X-Efficiency and Management Quality in Commercial Banks

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Introduction

Econometric studies of banking costs reveal surprisingly large cost differences between otherwise similar banks. After controlling for differences in size, product mix, number of branches, and a variety of market factors, these studies typically find that the average bank incurs costs that are 20 to 25 percent higher than costs at the most efficient banks. These excess costs are commonly referred to as X-inefficiencies to distinguish them from scale or scope inefficiencies. Estimates of X-inefficiency are considerably larger than estimates of scale and scope economies and appear to be comprised mostly of technical inefficiency, although some studies have also found nontrivial amounts of allocative inefficiency.

A number of empirical studies have found relationships between X-inefficiency and bank structure, organizational form, and market environment.[1] Studies have found higher levels of banking X-inefficiency in states with greater regulatory restrictions, and have also found that banks in multibank holding company organizations – allegedly formed to circumvent such restrictions – are more X-inefficient than branch banking organizations. There is evidence that X-inefficiency is larger in banks where the CEO chairs the board of directors, perhaps because this arrangement makes monitoring more difficult and reduces the effectiveness of incentive mechanisms. Some studies have found that X-inefficiency is less severe in larger banks, perhaps because large banks experience greater pressure from owners

[1] These studies are discussed in Section I, "Empirical Literature on Cost Inefficiency in Banks."

concerning bottom-line profits, are better able to attract capable managers, and/or operate in metropolitan markets that are both more competitive (creating pressure to control costs) and more densely populated (allowing more efficient delivery systems).

These results suggest a dichotomy: some X-inefficiency occurs because conditions outside managers' control (e.g., restrictive branching laws, low population density) prevent them from operating their banks efficiently, while the rest of X-inefficiency is due to, or is exacerbated by, bad management practices (e.g., managerial laxity when rivalry is not intense, utility-maximizing behavior by managers). No previous empirical studies have attempted to separate the proportion of X-inefficiency *imposed on* managers from the proportion *caused by* managers.

This study compares X-inefficiency in well-managed national banks to X-inefficiency in poorly managed national banks. Because management quality cannot be observed directly, national banks are assigned to these two groups based on the management component of the CAMEL rating assigned to them by examiners from the Office of the Comptroller of the Currency (OCC). The intergroup difference in X-inefficiency is estimated using a thick frontier cost approach that filters out cost differences that are beyond the control of managers. The results are compared to estimates of total X-inefficiency in order to approximate the relative importance of management quality in determining overall X-inefficiency in banks. On average, poorly managed banks exhibited about 12 percent more X-inefficiency than did well-managed banks. This result is around two-thirds as large as total X-inefficiency.

Section I summarizes the empirical literature on X-efficiency in banking. Section II describes how bank examiners assign management quality ratings to banks and shows how these ratings are related to various measures of bank performance. Section III presents the statistical cost model used to generate estimates of X-inefficiency. Section IV describes the data. Section V contains preliminary results. Section VI draws some conclusions from the results and discusses the potential for future research.

I. Empirical Literature on Cost Inefficiency in Banks

The empirical literature on cost efficiency in banks has burgeoned during the past five years. Berger, Hunter, and Timme (1993) and Evanoff and Israilevich (1991a) contain good reviews of this literature. In general, these studies find that banks of similar size and product mix incur widely divergent costs that vary by amounts far larger than the savings available from scale and scope economies. Many of the studies focus on what Leibenstein (1966) called "X-inefficiencies," i.e, costs incurred over and above the minimum cost necessary to sustain output at its current level. Leibenstein coined the term to describe management laxity that arises in firms with market power, but in the banking cost literature it has come to be used in a more general sense to describe any excess cost of production not caused by suboptimal scale or scope.

I.A Estimates of X-Inefficiency in Banks

X-inefficiencies are usually estimated by computing the distance between a bank's actual costs and a "frontier-efficient" or "best practices" cost function representing the lower bound of costs attainable only by the most cost-efficient banks. Empirical studies using these methods generally control for cost differences due to scale, product mix, branching status, and regional variation in input prices, and often decompose the resulting estimates of X-inefficiency into technical inefficiency (employing unnecessary inputs or paying above market prices for inputs) and allocative inefficiency (employing inputs in suboptimal combinations).

Four different techniques, which differ based on maintained assumptions about error term(s), have been used to generate estimates of X-inefficiency in banks. The econometric frontier approach (EFA) separates the error term in an econometric cost function into two components: a symmetric, random disturbance, and a one-sided, nonrandom component that is assumed to be related to inefficiencies. Using EFA methods, Ferrier and Lovell (1990) found that costs at the average bank were about 26 percent greater than the frontier, approximately two-thirds of which was allocative inefficiency, Pi and Timme (1993) found that the average bank in their sample of large, publicly traded banks incurred controllable costs that were approximately 11 percent higher than the frontier, and Bauer, Berger, and Humphrey (1993) found that X-inefficiencies averaged around 16 percent over an 11-year period.

The thick frontier approach (TFA) uses *a priori* information on unit costs to select subsamples of efficient and inefficient banks, then uses standard econometric techniques to estimate "thick" (as opposed to discrete edges) upper and lower cost boundaries. The error terms within each of the two subsamples are assumed to reflect only random error and luck, whereas the difference between the two subsamples is assumed to reflect only inefficiencies and market factors. This method was pioneered by Berger and Humphrey (1991), who found that the average bank had unit costs around 25 percent greater than the efficient lower bound, over two-thirds of which was technical inefficiency. Using the thick frontier approach, Bauer, Berger, and Humphrey (1993) found that X-inefficiencies averaged around 21 percent over an 11-year period.

The distribution-free approach (DFA) generates measures of cost inefficiency using the residuals from a standard econometric cost model estimated separately over a series of years. This method assumes that, because the randomness in the error terms will cancel out over time, the interyear average residual contains only information about X-efficiency. Berger and Humphrey (1992) used this method to generate an ordinal efficiency index to test for cost efficiencies in large bank mergers.

