would be advisable for supervisors to concentrate more of their resources on evaluating banks' credit control procedures as well as the capital adequacy of banks. Properly setting capital requirements, so that banks internalize the costs of operating a risky bank, would deter excessive risk-taking and also provide a buffer to protect the bank in the event of poor loan performance. Given the direct cost of $6.8 billion to handle the closing of numerous New England banks between 1989 and 1992 (FDIC 1995), it is important to understand the causes of the crisis and take steps to avoid repeating it.

In this analysis, measures of bank efficiency are used to achieve a better understanding of this crisis. Bank efficiency studies are numerous in the banking literature.[2] Only recently, however, have researchers given attention to the relationship between bank efficiency and problem loans. Berger and DeYoung (1997) were the first to investigate this relationship directly. For a sample of U.S. commercial banks, the authors attempt to identify whether managers' operating decisions or exogenous events are the key determinant of a bank's loan problems. They conclude that "neither hypothesis dominates the other," but rather that there is evidence of both (Berger and DeYoung 1997, p. 859).

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This analysis differs from the Berger and DeYoung study in that it does not attempt to determine whether exogenous shocks, those outside the control of managers, are contributing factors in the determination of problem loans. This study concedes that outside shocks play a major role in most banking crises. Instead, the analysis asks whether differences in managers' operating decisions can help explain why some banks have tremendous difficulty when faced with an external shock, while others escape relatively unscathed. All banks operating in the First Federal Reserve District during the late 1980s and early 1990s faced the collapse in the region's real estate market. For this reason, differences among them in loan problems should reflect differences in the decisions bank managers made earlier regarding the operation of their institution.

Efficiency measures show evidence in support of the 'policies' hypothesis. This study finds that higher measures of profit efficiency in the 1984–88 period are associated with higher levels of problem loans in the 1989–92 period. These results suggest that managers of these "profit-efficient" banks deliberately adopted policies designed to generate higher returns, but at a cost of higher risk. As a result, they traded off relatively high profitability in the 1984–88 period against relatively poor loan performance in the 1989–92 time period.

Poor loan performance was not a perfect predictor of which institutions went on to fail. Some banks that incurred relatively high loan losses between 1989 and 1992 also had a capital base that was sufficient to absorb their losses. Banks that failed may have had insufficient capital to absorb their losses either because managers underestimated the true riskiness of their loan portfolio or, conversely, because they were willing to take a gamble on a low-probability event that they had correctly incorporated into their risk assessments. Either way, risk-based capital requirements that attempt to make banks' capital positions vary with asset risk will likely help alleviate the problem of undercapitalization at risky banks.

I. Bank Efficiency

An efficient banking institution has been defined as one that optimally combines input bundles and output bundles in a manner that either maximizes profits or minimizes costs. In this study, bank outputs are defined as the loans extended by the bank and securities held by the bank on its balance sheet. Inputs are defined as the amount of labor the bank employs and the various sources of funds the bank uses in its intermediation process. In the literature, this is known as the "intermediation" approach. It assumes depository institutions are in the business of collecting deposits and purchasing funds in order to intermediate loans and other assets subsequently. A banking institution is termed to be inefficient if it has suboptimal combinations of input and output bundles or if, for a given level of output, it uses higher than optimal quantities of inputs. In practice, because the theoreti-

[1] A recent study by Berger and DeYoung (1997) examined similar hypotheses. The 'skills' hypothesis stated here is analogous to their 'bad management' hypothesis. The 'policies' hypothesis stated above, although similar to their 'skimping' hypothesis, can potentially have a different interpretation. Because the two hypotheses are not an exact match, different terminology was chosen.

[2] See Berger and Humphrey (1997) for a comprehensive review of these studies.

cal cost-minimizing or profit-maximizing firm is not observed, studies typically determine bank efficiency by comparing a particular bank to the 'best-practice' bank in the sample.

Cost Efficiency

A measure of cost efficiency compares a particular bank's costs with the costs of a 'best-practice' bank producing the same output bundle under the same conditions. Banks whose costs are relatively close to those of the best practice bank are considered efficient relative to those banks whose costs are significantly above those of the best practice bank. To compute bank efficiency, a cost function is estimated for a sample of banks. This cost function specifies variable costs as being determined by the prices of variable inputs, the quantities of variable outputs, and some control variables. The portion of a bank's variable costs that cannot be explained by these factors, after controlling for random error, is then attributed to its efficiency.

Specifically, residuals obtained from the estimated cost function are purged of random error and then used to compute relative cost efficiency.[3] Banks with relatively high residuals, which occur because these banks have high costs relative to comparable banks, are classified as inefficient. Banks with relatively low residuals, which occur because these banks have low costs relative to comparable banks, are classified as efficient. An index is then constructed with a range of 0 to 1, with the most efficient bank taking on the value of 1. The estimation technique used in this analysis estimates how well a bank manages its resources over the long run. A bank is considered efficient only if it can consistently deliver its output at costs below those of comparable banks. (See the Appendix for details of this analysis.)

Cost inefficiencies measured in this fashion incorporate both allocative inefficiencies and technical inefficiencies. Allocative inefficiencies arise when, given the relative prices of bank inputs, the bank uses a combination of inputs that does not minimize costs. That is, a particular input is used at a higher proportion than the bank's relative prices of inputs and the practices of comparable banks would say is warranted. Technical inefficiencies arise when a bank employs more inputs when producing a particular output than the practice of comparable banks would say is warranted. Cost inefficiencies computed in this study attempt to capture both types of inefficiencies. It should be noted that these measured cost inefficiencies, which control for differences in output quantities, do not capture any inefficiencies that might arise from a suboptimal output levels or a suboptimal mix of outputs. All cost inefficiencies are derived from the suboptimal use of inputs, given the firm's chosen level and mix of outputs.

Profit Efficiency

Like the analysis of cost efficiency, a measure of profit efficiency compares a particular bank's profits with those of the 'best-practice' bank. Even though the techniques used to capture cost and profit efficiency are similar, what the two estimates attempt to measure is potentially quite different. Profit efficiency is based on the economic goal of profit maximization rather than the cost minimization assumed when estimating cost efficiencies. If a firm has chosen the optimal level and mix of outputs, minimizing costs will also maximize profits. In such a case, measures of profit efficiency and cost efficiency would be analogous. However, this is only a special case. Berger, Hancock, and Humphrey (1993) show that output inefficiencies at commercial banks, stemming from the wrong scale or mix of outputs, are as large as or larger than inefficiencies stemming from improper use of inputs. Measuring profit efficiencies allows one to capture inefficiencies stemming from both the input and the output sides, overcoming the assumption made in cost efficiency that management has chosen the optimal level and mix of outputs.

