PRODUCTIVE EFFICIENCY IN COMMERCIAL BANKS

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Productive Efficiency in Commercial Banks

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Abstract

Commercial banks are of many different sizes, are subject to a myriad of regulatory guidelines, and have experienced both hardship and (financial) health over the past two decades. This work examines the productive efficiency of commercial banks. Efficiency measures are examined under different bank delineations- small, large, agricultural, nonagricultural, single-office, and multi-office. Productive efficiency is also analyzed with bank loan diversity, market share, market concentration, and profitability. The results are quite like others in that input-output specification, or the decision as to what banks truly produce, and what resources are utilized, markedly influence the findings. Generally, very small banks are not as efficient as large(r) banks. Single-office and multi-office banks perform with similar efficiency, as do agricultural and nonagricultural banks. Surprisingly, bank efficiency is not related to bank profitability, but is higher among banks with less diversified loan portfolios. Well diversified lenders, though, generate higher profits than do the more efficient, less-diversified lenders. Bank market share and banking market's concentration are positively related to efficiency, but there is no significant relationship between the profitability of banks and the concentration of the banking markets in which banks operate.

BACKGROUND

Commercial banks play a vital role in the economy for two paramount reasons. They provide a major source of loanable funds and their checkable deposit liabilities represent the bulk of the nation's money stock. Evaluating their performance and monitoring their financial condition is important to (and the responsibility of) bank managers, bank regulators, and the public at large as bank customers.

Competitive pressures in the marketplace force bank managers to be efficient in terms of both input and output productivity and by choice of the appropriate scale of operation.

Bank regulators, in decisions concerning branching, mergers, and holding company affiliations, must balance the vice of market concentration with the possible benefits of increased efficiency. The more efficiently banks are operated, the larger the earnings flows that may improve safety by absorbing losses, the more efficiently the nation's payments system works, and the more efficiently savings are channeled into investment (Benston et al., 1982). In the actions of dealing with insolvent institutions, regulators have in general taken a more favorable position toward larger, but not necessarily more efficient, multi-office banks applying a double standard in dealing with failed banks; allowing small banks to fail while frequently bailing out large banks. A relevant question is whether such a dual policy is justified on efficiency grounds. Are large banks more efficient than small banks?

RESEARCH APPROACH

Measures of technical, allocative, and scale efficiency are based upon the work of Farrell and extensions of it by Färe, Grosskopf and Lovell. The relative measures are illustrated through the use of Figures 1.1 and 1.2. In Figure 1.1, it is assumed that a bank uses two inputs, capital and labor, to produce loans. Let L_0L_0 and the area above and to the right represent all combinations of capital and labor which yield at least loan level L_0. Given the technology and input prices of capital and labor, represented by KL, efficient operation in production (cost minimization) occurs at point A. If point C represents a particular bank producing at output level L_0, then overall efficiency for firm C is represented by OD/OC. Further decomposed, technical efficiency, OB/OC, measures the bank's ability in generating enough loan volume with given capital and labor. Allocative efficiency, OD/OB, measures the degree to which the bank is using the economically correct combination of capital and labor. Since in ratio form, efficiency measures of unity represent (technical or allocative) efficiency, while efficiency measures of less than 1 imply input use either to the northeast (and off) of production frontier L_0L_0 or on the L_0L_0 frontier, but not at point A.