Data envelopment analysis (DEA) uses a nonparametric (linear programming) method to generate a lower envelope of the production function. Since DEA is a nonstochastic approach, random error is assumed away, and any cost differences due to random events are included in inefficiency. Using DEA methods, Ferrier and Lovell (1990) found that the average bank used 21 percent more inputs than necessary, approximately three-quarters of which was technical inefficiency. Aly, Grabowski, Pasurka, and Rangan (1990) found that banks could have employed 35 percent fewer inputs without reducing output. Elyasiani and Mehdian (1990), who used a technique that measured technical but not allocative efficiency, found that banks overemployed inputs by about 12 percent.

I.B Determinants of Cost Inefficiency in Banks

There are many, non-mutually exclusive explanations for why some banks are more X-inefficient than others, and the set of empirical studies linking X-inefficiency in commercial banks to these phenomena is growing.[2] None of these studies, however, tests the relationship between management quality and X-efficiency.[3]

One line of inquiry focuses on agency theory. Using an EFA approach, Pi and Timme (1993) found that X-inefficiency in large, publicly traded commercial banks decreased as CEO stock ownership increased *as long as* the CEO was not also the chairperson of the board of directors. When the two positions were consolidated, X-inefficiency *increased* with the percentage of the firm owned by the CEO. These results suggest that stock ownership can be an effective way to reduce owners' monitoring costs and discourage utility-maximizing behavior by managers, but that such arrangements become ineffective and X-inefficiencies can result when too much power is concentrated in the hands of the CEO.

Another line of inquiry looks at differences in organizational form across banks. Using DEA methods, Grabowski, Rangan, and Rezvanian (1993) found that X-inefficiency is larger in multibank holding companies than in branch banking organizations. The authors conclude that, to the extent that multibank holding companies are organizational arrangements designed to circumvent product and geographic market restrictions, removal of regulatory barriers will improve efficiency in banking markets by reducing X-inefficiency. Newman and Shrieves (1993) found the opposite – that multibank holding company *organizations* have about a 2 percent cost advantage over branch banking organizations – although they did not use a cost frontier approach to estimate their cost model.

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[2] See Berger, Hunter, and Timme (1993, p. 228) and Evanoff and Israilevich (1991a, p. 27) for discussions of theory and evidence.

[3] A 1988 OCC study, *Bank Failure: An Evaluation of the Factors Contributing to the Failure of National Banks*, concluded that the predominant cause of bank failure is poor management, but this study did not measure cost efficiency in these banks.

There is evidence that branching and other restrictions prevent banks from operating as efficiently as possible. Evanoff and Israilevich (1991b) found that X-inefficiency in large banks is greater in regions characterized by more restrictive state level regulation, and also found that X-inefficiency in these banks decreased after the financial deregulation of the early 1980s. Evanoff, Israilevich, and Merris (1990) estimated that inefficiency due to regulation amounts to about 2 percent of total costs for large commercial banks.

Many of the studies mentioned above compare estimates of X-inefficiency across institutions of different sizes. Large banks may be more X-efficient than small banks if they face greater pressure from owners concerning bottom-line profits or are better able to attract capable managers. In addition, large banks tend to be located in highly competitive, densely populated metropolitan areas, which may create pressure to control costs and/or require fewer branch locations to provide a given amount of financial services. Evidence on the relationship between cost-based X-inefficiency and commercial bank scale is mixed. Aly, et al (1990) found a positive and statistically significant relationship between scale and only one out of four alternate measures of X-inefficiency. Berger and Humphrey (1991) found that X-inefficiency at first falls, then rises, with scale. Bauer, Berger, and Humphrey (1993) found that X-inefficiency increases with size when using EFA methods, but is not related to size when using TFA methods. Berger, Hancock, and Humphrey (1993) extended the concept of X-inefficiency to include output inefficiency (e.g., suboptimal revenues) in addition to cost-based input inefficiencies and found that this measure of X-inefficiency is negatively related to scale.

Ironically, only one study (to the author's knowledge) has attempted to find the negative relationship between X-inefficiency and market rivalry originally hypothesized by

Leibenstein. Berger and Humphrey (1992) regressed an ordinal measure of X-inefficiency on a set of variables that included market concentration and found no relationship between concentration and X-efficiency. It may not be possible to establish this relationship empirically given the difficulty of constructing meaningful measures of market concentration for banks that operate branches (or banking companies that operate banks) in multiple geographic markets.

It is possible that studies mistakenly identify banks that provide higher quality service as X-inefficient if high quality services require banks to purchase more and/or more expensive inputs than banks offering services of lesser quality. However, measurement problems make it difficult to separate cost-based X-inefficiency from cost-intensive service quality in banking. Standard measures of service or product quality (e.g., customer turnover, defect rates) are either not applicable or not available for banks. Available proxies for service quality (e.g., FTE labor per deposit account, branches per deposit account) are also not useful, because they are highly correlated with costs, and hence with X-inefficiency, by construction. Using a profit function rather than cost function to estimate X-inefficiency might control for levels of service quality – presumably, the market is willing to pay more for higher quality service – but separating service quality from other determinants of the resulting estimates of X-inefficiency would still be difficult.

II. Measuring the Quality of Bank Management

Under the Federal Deposit Insurance Corporation Improvement Act of 1991 (FDICIA), every commercial bank is examined annually for safety and soundness by either its primary federal regulator (the FDIC, the Federal Reserve System, or the OCC) or by its state regulator.[4] The most important product of the annual exam is the "CAMEL" rating. The CAMEL rating is a composite of five performance dimensions – capital adequacy (C), asset quality (A), management/administration (M), earnings (E), and liquidity (L) – each of which ranges in whole numbers from 1 ("strong performance") to 5 ("unsatisfactory").[5] The CAMEL rating also ranges from 1 ("...basically sound in every respect") to 5 ("...extremely high immediate or near term probability of failure"), although it is not an arithmetic combination of the five performance ratings.