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To compute profit efficiency, a profit function is estimated from a sample of banks where the function specifies variable profits as being determined by the prices of variable inputs, the prices of variable outputs, and some control variables. The estimated profit

[3] The econometric technique used to estimate the cost function will determine how one decomposes the residuals into random error and inefficiency. In this study, the distribution-free technique developed by Berger (1993) is used. See the Appendix for details.

function differs from the estimated cost function in two ways: The dependent variable is now variable profits instead of variable costs, and output prices replace output levels as explanatory variables. As in estimating cost efficiency, the portion of a bank's variable profits that cannot be explained by these factors, after accounting for random error, is attributed to its efficiency. Banks that have high profits relative to comparable banks are classified as profit-efficient, those with low profits relative to comparable banks are classified as inefficient. An index is then constructed that has a range of 0 to 1, with the most profit-efficient bank having a value of 1 in the index. As was the case with cost efficiency, the estimation technique emphasizes long-run efficiency. Banks must consistently earn profits above comparable banks to be classified as efficient.

II. Managerial 'Policies' Hypothesis versus Managerial 'Skills' Hypothesis

In most bank efficiency studies, researchers assume banks are neutral toward risk.[4] In the context of cost efficiency, the assumption is made that managers choose the least costly mix of inputs to produce a given level of output. In the context of profit efficiency, it is assumed that managers choose both the level and the mix of outputs and inputs to earn the highest possible profit. However, if some managers are averse to risk, they may give up some profits or be willing to incur higher costs in return for a safer bank.[5] For example, risk-averse managers may monitor their loan customers with great diligence, and thus incur high costs, in order to reduce the chance of default. In another example, managers may refrain from extending risky loans with high potential returns in order to hold a safer loan portfolio.[6]

The estimation of cost and profit efficiency in this study makes no explicit effort to control for differences in a bank's lending policies. If some managers are more risk averse than others, and if risk-averse managers trade off lower profitability for a safer bank, then those banks with risk-averse managers will have efficiency estimates that are biased downward. That is, given their risk preferences, these banks would be inaccurately classified as inefficient. However, it is possible that differences in lending policies are of only second-order importance and the resulting bias in efficiency estimates small. In this case, measured inefficiencies would reflect true inefficiencies. This study exploits the fact that measures of bank efficiency will be biased downward if significant differences exist in banks' lending policies, in order to test the following two hypotheses:

1. *Managerial 'Policies' Hypothesis*. If significant differences in lending policies are present among banks, and some have aggressive policies that result in a risky bank while others have more conservative policies that result in a safer bank, those banks measured to be the *most* efficient should also have the greatest problems with their loan portfolios. Thus, a *positive relationship* between measured bank efficiency and the severity of problem loans would be evidence in support of the hypothesis that some banks are willing to accept a riskier loan portfolio in return for higher expected profitability. This is the 'policies' hypothesis.

Because a risky loan portfolio can result either from managers skimping on resources allocated to the underwriting process or from managers deliberately accepting riskier loan customers in return for higher expected returns, the 'policies' hypothesis may not imply a positive relationship between problem loans and both cost and profit efficiency. If problem loans arise primarily because managers are skimping on resources allocated to the loan origination and monitoring process, one would expect a positive relationship between cost efficiency and problem loans. To the extent skimping on costs improves profitability, a positive relationship between profit efficiency and problem loans would also be expected. However, if

[4] Notable exceptions are studies by Mester (1996); Hughes et al. (1995, 1996a, 1996b); and Hughes and Mester (1993). These studies attempt to explicitly model managerial risk preferences.

[5] Fixed-rate deposit insurance has been recognized as providing an incentive for bank shareholders to prefer a riskier banking institution than they would in the absence of this insurance (Merton 1977; Marcus and Shaked 1984; and Ronn and Verma 1986). Whether banks fully exploit the risk-taking incentives will depend in part on the incentives bank managers have to operate a risky institution (Benston et al. 1986). This paper attempts to identify whether there were significant differences in the risk-taking by New England bank managers in the 1980s.

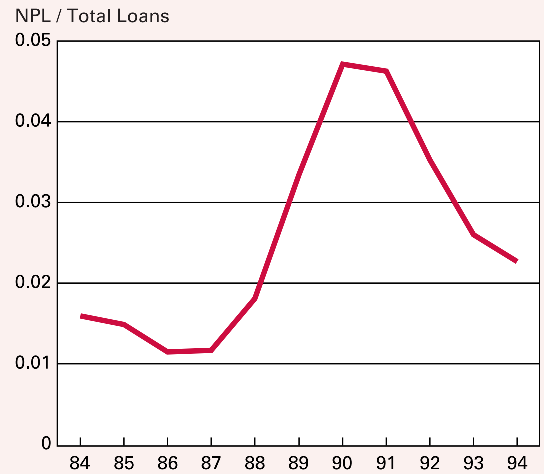
[6] Another place where differences in risk preferences manifest themselves is in managers' decisions regarding the level of financial capital to hold. Hughes and Mester (1993) show that differences in managerial risk preferences result in some managers choosing to hold higher levels of capital in order to lower their risk of insolvency. This strategy will likely fail to minimize costs, because financial capital is more costly than other sources of funds. Following Berger and Mester (1997), this study controls for differences in financial capital when estimating efficiency. By controlling for financial capital, the cost and profit function allows financial capital to deviate from the least-cost level while maintaining the assumption that banks choose all other input and output allocations to minimize costs or maximize profits.

problem loans arise because managers deliberately extend risky loans with high potential returns but at the same time they do not skimp on the resources allocated to the loan process, one would expect a positive relationship between profit efficiency and problem loans but no relationship between cost efficiency and problem loans.[7]

2. *Managerial 'Skills' Hypothesis*. 'True' managerial inefficiencies provide an alternative explanation for the problems banks had with their loan portfolios. If the presence of managers who have difficulty containing costs or raising revenues signifies poor managerial skills, then inefficiency may well be a bankwide phenomenon. Poor managerial skills thus may manifest themselves in managers' difficulties in identifying risky loan applicants and in resolving problems with existing loan customers. If this is the case, then those banks measured to be the *least* efficient should also have the greatest problems with their loan portfolios. A *negative relationship* between measured bank efficiency and the severity of problem loans would be evidence in support of the 'skills' hypothesis. If deficient managerial skills manifest themselves in difficulties controlling operating expenditures, one would expect a negative relationship between cost efficiency and problem loans and, to the extent poor cost controls affect bank profitability, a negative relationship between profit efficiency and problem loans. Alternatively, if skill deficiencies manifest themselves in managers' inability to raise revenues effectively, a negative relationship between profit efficiency and problem loans would be expected, but no relationship between cost efficiency and problem loans.

Figure 1

Nonperforming Loans at New England Banks 1984 to 1994



NPL / Total Loans represents the average of the ratios of nonperforming loans to total loans for all First Federal Reserve District commercial banks.
Source: Call Reports and author's calculations.