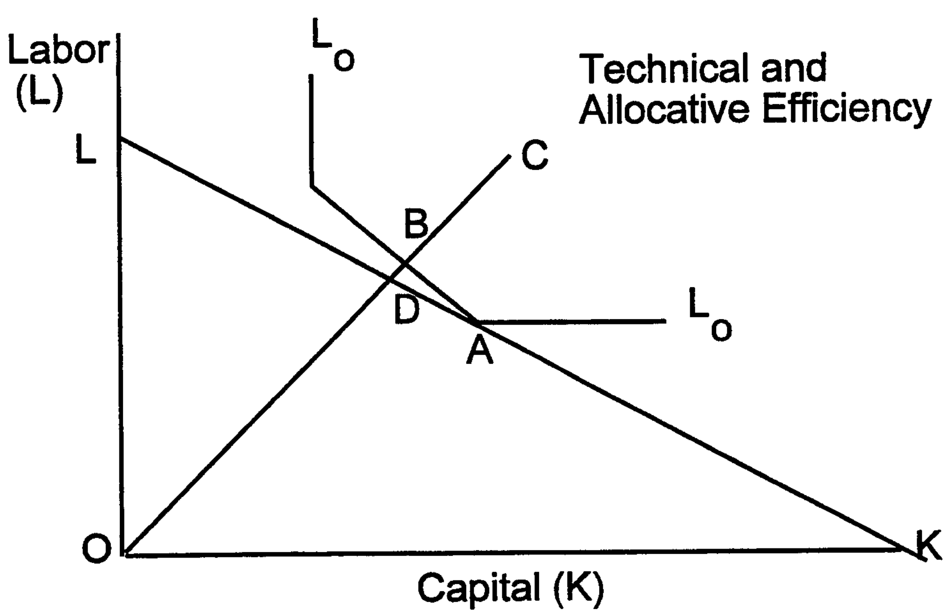

Figure 1.1 Two-Input, One Output Technology and Efficiency Measures

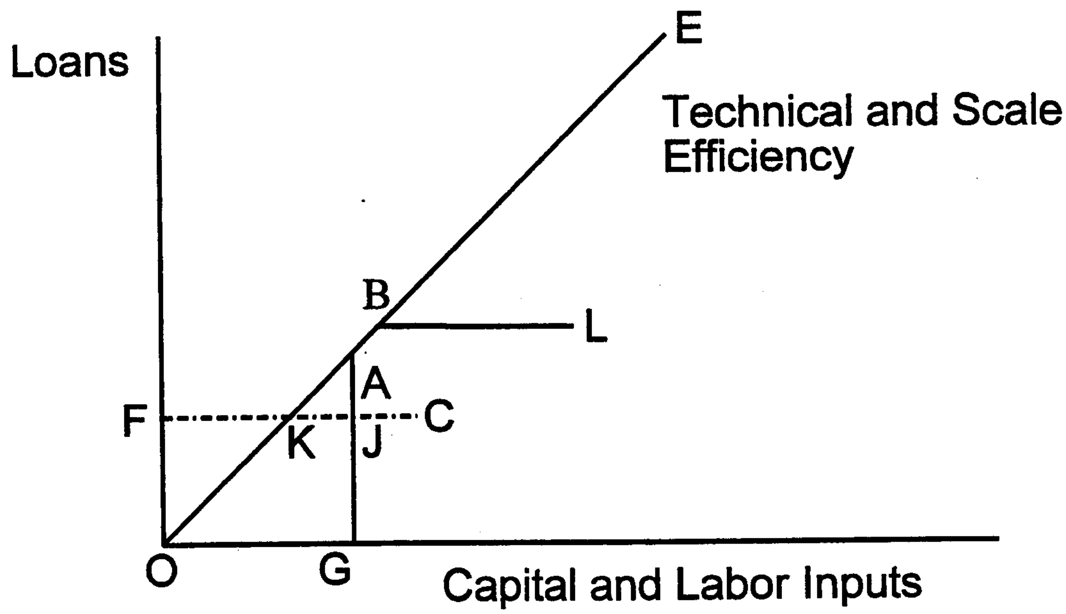

Figure 1.2 Input-Output Relationship and Efficiency Measures

In Figure 1.2, a constant returns to scale production frontier is represented by OE, which traces the potential level of loans which can be produced with given capital and labor inputs. Note the constant slope and bisection of the axes. This implies a proportional increase in loan volume and input utilization over the graph space. In contrast, the production frontier GABL is that of Farrell efficient banks, reflecting increasing, constant, and decreasing returns to scale over its mapping. For firm C, the technical efficiency is measured by FK/FC, which corresponds to OB/OC in Figure 1.1. In order to measure scale efficiency, the operating volume at which unit costs of production are minimized, a ratio of technical efficiency, FK/FC and pure technical efficiency, FJ/FC, is formed. Scale efficiency measures are always less than 1 except at optimal bank size, somewhere on segment AB.

SAMPLE BANKS

Four sets of data are used in this research. The Call and Income Report tapes published by the National Technical Information Service (NTIS) of the Department of Commerce were accessed at the University of Illinois' Department of Agricultural Economics. A quasi-random sample of 200 banks was extracted from the 1990 year-end tapes, and 200 banks extracted from the 1991 year-end tapes. Data tapes were also procured from the Federal Reserve Bank of Richmond. Data from the Federal Reserve System's Functional Cost and Profit Analysis program in 1990 and 1991 results in 208 and 399 useable observations (banks), described in detail in the following tables.

Table 1 Sample Descriptive Statistics, 200 Banks from 1990 Call Report (in millions of dollars, excepted those noted otherwise)