Examiners determine the C, A, E, and L ratings based on a combination of objective information and subjective judgment, with the primary focus on the former. Ratings in these four areas are based mostly on quantifiable measures of financial performance (e.g., capital ratios, profitability ratios, earnings retention, percentage of nonperforming loans, deposit volatility, etc.), often using the performance of peer institutions as a benchmark. These four ratings are each influenced to a lesser degree by examiners' subjective evaluation of nonquantifiable phenomena (e.g., the adequacy of procedures and policies, the demonstrated ability of managers to respond to unforeseen developments, and any special circumstances that may be influencing the bank's performance).

Examiners base the M rating on more subjective analysis. Examiners attempt to gauge whether management demonstrates leadership and administrative ability, is technically

[4] A small number of banks are examined every 18 months. Banks qualify for this exception if they have less than $100 million of assets, have CAMEL ratings of 1, are well capitalized, and have not experienced a change of control during the previous 12 months.

[5] See OCC Examining Circular 159 (1979) for details of the composite CAMEL rating and its individual components.

competent, shows the ability to respond to changing circumstances, and has adequate internal controls in place – qualities that are also important for controlling costs. Examiners consider whether the board has made provisions for managerial succession, and how well management complies with the internal controls that are in place – indicators of how well the bank's board of directors monitors management, which in turn might be predictive of principal-agent problems. Compliance with regulatory statutes and tendencies toward self-dealing are also considered – qualities arguably related to the integrity of management – as well as management's willingness to serve the banking needs of the community.

The joint distribution of M ratings and CAMEL composite ratings for 3,523 national banks as of year-end 1992 is shown in Table 1.[6] The majority of banks (59 percent) were assigned CAMEL ratings of 2 ("fundamentally sound, but may reflect modest weaknesses correctable in the normal course of business"), and nearly as many banks (58 percent) were assigned M ratings of 2 ("satisfactory performance"). Banks with high CAMEL ratings tend to have high M ratings, and vice versa – the correlation between M and CAMEL was + .819. Highly positive *ex post* correlations among the performance ratings are not surprising, given that the C, A, M, E and L ratings measure phenomena that are interrelated *ex ante* by definition. In this case, however, a strong correlation raises the concern that M ratings are not independent measures of management quality, i.e., that examiners assign M ratings based primarily on banks' financial performances. To investigate further, the following OLS regression was estimated using Table 1 data:

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[6] All of the exam ratings referred to here are the most current ratings for each national bank during the eight quarters ending in fourth quarter 1992.

$$M = .773 + .147*C + .280*A + .184*E + .131*L$$
$$\quad (.025) \quad (.018) \quad (.016) \quad (.013) \quad (.016)$$

Standard errors appear in parentheses. $R^2 = .58$, which implies that 42 percent of the information in M is independent of C, A, E and L. In recognition of the discrete dependent variable, an ordered logit model:[7]

$$\text{Probability}(M=j) = \exp(\beta'X)/(1 + \exp(\beta'X))$$

was also estimated, where j = (1,5) . The resulting maximum likelihood coefficients were:

$$\beta'X = \alpha_j - .487*C - 1.120*A - .673*E - .382*L$$

where estimated α = 2.203, 6.648, 9.843, or 12.544, respectively, for j = 1, 2, 3, or 4. (The probability that M= 5 is the complement of the other four probabilities.) All of the estimated parameters were significantly different from zero at the 1 percent level. The model classified 72 percent of the M ratings correctly, i.e., in 28 percent of banks, M could not be inferred based solely on C, A, E and L. The independence of the M rating from the other performance ratings is discussed further in Section V.

Mean values for selected measures of financial performance are shown in Table 2 for banks in different M categories. All financial ratios are for year-end 1991, the midpoint of the eight-quarter period over which the M ratings were collected. Complete financial data

[7] See Maddala (1983), pp. 46-49.

Table 1: Joint Distribution of M Ratings and CAMEL Ratings

Most recent exam ratings as of year-end 1992. Data for 3,523 national banks.

	CAMEL Rating				
M Rating	1	2	3	4 and 5	Total
1	259	48	0	0	307
2	217	1718	110	6	2051
3	1	319	451	66	837
4 and 5	0	0	69	259	328
Total	477	2085	630	331	

were available for 3,345 banks.

M ratings vary with financial performance in the expected direction, and all of the reported correlation coefficients in Table 2 are significantly different from zero at the 1 percent level. M ratings improve as profitability (ROA, ROE) and as capital levels (equity/assets) increase, and get worse as asset quality (OREO/real estate loans) deteriorates. The percentage of loans made to executive officers in M 4- or 5-rated banks is triple the percentage of insider loans in M 1-rated banks, evidence that the M rating may contain information about principal-agent problems. Fee income as a percentage of assets is negatively related to M, suggesting that highly rated managers moved their banks quickly into nontraditional products and services.

M ratings are positively related to the efficiency ratio (noninterest costs/revenue). Furthermore, the evidence indicates sizeable technical inefficiencies in poorly run banks – M 4- or 5-rated banks employed one-third more workers per asset dollar, and operated two-thirds more branches per deposit dollar, than did M 1-rated banks.

M ratings tended to get worse as banks got smaller.[8] The average M 4- or 5-rated bank ($320 million in assets) was about three-quarters the size of the average M 1-rated bank ($441 million). Given that national banks range in assets from less than $10 million to over $1 billion, however, it is unlikely that bank size is the major determinant of the other results shown in Table 2.

[8] In order to maintain the confidentiality of the CAMEL ratings, the banks designated "multinational" by the OCC are excluded from the average asset figures.