III. Measuring Problem Loans: The Case of New England Banks

Some efficiency studies attempt to quantify, ex ante, differences in loan quality in order to account for differences in underwriting standards. Unfortunately, the proxy often used, the contemporaneous level of nonperforming loans, is an imperfect measure. First, since problem loans do not surface until some time after loan origination, the use of contemporaneous measures of problem loans will often fail to capture differences in underwriting standards. Second, since problem loans can also arise because of events outside the control of management, the level of nonperforming loans is not entirely endogenous. If the level of nonperforming loans is driven primarily by exogenous events, it will not reflect differences in managerial operating decisions. Ultimately, whether or not problem loans are determined by exogenous or endogenous events will determine how one should treat them when estimating bank efficiency.

By concentrating on banks operating in the First Federal Reserve District during the 1980s and early 1990s, this study avoids the exogeneity/endogeneity problem typically encountered when studying the relationship between problem loans and bank efficiency. In this study, estimates of bank efficiency should not be significantly affected by exogenous events that cause loan problems, because efficiency is measured over the 1984–88 period when nonperforming loans were low for virtually all banks in the region. As Figure 1 shows, it was not until 1989 that loan delinquencies became a significant problem in the region. The study measures loan problems during the 1989–92 period, so that banks' operating decisions

[7] Berger and DeYoung (1997) directly test the 'skimping' hypothesis using measures of problem loans and cost efficiency. Their analysis of a national sample of commercial banks fails to find support for the 'skimping' hypothesis. This study differs from theirs in that it looks to explain problem loans only at New England banks. In addition, measures of profit efficiency are considered along with measures of cost efficiency. Because banks that deliberately choose to underwrite risky loans may not be 'skimping' on resource allocation, this study does not use the 'skimping' terminology defined by Berger and DeYoung.

over the 1984–88 period regarding their loan portfolios have had time to be reflected in loan performance measures. This analysis assumes that if significant deficiencies in managerial underwriting skills were present between 1984 and 1988, these deficiencies would surface in loan problems between 1989 and 1992. Alternatively, if lending policies differed significantly across banks between 1984 and 1988, this analysis assumes the effects of these policies would surface in loan problems between 1989 and 1992. Moreover, since all New England institutions likely faced the same exogenous shock, the real estate crisis, differences across banks in problem loans should reflect the endogenous factors leading to nonperforming loans.

IV. The Evidence

The New England Banking Crisis

Table 1 reviews the extent of loan problems between 1989 and 1992 at the 174 banks satisfying data requirements for this study's efficiency analysis (described in the Appendix). Problem loans are defined as the cumulative amount of loan charge-offs between 1989 and 1992 plus the bank's outstanding nonperforming loans, as of December 1992 (or as of the last filed call report, for banks that failed or were acquired between 1989 and 1992). To permit comparisons of loan problems across banks, these problem loans are then divided by total loans as of December 1992 (or as of their last call report) plus the cumulative charge-offs over the 1989–92 period.[8]

Since the analysis attempts to attribute differences in loan problems between 1989 and 1992 to differences in managerial decisions made over the 1984–88 period, two issues regarding bank mergers must be addressed. First, problem loan data for banks acquired between 1989 and 1992 are not available after the acquisition date, and thus any measure of problem loans using the limited data will likely underestimate the extent of their loan problems. The second issue concerns those banks that acquired another bank between 1989 and 1992. The problems these acquirers had with their loan portfolios come about not only from their own decisions in prior years but also from decisions made by managers of the acquired institution, and thus cannot be attributed completely to the managers of the acquirer bank. For these reasons, in Table 1 banks are differentiated according to their merger status.

Of the 174 banks in the sample, 49 banks were acquired some time between 1989 and 1992. Thirty-two acquired another banking institution over the same period. This leaves 125 banks in the 'non-acquired' sample and 96 banks is the 'non-acquired/non-acquirer' sample.[9] This final sample of 96 banks, consisting of 83 institutions that survived and 13

Table 1
Percentage of Problem Loans[a] at New England Banks, 1989 to 1992
Sample: 174 New England commercial banks that satisfied data requirements for estimation of cost efficiency between 1984 and 1988

	N	Mean	25th Percentile	75th Percentile
A. Banks that operated between 1984 and 1988:				
Total	174	9.16	4.47	11.73
B. Banks that operated between 1984 and 1988 and were not acquired between 1989 and 1992:				
Total	125	9.10	4.06	11.73
Survivors	106	7.28	3.40	10.35
Failures	19	19.29	15.09	25.78
C. Banks that operated between 1984 and 1988 and were neither acquired nor acquirers between 1989 and 1992:				
Total	96	7.96	3.38	10.55
Survivors	83	6.36	3.28	8.78
Failures	13	18.18	15.09	23.62

[a]Percentage of Problem Loans is defined as follows: [The cumulative amount of loan charge-offs between 1989 and 1992 plus nonperforming loans as of Dec. 31, 1992 (or the last filed call report)]/[Total loans as of Dec. 31, 1992 (or the last filed call report) plus cumulative charge-offs between 1989 and 1992] × 100.
Source: Call Reports and author's calculations.

[8] Because a loan classified as nonperforming may not eventually be charged off, weighting charge-offs and nonperforming loans equally in this proxy for problem loans may result in measurement error. To examine the robustness of the results, problem loans were calculated using a number of alternative definitions. These include the following: 1) defining problem loans as the ratio of cumulative charge-offs of loans to total loans, and 2) defining problem loans as the maximum ratio of nonperforming loans to total loans between 1989 and 1992. In addition, the time period over which these problem loans were measured was also varied (1989 to 1992; 1989 to 1991; and 1989 to 1993). The results in this analysis are robust to all these definitions of problem loans.

[9] Three banks were acquirer banks between 1989 and 1992 and then were subsequently acquired themselves during this same time period. Thus, the final 'non-acquired/non-acquirer' sample consists of 96 banks (174 original banks minus 46 acquired banks minus 29 acquirer banks minus 3 banks that were acquirers but subsequently were acquired themselves).

institutions that failed, is used to test the policies and skills hypotheses. For the average bank in this 'clean' sample, problem loans made up 7.96 percent of its loan portfolio. Twenty-five percent of the banks had a problem loans ratio below 3.4 percent, while another 25 percent had a ratio of 10.5 percent or more. These results demonstrate how widespread banking problems were in New England between 1989 and 1992 and, in addition, they emphasize the disparity in the quality of loan portfolios among banks in the region.