Table 2: Performance Variable Means by M Rating

Year-end 1991 data for 3,345 national banks.
All reported correlations are significantly different from zero at the 1 percent level.

	M Rating				Correlation
	1	2	3	4 and 5	with M
Return on Assets	.017	.012	.006	-.010	-.445
Return on Equity	.198	.147	.053	-1.216	-.106
Equity/Assets	.089	.085	.078	.060	-.254
OREO/RE Loans	.005	.011	.021	.040	.284
Inside Loans/Assets	.0003	.0004	.0005	.0008	.074
Fees/Assets	.0032	.0019	.0016	.0010	-.073
Nonint. Costs/Revenues	.622	.684	.770	.918	.402
Branches/$M of Deposits	.037	.042	.047	.054	.133
FTEs/$M of Assets	.507	.527	.585	.680	.244
Assets ($M)*	$441	$411	$364	$320	
N	289	1970	808	278	

* OCC multinational banks excluded from asset means.

III. Measuring X-Inefficiency

Assuming that M ratings are valid measures of management quality in commercial banks, the results in Table 2 suggest that poorly managed banks are more X-inefficient than well-managed banks. The cost differences revealed in Table 2, however, are not controlled for interbank differences in product mix, input prices, organizational form, or branching laws that can affect costs. This section develops a statistical model to estimate the difference in X-inefficiency between banks with M ratings of 1 ("fully effective" management) and banks with M ratings of 4 or 5 ("generally inferior" or "incompetent" management) while controlling for these conditions.[9]

III.A Cost Model

Following Berger and Humphrey (1991), a pair of thick cost frontiers were generated by estimating the following multiproduct translog cost model separately for well-managed and poorly managed banks:[10]

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[9] Banks with M ratings of 4 were included in the poorly managed sample because there were too few national banks with M ratings of 5 to estimate a cost frontier. See section IV for a description of this data.

[10] The factor share equations were generated by differentiating the cost function with respect to W_m and invoking Shepard's lemma. The physical capital share equation was omitted from the estimation to avoid singularity in the variance-covariance matrix. The remaining four equations were estimated simultaneously using seemingly unrelated regression (SUR) techniques after imposing the standard symmetry and homogeneity restrictions on the model. See Johnston (1984), pp. 335-336. See DeYoung (1993) for a discussion of the choice of specification and functional form.

$$lnC = \alpha_0 + \sum_{i}^{5} \alpha_i lnY_i + \frac{1}{2}\sum_{i}^{5}\sum_{j}^{5} \beta_{ij} lnY_i lnY_j + \frac{1}{2}\sum_{m}^{4}\sum_{n}^{4} \delta_{mn} lnW_m lnW_n \quad (1)$$

$$+ \sum_{m}^{4} \gamma_m lnW_m + \sum_{i}^{5}\sum_{m}^{4} \theta_{im} lnY_i lnW_m + \lambda_L * LIMIT + \lambda_U * UNIT + \lambda_B * BHC + \varepsilon$$

$$S_m = \gamma_m + \sum_{n}^{4} \delta_{mn} lnW_n + \sum_{i}^{5} \theta_{im} lnY_i + \eta \quad (2)$$

where:

C	=	interest expense plus noninterest expense.
Y_i	=	output vector, i = 1,5 (commercial and industrial loans, real estate loans, consumer loans, securities, and transactions deposits)
W_m	=	input price vector, m = 1,4 (wage rate, price of physical capital, interest rate paid for deposited funds, interest rate paid on purchased funds)
LIMIT	=	dummy equal to 1 in limited branching states.
UNIT	=	dummy equal to 1 in unit banking states.
BHC	=	dummy equal to 1 if bank is a member of a bank holding company.
S_m	=	the share of C generated by expenditures on input m.
ϵ, η	=	error terms assumed to capture random cost fluctuations.

The wage rate equals salaries and benefits divided by FTE labor; the price of physical capital equals depreciation expense divided by the original price of physical assets; the price of deposited funds equals interest expense on transactions, savings, and time deposits (excluding CDs > $100,000) divided by these balances; and the price of purchased funds equals interest expense on large CDs, Fed funds, foreign deposits, and other borrowed funds divided by these balances. Transactions deposits equal demand deposits, NOW accounts, and other nonsavings and nontime deposits, and are included as a proxy for the amount of payment and liquidity services produced by the bank. BHC controls for cost differences due to organizational form.

LIMIT and UNIT are included to control for the impact of branching restrictions on costs.

Two maintained assumptions are necessary to yield the thick frontiers:

A1. The error terms *within* the well-managed (M1) and the poorly managed (M45) samples reflect only random chance and luck.

A2. The cost differences *between* the M1 and M45 samples are not due to random error but can be divided into two classes of determinants:

a. conditions special to an individual bank or local banking market that are beyond the short-run control of management (e.g., prices of inputs, mix of demand for products, organizational form, or branching laws), or

b. conditions that management has the power to reduce or eliminate (e.g., agency effects or lax cost control when competitive rivalry is not intense) or that are the result of intrinsic differences in the abilities of managers.

Stated differently, the assumptions imply that M1 banks use a production technology that is distinctly different from the production technology used by M45 banks, that these technologies reflect the "quality" (experience, education, native ability, integrity, etc.) of bank management, and that managers can influence costs only through the amount and combination of inputs they hire. These assumptions obviously do not hold exactly, but they are reasonable approximations for the purpose at hand.[11]

Although the number of branches operated by a bank has been shown elsewhere to be a significant determinant of costs, no branch variable is included in the cost function.

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[11] Berger and Humphrey (1991, p. 121) defend a similar set of assumptions: "...the thick frontier approach may not yield precise estimates of the overall level of inefficiencies in banking. However, precise measurement is not our purpose. Rather, our goals are to get a basic idea of the likely magnitude of inefficiencies..."