Bank Efficiency

As discussed above, an analysis of bank efficiency is used to help explain the banks' different experiences with loan problems. Table 2 presents estimates of bank efficiency ratios for New England banks between 1984 and 1988. The manner in which the ratios are calculated permits the following interpretations: The cost-efficiency ratio can be interpreted as the proportion of a bank's costs that is spent efficiently. That is, an average cost-efficiency ratio of 80 percent implies that the average bank wastes 20 percent of its costs relative to the best-practice bank in the sample. The profit-efficiency ratio can be interpreted as the proportion of the best-practice bank's profits that is earned by a particular bank. Thus, an average profit-efficiency ratio of 80 percent implies that the average bank failed to earn 20 percent of its potential profits. It should be noted that these interpretations are accurate only if efficiency estimates reflect true inefficiencies and are not biased by failure to control appropriately for differences in risk preferences.

The cost-efficiency ratio can be interpreted as the proportion of a bank's costs that is spent efficiently, the profit-efficiency ratio as the proportion of the best-practice bank's profits that is earned by a particular bank.

For the sample of 174 New England banks that satisfied data requirements for the efficiency analysis, the average cost-efficiency ratio equals 0.919. This implies that the average bank wastes close to 10 percent of its costs compared to the best-practice bank. This estimate of 10 percent inefficiency is lower than many found in previous research, which generally document inefficiencies on the order of 20 percent.[10] Because significant differences exist across studies with regard to estimation techniques used, it is difficult to identify the reason this study's inefficiency estimate is lower than many others. However, using a translog functional form, the most commonly used functional form in previous studies, instead of the flexible Fourier form, resulted in a cost-efficiency ratio of 0.892. Thus, the choice of the functional form of the cost function is not the primary source of the difference.

To distinguish the traits of banks measured as efficient from those of banks measured inefficient, banks were separated into quartiles based on the ranking of cost-efficiency ratios. Table 2 lists characteristics of banks in the top and bottom quartiles. The most cost-efficient banks have 20.75 percent of variable costs as labor costs, whereas the most inefficient banks have 29.19 percent. In addition, cost-efficient banks depend more on core deposits to finance their lending activities and less on purchased funds than their inefficient counterparts. Finally, physical capital consists of 1.62 percent of total assets at the least efficient banks while physical capital represents 1.54 percent of assets for efficient banks.

The average profit-efficiency ratio equals 0.694 for the 144 banks satisfying data requirements for the profit-efficiency analysis (see the Appendix for details). This implies that the average bank fails to earn 30.6 percent of its potential profits, estimated from the best-practice bank. As was done with cost-efficiency ratios, banks were separated into quartiles based on the ranking of their profit-efficiency ratios. Table 2 presents characteristics of banks in the top and bottom quartiles. The most profit-efficient banks held 68.62 percent of their assets as business and consumer loans, whereas the least efficient banks held only 57.97 percent. The most profit-efficient banks held 30.09 percent of their assets in securities, whereas the least profit-efficient banks held 40.42 percent in the form of

[10] See Bauer, Berger, and Humphrey (1993) for an example of efficiency estimates of a national sample of banks over a time period similar to the one in this study. Tannenwald (1995) estimated efficiency at New England banks in the 1980s and early 1990s and found a narrower efficiency gap for New England banks than many researchers had found in studies using a national sample of banks. The results in this analysis are consistent with Tannenwald's findings. However, since the estimation techniques are not identical across studies, direct comparison of results is not possible.

Table 2
Cost-Efficiency and Profit-Efficiency Ratios for New England Banks, 1984 to 1988
Sample: New England banks that satisfied data requirements for estimation of cost efficiency and profit efficiency between 1984 and 1988. N = 174 for the cost-efficiency sample and N = 144 for the profit-efficiency sample.

	N	Mean Cost-Efficiency Ratio	
Cost-efficiency ratios 1984–88, based on efficiency rankings derived from equation (1) in the Appendix.	174	.919	
Bank Characteristics Means of Individual Bank Ratios, 1984 to 1988		Banks in the lowest quartile ranking of cost efficiency	Banks in the highest quartile ranking of cost efficiency
Deposit to Assets		87.13	88.66
Total Loans to Assets		58.43	57.89
Business Loans to Assets		46.24	44.36
Consumer Loans to Assets		12.20	13.54
Securities to Assets		39.94	40.57
Labor Costs to Total Variable Costs		29.19	20.75
Core Deposits Costs to Total Variable Costs		59.00	68.05
Purchased Funds Costs to Total Variable Costs		11.81	11.20
Physical Capital to Assets		1.62	1.54
Financial Capital to Assets		6.68	6.99
	N	Mean Profit-Efficiency Ratio	
Profit-efficiency ratios 1984–88, based on efficiency rankings derived from a revised version of equation (1) in the Appendix.	144	.694	
Bank Characteristics Means of Individual Bank Ratios, 1984 to 1988		Banks in the lowest quartile ranking of profit efficiency	Banks in the highest quartile ranking of profit efficiency
Deposit to Assets		87.22	87.03
Total Loans to Assets		57.97	68.62
Business Loans to Assets		45.88	53.46
Consumer Loans to Assets		12.10	15.16
Securities to Assets		40.42	30.09
Labor Costs to Total Variable Costs		25.94	21.90
Core Deposits Costs to Total Variable Costs		63.33	63.54
Purchased Funds Costs to Total Variable Costs		10.72	14.56
Physical Capital to Assets		1.61	1.29
Financial Capital to Assets		7.36	5.91

Source: Call Reports and author's calculations.

securities. In addition, the most profit-efficient banks had a higher percentage of their costs coming from purchased funds and a lower percentage of their costs coming from labor costs than their least profit-efficient counterparts.

Bank Efficiency and Problem Loans

Tables 3 and 4 present results of tests of the 'policies' and 'skills' hypotheses, with examinations of the relationships between cost efficiency and problem loans and between profit efficiency and problem loans, respectively. In general, the data suggest that no relationship exists between cost efficiency and problem loans, but they show a positive and statistically significant relationship between profit efficiency and problem loans. Thus, the data favor the 'policies' hypothesis over the 'skills' hypothesis.

For the relationship between cost efficiency and problem loans, the Pearson correlation coefficient is 0.0521 and the Spearman rank-order correlation coefficient is 0.0343. Neither statistic is statistically different from zero (Table 3, panels A and B). Table 3, panel C, presents data on the average problem loans of banks, ranked according to cost-efficiency ratios. No clear relationship emerges from the data. Those banks in the lowest cost-efficiency quintile had more problem loans than those in the highest quintile, but banks in the next to highest cost-efficiency quintile had the most problems with their loan portfolios. In addition, panel D of Table 3 shows that one cannot reject the hypothesis that the extent of loan problems experienced by the 'least' cost-efficient banks was the same as that experienced by the 'most' cost-efficient banks. Both t-tests and Wilcoxon rank-sum tests detect no difference between problem loans of those banks in the lowest cost-efficiency

Table 3

Problem Loans, 1989 to 1992, and Cost Efficiency, 1984 to 1988, at New England Banks

Sample: New England banks that were neither acquired nor acquirer between 1989 and 1992 and satisfied data requirements for estimation of cost efficiency between 1984 and 1988. N = 96.