According to our maintained assumptions, differences in the *regressors* between the upper and lower frontiers are due to exogenous factors beyond the control of the bank and hence do not reflect efficiency, while differences in the *parameters* between the upper and lower frontiers do reflect differences in efficiency. The regressors in equation (1) – output mix, input prices, branching laws, and holding company organization – are all arguably beyond the short-run control of bank management (see section III.B), but management clearly has the short-run ability to close existing branches or (within limits in some states) open new branches. Hence, branches were excluded from the cost function, and their effect on costs is contained in the regression residual.

III.B. Estimating Cost Inefficiency Associated with Management Quality

The predicted percent difference in unit costs between banks in the M45 and M1 cost frontiers is given by:

$$DIFFM = [AC_{M45,M45} - AC_{M1,M1}]/AC_{M1,M1} \qquad (3)$$

where estimated unit costs $AC_{p,m} = C_p(X_m)/A_m$ and:

$C_p(.)$ = predicted total costs using the estimated parameters from equation (1) when the model is estimated for banks in sample p, p = (M1,M45).
X_m = the vector of variable means for banks in sample m, m = (M1,M45).
A_m = the average assets held by banks in sample m, m = (M1,M45).

Thus, DIFFM is the percentage by which the predicted unit cost of a poorly managed bank exceeds, on average, the predicted unit costs of a well-managed bank, where well-managed and poorly managed are defined by examiners' M ratings.

By construction, the cost discrepancies captured in DIFFM can be traced to two differences between the estimated M45 and M1 cost frontiers: differences in the estimated equation (1) parameters, or differences in the mean values of the regressors used to evaluate equation (1). Differences in the parameters between the M45 and M1 frontiers are attributed to the different production technologies being used by the banks – and hence, attributed to differences in decisions made by managers – in the two samples. In contrast, differences in the mean values of the regressors between the M45 and M1 cost frontiers are attributed to exogenous factors beyond the control of banks, such as local market conditions (input prices, state branching laws), customer demand (output level, output mix), or conditions that managers cannot alter in the short-run (organizational form). Thus, the portion of DIFFM owing to these exogenous factors is given by:

$$MARKETM = [AC_{M1,M45} - AC_{M1,M1}]/AC_{M1,M1} \qquad (4)$$

where $AC_{M1,M45}$ is the estimated unit cost for a bank operating with the estimated parameters of the average M 1-rated bank, but which receives exogenously the market conditions faced by the average M 4- or M 5-rated bank. The predicted percentage difference in unit costs between well-managed and poorly managed banks that cannot be attributed to exogenous market conditions is given by:

$$INEFFM = [AC_{M45,M45} - AC_{M1,M45}]/AC_{M1,M1} = DIFFM - MARKETM \qquad (5)$$

INEFFM is the percentage by which the predicted unit cost of the average poorly managed bank exceeds the predicted unit costs of the average well-managed bank, after controlling for the impact of exogenous factors on cost. It approximates the X-inefficiency in commercial banks due to differences in management quality.

MARKETM is expected to be small, but positive. Assuming that bank examiners control adequately for market conditions, the M ratings they assign will be unrelated to conditions beyond the control of bank managers, and MARKETM will be zero.[12] However, the maintained assumption that the exogenous variables are beyond the short-run control of management does not hold perfectly. For example, input prices could be related to management quality if poorly managed banks reprice their deposits less often than well-managed banks reprice theirs. This X-inefficiency will be captured in MARKETM.

III.C Management-Related X-Inefficiency as a Percentage of Total X-Inefficiency

INEFFM can be compared to estimates of total (management-related plus nonmanagement-related) X-inefficiency to approximate the portion of X-inefficiency in banks associated with differences in management quality. Again following Berger and Humphrey (1991), the following sampling technique was used to select high-cost and low-cost banks from the population of national banks in 1991. The population of banks was placed in order by asset size, and then partitioned into deciles. Within each asset decile, banks were ordered by average cost (the sum of interest and noninterest costs as a percentage of assets) and then partitioned into quartiles. The lowest cost quartiles from each of the asset deciles were assumed to contain the most cost-efficient or "best practices" banks; this subset of banks is denoted Q1. Similarly, the highest-average-cost quartiles were assumed to contain the most

[12] It is possible that bank examiners make systematic (in addition to random) errors which result in higher M ratings for banks that face exogenous, cost-increasing conditions. This issue is beyond the scope of this paper.

cost-inefficient banks; this subset of banks is denoted Q4.

Thick frontier cost functions were estimated using cost model (1) and (2) for both the cost-efficient and the cost-inefficient samples. The maintained assumptions presented above about the error terms continue to hold. The estimation results were used to generate a corollary to INEFFM:

$$INEFFQ = [AC_{Q4,Q4} - AC_{Q1,Q4}]/AC_{Q1,Q1} = DIFFQ - MARKETQ \quad (6)$$

INEFFQ is the predicted percentage difference in unit costs between the most cost-efficient banks and most cost-inefficient banks, after controlling for market factors. *A priori*, one would expect the cost residual INEFFQ to be larger than the cost residual INEFFM, because samples Q1 and Q4 are determined directly by costs, whereas samples M1 and M45 are determined based on a phenomenon (M ratings) that is merely related to costs.

IV. Data

There were 3,345 national banks for which complete end-of-year 1991 data were available. Thus, to determine the Q1 and Q4 subsamples, there were 335 banks in each asset decile (3,345÷ 10), 84 banks in each quartile within these asset deciles (335÷ 4), and 840 banks in the upper and lower unit cost quartiles (84*10). Table 3a contains descriptive statistics for Q1 and Q4 banks.