A. Pearson Correlation Coefficient, Problem Loans and Cost Efficiency: .0521 Significance Level: .6142

B. Spearman Rank Correlation Coefficient, Problem Loans and Cost Efficiency: .0343 Significance Level: .7399

C. Mean and Median Problem Loans at New England banks, ranked by cost efficiency:

	Problem Loans at These Banks, 1989–1992	
Banks Sorted by Cost Efficiency, 1984–1988	Mean	Median
Lowest Quintile (least cost-efficient banks)	8.36	6.99
2nd Quintile	7.17	5.21
3rd Quintile	6.38	4.47
4th Quintile	9.92	7.30
Highest Quintile (most cost-efficient banks)	8.05	6.97

D. Tests for statistical differences in problem loans between 'least' cost-efficient banks and 'most' cost-efficient banks:

Mean Problem Loans at 'Least' Cost-Efficient Banks	Mean Problem Loans at 'Most' Cost-Efficient Banks	t-statistic for differences in means between groups	Wilcoxon Rank-Sum test statistic for differences in means between groups
Lowest-Decile Banks	*Highest-Decile Banks*		
8.36	8.24	.0669	.0000
Lowest-Quintile Banks	*Highest-Quintile Banks*		
8.36	8.05	.1817	.2919
Lower-Half Banks	*Upper-Half Banks*		
7.02	8.80	1.5265	1.1321

Note: None of the test statistics signify that the means are statistically different from each other at the 10 percent significance level.
Source: Call Reports and author's calculations.

decile and those banks in the highest cost-efficiency decile.[11]

This evidence suggests that deficient managerial skills do not help explain the problems banks had with their loan portfolio and thus it goes against the 'skills' hypothesis. In addition, since no relationship between problem loans and cost efficiency was found, it is unlikely loan problems arose because some banks were willing to skimp on costs involved with the loan origination process and thus it goes against the skimping version of the 'policies' hypothesis. These results are consistent with those found by Berger and DeYoung (1997).

In contrast to the relationship between cost efficiency and problem loans, the results presented in Table 4 suggest a positive and significant relationship between profit efficiency and problem loans. The Pearson correlation coefficient and the Spearman rank-order correlation coefficient are 0.2409 and 0.2310, respectively, for the relationship between profit efficiency and problem loans. Both statistics are statistically different from zero at the 5 percent level (Table 4, panels A and B). When banks are ranked according to profit-efficiency ratios, those in the lowest cost-efficiency quintile had average problem loans equal to 6.4 percent of their loan portfolio. The median level was 4.6 percent, while for banks in the highest quintile of profit-efficiency, problem loans on average equaled 9.5 percent of the loan portfolio, with a median of 10.4 percent (Table 4, panel C). Panel D of Table 4 shows that one can reject the hypothesis that the level of problem loans experienced by the 'least' profit-efficient banks was the same as that for the 'most' profit-efficient banks. Regardless of whether one compares banks in the lowest and highest deciles or those in the bottom half and upper half of the profit-efficiency rankings, both t-tests and Wilcoxon rank-

[11] Regression analysis was performed to examine the relationship between problem loans and cost efficiency. Using a number of specifications, cost-efficiency ratios added no significant explanatory power to regressions attempting to explain the cross-sectional variation in problem loans.

Table 4
Problem Loans, 1989 to 1992, and Profit Efficiency, 1984 to 1988, at New England Banks
Sample: New England banks that were neither acquired nor acquirer between 1989 and 1992 and satisfied data requirements for estimation of profit efficiency between 1984 and 1988. N = 73.

A. Pearson Correlation Coefficient, Problem Loans and Profit Efficiency: .2409* Significance Level: .0400

B. Spearman Rank Correlation Coefficient, Problem Loans and Profit Efficiency: .2310* Significance Level: .0493

C. Mean and Median Problem Loans at New England banks, ranked by profit efficiency:

Banks Sorted by Profit Efficiency, 1984–1988	Problem Loans at These Banks, 1989–1992 Mean	Median
Lowest Quintile (least profit-efficient banks)	6.37	4.64
2nd Quintile	8.75	6.10
3rd Quintile	8.02	5.26
4th Quintile	8.80	6.97
Highest Quintile (most profit-efficient banks)	9.52	10.43

D. Tests for statistical differences in problem loans between 'least' profit-efficient banks and 'most' profit-efficient banks:

Mean Problem Loans at 'Least' Profit-Efficient Banks	Mean Problem Loans at 'Most' Profit-Efficient Banks	t-statistic for differences in means between groups	Wilcoxon Rank-Sum test statistic for differences in means between groups
Lowest-Decile Banks	*Highest-Decile Banks*		
6.08	13.28	3.7335*	2.6833*
Lowest-Quintile Banks	*Highest-Quintile Banks*		
6.37	9.52	1.7943*	1.7690*
Lower-Half Banks	*Upper-Half Banks*		
7.02	9.54	1.7226*	1.7700*

Note: * signifies that the means are statistically different from each other at the 10 percent significance level or better.
Source: Call Reports and author's calculations.

sum tests detect that problem loans of those banks in the most profit-efficient banks are greater than those experienced by the least profit-efficient banks.[12]

These results, along with the measures in Table 2 that characterize profit-efficient banks, provide evidence in support of the 'policies' hypothesis. The data suggest that some managers were more willing than others to hold a riskier loan portfolio but they also required a higher return for this increased riskiness. Given that banks classified as profit-efficient extended more loans than their inefficient counterparts, but also had a higher percentage of their loan portfolio go bad, this suggests significant differences in managerial loan policies. The data show that aggressive lenders, taking advantage of the premia on risky loans, were more profitable in the 1984–88 period than their less aggressive counterparts, but they also experienced more loan problems between 1989 and 1992.[13]

Bank Efficiency and Bank Failures

This analysis has provided evidence that some banks had riskier loan portfolios than others in the 1980s. Whether these banks with risky loan portfolios also were the ones that failed depends on whether they had an adequate capital base to absorb the loan

[12] Regression analysis was also performed to examine the relationship between problem loans and profit efficiency. Confirming the results above, profit-efficiency ratios added significant explanatory power to regressions attempting to explain the cross-sectional variation in problem loans.

[13] Because loan problems at banks that were acquirers cannot be attributed entirely to their own decisions but should also be attributed in part to managers of the banks they acquired, acquirer banks that operated during the region's crisis were excluded from this analysis. A total of 32 banks were excluded. To check to see if the exclusion of these banks significantly affects the results, the analysis was done omitting only those banks whose acquisitions were large relative to itself. Acquiring banks were excluded if the amount of assets acquired between 1989 and 1992 consisted of more than 50 percent of the acquiring bank's assets as of December 1988. Only 6 acquiring banks were excluded using this sample selection. The conclusions presented above are unchanged when using this alternative sample selection.

Table 5

Efficiency at New England Banks, 1984 to 1988, and Failure/Survival Status as of 1992

Sample: New England banks that were not acquired between 1989 and 1992 and satisfied data requirements for estimation of profit and cost efficiency between 1984 and 1988. N = 125.

Bank Characteristics	Banks That Failed as of Dec. 1992	Banks That Survived as of Dec. 1992	t-statistic for Difference in Means between Groups
Bank Efficiency, 1984–1988 (group means)			
Cost-Efficiency Ratio	.9148	.9169	.2714
Profit-Efficiency Ratio[a]	.6958	.6748	.8683
Bank Profitability, 1984–1988 (group means)			
Return on Assets (ROA), yearly bank observations	.0149	.0141	.6376
Return on Equity (ROE), yearly bank observations	.2273	.1990	1.6810*
Bank Solvency Variables, as of December 1988			
Mean Capital to Asset Ratio	.0626	.0737	2.7420*
Mean Standard Deviation of Yearly Bank ROA	.0057	.0034	3.1958*
Mean Standard Deviation of Yearly Bank ROE	.0090	.0049	3.8223*
Mean Individual Bank Z Score	21.2174	37.6181	2.3554*
Median Individual Bank Z Score	16.7616	29.5603	n.a.
Group Z Score	8.7085	13.3276	n.a.
Number of Observations	19	106	

n.a. = not applicable.

*Signifies that the means are statistically different from each other at 10 percent significance level or better.

[a]Since some banks did not satisfy the data requirements for estimation of profit efficiency, the number of observations for this variable is 99, including 16 institutions that failed and 83 that survived.

Source: Call Reports and author's calculations.

losses they incurred in the early 1990s. Banks with risky loan portfolios do not necessarily have a high risk of insolvency. If a bank with a high degree of risk in its loan portfolio also has a large amount of capital to absorb potential losses, its chance of failure may be no higher than that of a bank with a safer loan portfolio and a smaller capital base. For the case of the New England banking crisis in the early 1990s, Table 5 presents evidence to suggest that the combination of a risky loan portfolio and low capital explains why some New England banks failed while others survived.

Table 5 shows that the average profit efficiency is 0.70 for banks that failed and 0.67 for those that survived. Simple profitability ratios over the 1984 to 1988 period, the return on assets (ROA), and the return on equity (ROE) provide similar results. Cost efficiency is virtually the same for institutions that failed and those that survived. Although these results are consistent with the 'policies' hypothesis, lending policies alone do not fully explain why some banks failed while others survived, since the difference between failing banks and surviving banks in mean profit efficiency is not statistically significant. Since the previous analysis showed that banks that were measured to be profit-efficient incurred relatively higher loan losses than their less profit-efficient counterparts, it must be the case that some of these banks with risky loan portfolios were able to survive because their capital base was sufficient to cushion their loan losses. In support of this conjecture, Table 5 shows that the ratio of capital to assets at failing and surviving banks played a significant role. Banks that failed had significantly lower capital-to-asset ratios than those that survived (6.3 percent versus 7.4 percent, a difference that is significant at the 5 percent level). Thus, the banks that failed not only had relatively riskier loan portfolios but also had relatively lower capital-to-asset ratios.

Since insolvency risk depends both on the riskiness of a bank's portfolio and on its capital base, a risk index, generally known as Z, has been developed to capture the interaction between these two factors (see Hannan and Hanweck 1988). This measure of insolvency risk incorporates data on a bank's expected profits, the likelihood that these profits will be realized, and a bank's capital base. The Z statistic attempts to capture the likelihood of a bank's earnings in a given year becoming low enough to exhaust the bank's capital base and, thus, the likelihood of the bank becoming insolvent. Specifically, Z is defined as:

$$Z = [(\text{ROA}) + (\text{Capital-to-Asset Ratio})] / (\text{Standard Deviation of ROA}).$$

Higher values of Z imply lower insolvency risk because higher values of Z correspond with higher levels of equity relative to a potential shock to the earnings of a bank.[14] Thus, banks with risky loan portfolios can maintain a low risk of insolvency as long as they are adequately capitalized.

Table 5 presents two versions of the Z statistic. The first calculates Z statistics for individual banks. The bank's average ROA over the 1984 through 1988 period proxies for the bank's expected earnings and the standard deviation of each bank's ROA proxies for the riskiness of its earnings. The bank's capital-to-asset ratio is measured as of December 1988. Unfortunately, using this methodology yields Z scores that are implausibly high and, thus, failure probabilities that are implausibly low, since insolvency probabilities are inversely related to Z scores.[15] However, if the ordinal ranking of the banks in terms of their expected return/riskiness trade-off is captured during the 1984 through 1988 time period, even though the level of individual Z scores provides poor estimates of absolute insolvency risk, individual Z scores can still be used to examine relative insolvency risk. For example, one can ask whether banks that went on to fail sometime between 1989 and 1992 had relatively lower Z scores as of the end of 1988, and thus higher failure probabilities, than those banks that survived.

The second version of the Z score calculates a 'group' score for banks that went on to fail and a 'group' score for banks that survived. Expected earnings for a 'group' is proxied by averaging individual banks' ROA between 1984 and 1988 for all banks in a particular group (failed/survived). Earnings riskiness for each group is proxied by the standard deviation of this distribution of ROAs. The capital-to-asset ratio is the group average as of the end of 1988.

Table 5 shows that both individual Z scores and 'group' Z scores are lower for banks that went on to fail than for banks that survived. Banks that failed had an average individual Z score of 21.22 (the median was 16.76) while survivors had an average score of 37.62 (the median was 29.56). The difference in means is significant at the 5 percent level. Group Z scores provide similar results. The group of banks that went on to fail had a composite Z score of 8.71 while the composite score for the surviving banks was 13.33. This evidence suggests that banks that failed between 1989 and 1992 had relatively higher insolvency risk as of 1988 than banks that went on to survive. Since the Z score captures two key managerial choices, the amount of risk to accept in the asset portfolio and the level of capital to hold, this evidence suggests that managers' deliberate choices regarding the bank's riskiness, rather than just 'bad luck,' played a major role in determining whether a bank was able to survive an extreme shock to the region's economy in the early 1990s.

Whether the banks with risky loan portfolios also were the ones that failed depends on whether they had an adequate capital base to absorb the loan losses they incurred.

In a manner similar to the tests of the hypotheses regarding the riskiness of a bank's loan portfolio, one may question whether a bank's high risk of insolvency is the result of explicit managerial 'policies' or deficient managerial 'skills.' If management were risk-seeking, they may have chosen to have a risky loan

[14] See Kimball (1997) for further discussion of this index.