Descriptive statistics for M1 and M45 banks are shown in Table 3b. Of the 3,345 national banks in the overall sample, there were 289 banks in the M1 subsample and 278 banks in the M45 subsamples. A rating of M= 1 is "indicative of management that is fully

Table 3a: Descriptive Statistics for Upper and Lower Cost Quartile Banks

Year-end 1991 data for 1,681 national banks. OCC multinational banks excluded. Dollar amounts in thousands.

	lower quartile		upper quartile	
		% of assets		% of assets
Assets	$418,610		$440,076	
Cost	22,815	5.45%	33,215	7.55%
C&I Loans	64,295	15.35%	73,976	16.81%
Consumer Loans	45,874	10.96%	59,322	13.48%
RE Loans	85,808	20.50%	125,484	28.51%
Securities	98,001	23.41%	75,188	17.09%
Transactions Dep.	97,852	23.38%	99,274	22.56%

	lower quartile	upper quartile
Wage ($1,000/FTE)	$28.415	$30.817
Rate paid on:		
Deposited Funds	4.29%	5.08%
Purchased Funds	6.51%	7.66%
Physical Capital	43.50%	56.72%
BHC Dummy	0.763	0.723
Unit Dummy	0.112	0.022
Limit Dummy	0.351	0.289
M Rating	2.126	2.753

Table 3b: Descriptive Statistics for M = 1 and M = 4 or 5 Banks

Year-end 1991 data for 567 national banks. OCC multinational banks excluded. Dollar amounts in thousands.

	M = 1 banks	% of assets	M = 4,5 banks	% of assets
Assets	$441,116		$320,413	
Cost	27,798	6.30%	24,051	7.51%
C&I Loans	69,596	15.78%	54,636	17.05%
Consumer Loans	80,912	18.34%	25,404	7.93%
RE Loans	91,130	20.66%	111,275	34.73%
Securities	93,385	21.17%	52,715	16.45%
Transactions Dep.	94,804	21.49%	76,442	23.86%

	lower quartile	upper quartile
Wage ($1,000/FTE)	$28.613	$30.439
Rate paid on:		
Deposited Funds	4.84%	4.85%
Purchased Funds	6.65%	7.56%
Physical Capital	38.97%	53.84%
BHC Dummy	0.889	0.612
Unit Dummy	0.045	0.033
Limit Dummy	0.467	0.207
M Rating	1.000	4.225
N	289	276

effective," a rating of M= 4 is "indicative of a management that is generally inferior in ability," and a rating of M= 5 is assigned to "institutions where incompetence has been demonstrated." M 4-rated banks were added to M 5-rated banks to form the subsample of "poorly managed" banks because only 62 banks had M ratings of 5.

All variables used in the cost model were constructed from end-of-year 1991 data from the Reports of Condition and Income (call report), except for LIMIT and UNIT, which were constructed using information from Amel (1991). All CAMEL ratings were read from the National Bank Surveillance Video Display System (NBSVDS) and are used with the permission of the Office of the Comptroller of the Currency.

V. Results

Estimates of overall X-inefficiency (DIFFQ, MARKETQ, INEFFQ) are reported in Table 4, and estimates of management-related X-inefficiency (DIFFM, MARKETM, INEFFM) are reported in Table 5. In both tables, the results are segregated into asset classes to reveal possible relationships between size and X-inefficiency. (Parameter estimates for the Q1, Q4, M1, and M45 cost frontiers are reported in the Appendix.)

The estimates of overall X-inefficiency are consistent with those found in other studies of commercial banks. INEFFQ (overall X-inefficiency after adjusting for exogenous influences) averaged about 19 percent and ranged between 15 and 38 percent. Contrary to the hypothesis that larger banks are able to operate closer to the cost frontier, INEFFQ increases as banks get larger. In contrast, MARKETQ (X-inefficiency attributable to exogenous conditions)

Table 4: Total Cost Inefficiency

Year-end 1991 data for upper quartile and lower quartile national banks.
AC = predicted total costs as a percentage of total assets.
Assets in millions of dollars.

	lower quart.		upper quart.				
Assets	N	AC	N	AC	DIFFQ	MARKETQ	INEFFQ
$ 0-25	123	.057	114	.077	34.2%	17.7%	16.5%
25-50	187	.057	198	.078	37.7%	21.6%	16.0%
50-100	215	.056	208	.076	35.7%	17.4%	18.3%
100-300	202	.054	206	.072	33.3%	13.5%	19.8%
300-500	35	.055	33	.071	28.2%	12.9%	15.4%
500-1,000	27	.050	26	.069	37.2%	1.6%	35.7%
1,000+	51	.044	56	.058	29.1%	-4.5%	33.6%
Total	840		841				
Mean					34.8%	15.5%	19.3%

Table 5: Management-Related Cost Inefficiency

Year-end 1991 data for selected national banks.
Assets in millions of dollars. AC = predicted total costs as a percentage of total assets.

	M = 1		M = 4,5					
Assets	N	AC	N	AC	DIFFM	MARKETM	INEFFM	INEFFM÷ INEFFQ
$ 0-25	23	.058	83	.072	23.5%	5.8%	17.7%	107.5%
25-50	42	.063	81	.076	20.8%	11.6%	9.1%	57.1%
50-100	80	.063	45	.073	15.9%	5.1%	10.8%	59.0%
100-300	90	.062	40	.071	14.5%	3.6%	10.9%	55.1%
300-500	24	.062	10	.068	9.9%	3.5%	6.4%	41.6%
500-1,000	16	.062	2	.067	8.5%	-11.4%	19.9%	55.8%
1,000+	14	.049	17	.054	12.2%	-3.1%	15.3%	45.5%
Total	289		278					
Mean					16.7%	4.6%	12.1%	65.4%

comprised about 45 percent of DIFFQ (unadjusted X-inefficiency), a larger portion than found in other thick frontier cost studies.[13] This may be due to differences in the way the cost model is constructed – among other differences, earlier studies have specified separate equations for operating costs and interest costs, included variables to measure the number of branch offices, and estimated the model separately for banks in branching and unit banking states.[14]

Banks judged by examiners to be poorly managed displayed substantial X-inefficiency relative to banks judged by examiners to be well-managed. INEFFM (management-related X-inefficiency after adjusting for conditions beyond the control of management) averaged about 12 percent and ranged between 6 percent and 20 percent. However, the cost residual between M1 and M45 banks was uniformly smaller than the cost residual between Q1 and Q4 banks. Overall, INEFFM averaged about 65 percent the size of INEFFQ. As expected, MARKETM was relatively small, averaging 4.6 percent, or about 28 percent of the total cost residual DIFFM. There appears to be no relationship between management-related X-inefficiency and bank size.