[15] If one assumes that bank returns are normally distributed one can calculate the probability of insolvency using bank Z scores. However, the validity of such a distributional assumption is often questioned. Even if such a distributional assumption is valid, using a short time series to estimate the mean and variance of the assumed distribution likely results in measurement error. In this study, earnings and earnings riskiness are measured over a period when bank profitability was generally quite strong for all the region's banks and thus the proxy for expected earnings is likely biased upward, while the proxy for earnings riskiness is biased downward. This results in high Z scores and thus low insolvency probabilities. In addition, by definition, Z scores capture the chance that a single-period loss wipes out capital. Thus, insolvencies probabilities derived from Z scores fail to incorporate the possibility that a sequence of multi-period losses can wipe out capital. For all these reasons, estimated failure probabilities are implausibly low and thus are not presented.

portfolio and to be highly leveraged and, thus, differences in managerial policies would explain why some banks had a higher risk of insolvency than others. In contrast, if management underestimated the true risk of their loan portfolio and thus held less capital than they would have held if they had estimated correctly, poor managerial skills would be a viable explanation for differences in insolvency risk. Unfortunately, with the available data, it is not possible to identify whether bank managers correctly or incorrectly assessed the ex ante probability that an adverse shock to the real estate market would be large enough that loan losses would deplete their capital.

V. Conclusions

The evidence shows that managers at New England banks in the 1980s made conscious decisions regarding the quality of their loan portfolios. Managers who extended the riskiest loans headed the most profitable banks, before their loans started to go bad. This suggests that these banks were requiring a risk premium on their assets in comparison to safer banks. Thus, the willingness of some managers to trade off increased risk for higher returns over the 1984–88 period can help explain why some banks had a great deal of trouble with their loan portfolios in the 1989–92 period while others had relatively minor difficulty.

Prudent risk management can significantly increase the chances of a bank surviving an extreme shock outside its control, even one of the magnitude of the collapse of the New England real estate market.

Interestingly, poor loan performance alone is not a perfect predictor of which institutions went on to fail. Rather, it is the combination of banks' portfolio risk and the level of capital banks were willing to hold that determined which banks failed. Some banks that held risky loan portfolios also had a capital base that was sufficiently high to absorb the losses between 1989 and 1992. This suggests that the risk-based capital requirements imposed by the FDIC Improvement Act of 1991, which requires that the proportion of capital a bank must hold vary with the riskiness of its asset portfolio, should decrease the chance of a similar crisis occurring in the future. This is true regardless of whether New England bank failures resulted because managers underestimated the true risk exposure of their banks or because managers who correctly assessed the ex ante probability of the region's real estate collapse were willing nevertheless to take the risk of investing extensively in this market while maintaining a relatively small capital cushion.

The results of this study have implications for those studying the efficiency of banking institutions as well. The evidence suggests that differences in the quality of banks' outputs are significant enough to affect bank efficiency measures. Failure to take into account managerial preferences regarding risk can result in risk-averse banks being classified as inefficient when in reality they are optimizing relative to their own preferences and not those of the measured 'best-practice' bank. Efficiency studies have recently begun to control for these differences; however, more widespread acceptance is warranted.

Unfortunately, the findings in this study about differences in lending policies across New England banks in the 1980s do not uncover whether the risks undertaken by some banks were imprudent. It is difficult to judge the prudence of managerial decisions; clearly some portion of the problem loan experiences of New England banks was due to exogenous factors outside managerial control. Nevertheless, this analysis has shown that the problems experienced by New England banks were not entirely determined by events beyond the control of bank managers. Rather, conscious decisions by bank managers regarding the riskiness of their loan portfolios as well as the level of capital to hold help explain why some New England banks were able to survive the real estate crisis while others failed. Prudent risk management can significantly increase the chances of a bank surviving an extreme shock outside its control, even one of the magnitude of the collapse of the New England real estate market.

Appendix: Estimating Bank Efficiency

The computation of bank cost efficiency and profit efficiency requires the estimation of both an industry cost function and an industry profit function. The proper estimation technique has been the subject of much debate. Berger and Humphrey (1997), who document 130 studies in their review of the literature, highlight the differences among these many estimation techniques. Berger and Mester (1997) sort through many of these estimation techniques in an attempt to find the "most preferred model." Their analysis provides support for what is termed as the "distribution-free, Fourier-flexible functional form" model. This technique is found to have superior properties over other econometric specifications, and this study uses Berger and Mester's preferred model to examine both cost and profit efficiency.

The cost function specifies variable costs as being determined by the prices of variable inputs, the quantities of variable outputs, some control variables, random error, and bank efficiency. The variables are defined as follows. Variable costs, C, includes the cost of labor, the cost of purchased funds, and the cost of deposits. Input prices include the price of purchased funds, w_1, the price of core deposits, w_2, and the price of labor, w_3.[16] Variable outputs include the quantity of consumer loans, y_1, the quantity of business loans, y_2, and the quantities of securities, y_3. Two fixed inputs are physical capital, z_1, and financial equity capital, z_2. The Appendix Table presents the definitions and mean values of these variables for 1988. The functional form is specified as the Fourier-flexible form. This specification is similar to the familiar translog functional form found in many efficiency studies, but it includes Fourier trigonometric terms to improve the estimation of the function for banks that are not close to the sample averages.[17] Given this specification, linear homogeneity is imposed by normalizing all prices by one of the input prices.[18] Here, all input prices and total variable costs are normalized by the last input price, w_3. In addition, total variable costs and all output quantities are scaled by fixed equity capital, z_2, to control for heteroskedasticity. Given this specification, the estimated cost function takes the form:

$$\ln(C/w_3z_2) = \alpha + \sum_{i=1}^{2} \beta_i \ln(w_i/w_3) + \sum_{k=1}^{3} \gamma_k \ln(y_k/z_2)$$

$$+ \delta_1 \ln(z_1/z_2) + 1/2 \sum_{i=1}^{2}\sum_{j=1}^{2} \beta_{ij} \ln(w_i/w_3)\ln(w_j/w_3)$$

$$+ 1/2 \sum_{k=1}^{3}\sum_{m=1}^{3} \gamma_{km} \ln(\gamma_k/z_2)\ln(y_m/z_2) + 1/2\,\delta_{11}(\ln(z_1/z_2))^2$$

$$+ \sum_{i=1}^{2}\sum_{k=1}^{3} \eta_{ik} \ln(w_i/w_3)\ln(y_k/z_2) + \sum_{i=1}^{2} \rho_{il} \ln(w_i/w_3)\ln(z_1/w_2)$$

$$+ \sum_{k=1}^{3} \tau_{kl} \ln(y_k/z_2)\ln(z_1/z_2) + \sum_{n=1}^{6} [\phi_n \cos(x_n) + \omega_n \sin(x_n)]$$