In Section II, M ratings were shown to be positively related to financial performance, and it was suggested that bank examiners might not assess management quality independently from the other performance ratings. If so, then the portion of X-inefficiency associated with

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[13] Berger and Humphrey (1991) found that MARKET explained about 7 percent of DIFF for banks in unit banking states in 1984, and about 13 percent of DIFF for banks in branch banking states in the same year. Pantalone and Platt (1993) found that MARKET explained 28 percent of DIFF for thrifts in 1978 and 33 percent of DIFF for thrifts in 1988.

[14] Both UNIT and LIMIT had significant negative coefficients in the Q1 cost frontier, suggesting that banks that can branch freely tend to overbranch. Hence, MARKETQ will be larger to the extent that Q4 banks are more likely than Q1 banks to operate in states without branching restrictions. The data in Table 3a shows that both UNIT (.021 vs. .112) and LIMIT (.288 vs. .351) were lower for Q4 banks.

management quality may be less than 28 percent of banking costs, and differences in management quality might account for less than 65 percent of total X-inefficiency in banks. To address this concern, the results of the ordered logit model presented in Section II were used to separate the M rating into two components: information coincident with that portion of a bank's financial performance represented by the C, A, E, and L ratings, and information that is orthogonal to these four performance ratings. Each bank's actual M rating was compared to the M rating predicted for it (i.e., the M category assigned the highest probability estimate) by the logit model. A bank was assumed to be well-managed if its actual M rating was better than its predicted M rating, and poorly managed if its actual M rating was worse than its predicted M rating. This procedure resulted in 515 well-managed banks and 558 poorly managed banks.[15] Thick cost frontiers were estimated for these two sets of banks, and versions of DIFF, MARKET, and INEFF were generated.

The results are reported in Table 6.[16] On average, the X-inefficiency (INEFFL) associated with this "pure" measure of management quality increased costs by only about 1½ percent, and equaled only about 7 percent of total X-inefficiency (INEFFQ). There are two basic ways to interpret these results. At one extreme, one could conclude that management quality plays only a small role in determining cost differences between banks. At the other extreme, one could conclude that management quality plays a large role in determining inter-bank cost differences, but that roughly 90 percent of its impact (7 percent ÷ 65 percent) is

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[15] For the well-managed banks, mean CAMEL=2.12, mean actual M=1.66, and mean predicted M=2.68. For the poorly managed banks, mean CAMEL=2.62, mean actual M = 3.33, and mean predicted M = 2.28.

[16] A similar procedure based on the highest and lowest residuals from the OLS model produced results (not shown) substantially the same as those in Table 6.

Table 6: Management-Related Cost Inefficiency from Ordered Logit

Year-end 1991 data for selected national banks. Assets in millions of dollars.
AC = predicted total costs as a percentage of total assets. Predicted M = management rating with highest estimated probability in the ordered logit model.

	actual M < predicted M		actual M > predicted M					
Assets	N	AC	N	AC	DIFFL	MARKETL	INEFFL	INEFFL÷ INEFFQ
$ 0-25	57	.066	117	.066	-0.1%	0.4%	-0.5%	- 0.3%
25-50	84	.066	151	.067	1.9%	2.3%	-0.4%	- 0.3%
50-100	126	.066	142	.064	-2.5%	-4.7%	2.2%	12.2%
100-300	138	.062	107	.062	-0.3%	-2.3%	2.0%	10.1%
300-500	42	.063	17	.063	-0.0%	-3.5%	3.5%	22.7%
500-1,000	25	.061	10	.059	-4.4%	-4.4%	0.0%	0.0%
1,000+	43	.041	14	.053	30.9%	24.4%	6.5%	19.4%
Total	515		558					
Mean					1.2%	-0.2%	1.4%	7.5%

reflected in measurable financial performance captured by examiners in the C, A, E, and L ratings (e.g., good underwriting standards that result in fewer costly nonperforming loans, or cost controls that result in higher operating margins), while the other 10 percent of its impact is associated with less tangible financial outcomes (e.g., good internal controls that result in lower agency costs).

VI. Conclusions

It seems a straightforward proposition that good managers will run their banks efficiently and bad managers will run their banks inefficiently. The results found here for national banks in 1991 confirm this common sense proposition. After adjusting for exogenous factors beyond the control of management, unit costs at national banks with "inferior" or "incompetent" management (according to bank examiners) averaged about 12 percent higher than unit costs at banks with "fully effective" management. This difference amounts for roughly two-thirds of total banking X-inefficiency found both here and in other studies. This suggests that a large portion of the cost inefficiencies present in commercial banks is associated with – though perhaps not caused by – the quality of the managers that run those banks. When the 12 percent figure was disaggregated, about 90 percent was attributed to differences in management quality associated with subpar financial performance (e.g., poor asset quality or low earnings) and the remaining 10 percent was attributed to differences in management quality not reflected by financial performance (e.g., poor internal controls that might foster principal-agent problems).

Some caution should be exercised in interpreting these results, which rest on several assumptions about the characteristics of error terms in the statistical model, as well as on the assumption that M ratings sufficiently capture interbank differences in management quality. Although no good substitute measure of management quality exists, techniques that make different assumptions about the error terms are available (e.g., stochastic frontier or data envelopment), and might be used to test the robustness of the results found here.

Finally, the results found here suggest that an active market for corporate control of banks, which supposedly identifies bad managers and replaces them with better managers, would be a potent weapon for reducing X-inefficiency. The empirical literature on bank mergers, however, raises doubts about the efficiency-enhancing potential of bank mergers. Although some studies of bank mergers have found post-merger improvements in stock prices, earnings, loan-to-asset ratios, and labor expenses, the existing literature contains little evidence of post-merger improvement in X-inefficiency.[17] Future research might attempt to reconcile the results of these studies.

[17] See Berger, Hunter, and Timme (1993) for a discussion of this literature.

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Appendix

Equation 1 parameter estimates for Q1, Q4, M1, and M45 samples.

	α_0	α_1	α_2	α_3	α_4	α_5
Q1	4.40828*	-0.22839	0.54268*	0.51123*	-0.00522	-0.10510
Q4	3.59959*	-0.53617*	0.38666*	-0.06678	0.31591*	0.49178*
M1	4.28801	0.42704	-0.20161	0.20593	-0.64860*	1.07170*
M45	1.83230	-0.09688	0.18903	-0.03932	-0.05907	0.52832

	β_{11}	β_{22}	β_{33}	β_{44}	β_{55}	β_{12}
Q1	0.065516*	0.02812*	0.09727*	0.11592*	0.14083*	-0.02441*
Q4	0.031516*	0.05541*	0.20275*	0.09241*	0.08866*	-0.02708*
M1	0.047351*	0.08056*	0.13685*	0.09322*	0.12620*	-0.02555
M45	0.097173*	0.04369*	0.16195*	0.09774*	0.16431*	-0.02912*

	β_{13}	β_{14}	β_{15}	β_{23}	β_{24}	β_{25}
Q1	-0.02671*	0.00482	-0.01789	0.00542	-0.02870*	0.02003
Q4	-0.02091*	-0.00412	0.02577*	-0.01058*	-0.03359*	0.02080*
M1	-0.02382*	-0.02844	0.02595	-0.00773	-0.01259	-0.01032
M45	-0.02281	-0.00400	0.03597	0.01627	-0.01536	-0.02011

	β_{34}	β_{35}	β_{45}	γ_1	γ_2	γ_3
Q1	-0.01513*	-0.05183*	-0.07208*	-0.59212*	0.51480*	0.75634*
Q4	-0.02966*	-0.13151*	-0.01327	0.03623	2.15105*	-0.74878*
M1	0.01691	-0.11361*	-0.05043*	-0.61779	2.31158*	-0.92748
M45	-0.04195*	-0.09108*	-0.02433	0.72170	1.31255*	-0.80376

	γ_5	δ_{11}	δ_{22}	δ_{33}	δ_{44}	δ_{12}
Q1	0.32097*	0.14883*	0.06987	0.07141*	-0.00385	0.02142
Q4	-0.43850*	-0.00179	0.30252*	0.02773	0.03397*	-0.10461*
M1	0.23369	0.16329	0.42065*	0.04218	0.01857	-0.22455*
M45	-0.23049	-0.13777	0.16800	-0.20137*	-0.00705	-0.03845

	δ_{13}	δ_{14}	δ_{23}	δ_{24}	δ_{34}	θ_{11}
Q1	-0.13713*	-0.03312	-0.09526	0.02702	0.00995	0.06126*
Q4	0.05729	0.04910	0.05576*	-0.09331*	0.01023	0.10958*
Q1	0.14302	-0.08177	-0.21995*	0.02844	0.03475	-0.03616
M45	0.13326	0.04295	0.05520	-0.09111*	0.05520	0.03706

	θ_{12}	θ_{13}	θ_{14}	θ_{21}	θ_{22}	θ_{23}
Q1	-0.06769*	0.02700	-0.02068*	-0.06556*	0.11439*	-0.03880*
Q4	-0.05128*	-0.02080	-0.03748*	-0.05847*	0.05658*	-0.04354*
M1	0.03073	0.00875	-0.00333	0.00604	-0.05927	0.03963
M45	-0.04591	0.00600	0.00274	-0.01413	-0.05815	0.06248

	θ_{34}	θ_{31}	θ_{32}	θ_{33}	θ_{34}	θ_{41}
Q1	-0.01003	-0.07186*	0.04111	0.013074	0.01766*	0.02951
Q4	0.04542*	0.01723	-0.05603*	0.022597	0.01619	-0.05344*
M1	0.01359	-0.01442	0.02370	0.001571	-0.01086	0.10388*
M45	0.00980	0.00564	-0.02287	-0.016810	0.03403*	0.01978

(* indicates statistical significance at the 10 percent level.)

Appendix

Continued.

	θ_{42}	θ_{43}	θ_{44}	θ_{51}	θ_{52}	θ_{54}
Q1	-0.01151	0.01072	-0.02873*	0.03268	-0.06448	0.00261
Q4	-0.01695	0.05048*	0.01990*	0.00118	0.00325	0.02957
M1	-0.04401	-0.03227	-0.02760	-0.08696	0.04018	-0.00998

M45	-0.01830	0.01310	-0.01459	-0.02755	0.11351	-0.04927

	θ_{54}	λ_{BHC}	λ_{UNIT}	λ_{LIMIT}	R^2
Q1	0.02918*	-0.00628	-0.03526*	-0.00900	0.9891
Q4	-0.03401*	0.02548*	-0.03790	0.00300	0.9909
M1	0.05676	0.05133*	-0.02776	-0.01655	0.9930
M45	-0.03669	0.02316	-0.08143	0.01137*	0.9917

(* indicates statistical significance at the 10 percent level.)