$$+ \sum_{n=1}^{6}\sum_{q=1}^{6} [\phi_{nq} \cos(x_n + x_q) + \omega_{nq} \sin(x_n + x_q)]$$

$$+ \sum_{n=1}^{6} [\phi_{nnn} \cos(x_n + x_n + x_n) + \omega_{nnn} \sin(x_n + x_n + x_n])$$

$$+ \ln u + \ln \varepsilon.$$

The trigonometrically transformed x_n terms, which are rescaled values of (w_1/w_3), (w_2/w_3), (y_1/z_2), (y_2/z_2), (y_3/z_2), and (z_1/z_2), allow for improved estimation of the cost function.[19] u represents an efficiency factor that can cause a bank's cost to be above or below that of a comparable bank. ϵ represents random error. All quantity variables have 1 added to them to avoid taking the natural logarithm of zero. Factor share equations, derived from Shephard's Lemma, are not estimated because this would impose allocative efficiency for all firms. Finally, the standard symmetry restrictions apply to the translog portion of the cost function ($\beta_{ij} = \beta_{ji}$ and $\gamma_{km} = \gamma_{mk}$).

The cost equation is estimated for each year from 1984 through 1988. The sample of banks included consists of all commercial banks operating in New England region that had been in existence for at least four years prior to the estimation year. Also, banks had to be in the 'intermediation' business: Commercial banks had to have at least 15 percent of their assets as loans and 15 percent of their liabilities as deposits to be included. Cost functions were estimated for a sample consisting of 240 banks in 1984, 232 in 1985, 217 in 1986, 208 in 1987, and 189 in 1988. One hundred and seventy-four of these banks met data requirements during the estimation period and also operated for some period of time after 1988. The R^2s for the five yearly regressions ranged from 0.968 to 0.975. (The estimated parameters from these regressions are available from the author upon request.)

Of the 174 banks that satisfied data requirements, each has five annual residuals from the estimated cost functions. The annual residual measures cost inefficiencies not accounted for by the control variables in the model, as well as random error. How to decompose this residual into cost inefficiencies and random error has been the focus of many studies. The method chosen here is the "distribution-free" approach of Berger (1993). This approach assumes that random error averages out over time. Thus, to uncover cost

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[16] The price of purchased funds and the price of core deposits are in the form of interest rates, calculated as the amount paid over the calendar year for a particular input (a flow) divided by the quantity of that input as of the end of the year (a stock). Since prices are calculated in this manner, a flow divided by a stock, measurement error is a concern. Thus, observations where prices deviate more than 2.5 standard deviations from the sample mean are eliminated.

[17] Mitchell and Onvural (1996) provide evidence that the Fourier-flexible functional form is a superior specification to the standard translog functional form.

[18] Linear homogeneity assures that a change in input prices will translate into a proportional change in total variable costs. For example, if all prices double, total variable costs double.

[19] The x_n terms are rescaled so that they fall within the interval [0.1·2π, 0.9·2π].

inefficiencies, the annual residuals are averaged over the five years, assuming random errors will average to zero over the long run. After averaging, what should remain are measures of cost inefficiencies. High averaged residuals indicate high costs relative to comparable banks. Low averaged residuals indicate low costs relative to comparable banks. An index is then created, ranging from 0 to 1, such that the most efficient bank has a value of 1 in the index. This index is constructed as in Berger and Mester (1997).

To calculate profit efficiency, the same techniques used for cost efficiency are used, with the following exceptions. First, variable costs are replaced by variable profits, P, defined as revenues from loans and securities less variable costs. Since profits can take on negative values, and since the natural logarithm of a negative value is undefined, a constant is added to each bank's profit so that the natural logarithm is taken of a positive number. This constant is equal to the absolute value of the profits earned by the bank with the lowest profits. Second, instead of specifying quantities of outputs as explanatory variables, prices of outputs are specified. Specifically, the prices of outputs include the price of consumer loans, p_1, the price of business loans, p_2, and the price of securities, p_3. The Appendix Table gives the definition and mean values of these variables. After making these adjustments, the estimation technique is identical to that of the cost-efficiency analysis. Profit functions were estimated for a sample consisting of 195 banks in 1984, 201 in 1985, 193 in 1986, 183 in 1987, and 166 in 1988. One hundred and forty-four of these banks met data requirements during the estimation period and also operated for some period of time after 1988.[20] The R^2s for the five yearly regressions ranged from 0.578 to 0.768. The estimated parameters from these regressions are also available from the author upon request.

In order to check the robustness of the results to alternative estimation techniques, the cost and profit functions were also specified using the traditional translog functional form. The results are similar using either specification. The Spearman rank correlation coefficient for the relation between efficiency estimates derived from the Fourier-flexible specification and efficiency estimates derived from the translog specification was 0.88 for cost efficiency and 0.85 for profit efficiency.

Appendix Table

Variables Employed in the Cost and Profit Functions for the 1988 Cost and Profit Function Regressions

Sample: New England banks that satisfied data requirements for estimation of cost efficiency and profit efficiency for 1988. N = 189 for the cost-efficiency sample and N=166 for the profit-efficiency sample.

Variable	Definition	Mean	Standard Deviation
Dependent Variables			
C	Variable operating costs plus interest costs; includes costs of purchased funds, deposits, and labor ($000)	41,303	119,859
P	Variable profits; includes revenues from loans and securities less variable costs ($000)	13,381	33,388
Variable input prices			
w_1	Price of purchased funds; includes jumbo CDs, foreign deposits, federal funds purchased, all other liabilities except core deposits (percent)	.0627	.0164
w_2	Price of core deposits; includes domestic transactions accounts, time and savings accounts (percent)	.0512	.0061
w_3	Price of labor ($ per employee)	27,100	5,700
Variable output quantities (cost efficiency only)			
y_1	Consumer loans; includes installment, credit card and related plans ($000)	65,791	166,631
y_2	Business loans; includes all loans not included in consumer loans ($000)	375,204	1,042,184
y_3	Securities; includes all non-loan financial assets (Total Assets − y_1 − y_2 − z_1) ($000)	188,670	644,867
Variable output prices (profit efficiency only)			
p_1	Price of consumer loans (percent)	.1152	.0417
p_2	Price of business loans (percent)	.1115	.0201
p_3	Price of securities (percent)	.0467	.0143
Fixed input quantities			
z_1	Physical Equity Capital ($000)	8,325	22,798
z_2	Financial Equity Capital ($000)	37,959	99,614

Note: Variables are defined as in Berger and Mester (1997).
Source: Call Reports and author's calculations.

[20] The sample size for the profit function regressions is smaller than the sample size for the cost function regressions since some banks were eliminated because of measurement error in calculating output prices. Output prices were calculated in the same manner as input prices (see footnote 16).

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