Variable	mean	std.dev.	minimum	maximum
Total Assets	245	244	28	1,560
Total loans	151	210	9.2	1,200
Ag prod. loans	2.1	3.2	0	23.7
Ag re loans	1.7	2.8	0	20.4
Real estate loans	84.2	109	1.8	974
Commercial loans	32.9	120	0	500
Consumer loans	26.8	50	0.2	290
Fed funds sold	12.1	56	0	237
Securities owned	68.2	86	0	586
Prem./fixed assets	3.5	6	0.1	17.2
Nonint. deposits	28.6	43	0	245
interest deposits	183	200	20	1136
Fed funds bought	8.4	21	0	377
Interest income	22	25	1.2	155.7
noninterest income	2.7	4.1	0.07	27
service chge inc.	0.8	1.1	0	6.2
NIBE	1.1	4	0.12	21
sal. and benefits	3.5	4	0.12	21
occupancy costs	1.1	1.6	0.023	7.3
other expenses	2.8	3.8	0.14	21.1
Loan Loss provision	1.9	4	0	58
Employees[1]	120	127	6	681
People Cost[2]	28.9	8.3	12.9	65.1
Other*	0.013	0.008	0.0005	0.043
Funds Cost[3]	0.0586	0.008	0.03	0.087
Loan Price[4]	0.113	0.02	0.059	0.166
Ag Bank?[5]	0.025	0.08	0	0.74

[1] Total, full-time equivalency basis
[2] Annual salary in thousands of dollars
[3] Annual dollar cost per dollar deposits
[4] Annual interest charge per dollar loaned
[5] Proportion of loan portfolio agricultural loans

* Other bank expenses generally include, but are not limited to: supplies, postage, courier, freight, travel, marketing, advertizing, and promotion, small fixtures and software, professional services, general insurance, dues, publications, subscriptions, telephone, telegraph, and cafeteria per dollar deposits.

Table 2 Sample Descriptive Statistics, 200 Banks from 1991 Call Report (in millions of dollars, excepted those noted otherwise)

Variable	mean	std.dev.	minimum	maximum
Total assets	288	302	25.2	2,284
Total loans	169	174	7	1,962
Ag production loans	1.6	4	0	17
Ag real estate loans	1.5	3	0	21
Real estate loans	96	111	0	649
Commercial loans	36	55	0	1,627
Consumer loans	30	38	0.006	465
Fed funds sold	16.7	24	0	699
Securities owned	83.6	75	0	526
Prem/fixed assets	4.7	3.3	0.03	41.9
nonint. deposits	33.9	33	0	281
interest deposits	213	174	21	1175
Fed funds bought	7.4	31	0	194
Interest income	24.5	23	0.4	192
noninterest income	3.9	2.6	0.06	39.3
service charge income	1.1	0.9	0	9.8
NIBE	1.8	5.4	-29	20
salaries and benefits	4	3.7	0.3	26
occupancy costs	1.2	1.2	0.02	15.3
other expenses	4	3.4	0.065	35.2
Loan Loss provision	2	5.7	0	35.9
Employees[1]	137	116	11	730
People Cost[2]	29.4	7	10.4	81.3
Other* costs	0.015	0.00	0.001	0.035
Funds Cost[3]	0.0528	0.008	0.041	0.080
Loan Price[4]	0.1063	0.02	0.03	0.178
Ag Bank?[5]	0.019	0.12	0	0.62

[1] Total, full-time equivalency basis
[2] Annual salary in thousands of dollars
[3] Annual dollar cost per dollar deposits
[4] Annual interest charge per dollar loaned
[5] Proportion of loan portfolio agricultural loans

* Other bank expenses generally include, but are not limited to: supplies, postage, courier, freight, travel, marketing, advertising, and promotion, small fixtures and software, professional services, general insurance, dues, publications, subscriptions, telephone, telegraph, and cafeteria per dollar deposits.

Table 3 Descriptive Statistics, 208 Functional Cost Participants, 1990 (in millions of dollars, excepted those noted otherwise)

Variable	mean	std.dev.	minimum	maximum
Total assets	303	310	7	5,463
Total loans	194	220	4	4,299
Agricultural loans	1.7	4	0	27
Real estate loans	84	115	0	3,633
Commercial loans	61	70	0	403
Consumer loans	25	35	0	320
Fed funds sold	10	16	0	208
Securities owned	84	83	0.6	1,562
Prem./fixed assets	4.2	4	0.04	117
nonint. deposits	21	18	0	351
Fed funds bought	1.4	10	0	59
Interest income	28	25	0.7	489
noninterest income	2	2.5	0.01	29.6
NI	0.6	4	-100	10
sal. and benefits	4	4.7	0.06	47
occupancy costs	1.2	1.2	0.02	15.3
Loan Loss provision	1.8	6	0.2	70
Officers	33	24	1	246
Employees[1]	108	101	3	1330
Officer cost	51.2	30	23	127
Employee Cost[2]	19.5	9.7	12	42
Funds Cost[3]	0.061	0.009	0.035	0.080
Loan Price[4]	0.11	0.02	0.086	0.156
Ag Bank?[5]	0.009	0.15	0	0.75

[1] Total, full-time equivalency basis
[2] Annual salary in thousands of dollars
[3] Annual dollar cost per dollar deposits
[4] Annual interest charge per dollar loaned
[5] Proportion of loan portfolio agricultural loans

Table 4 Descriptive Statistics, 399 Functional Cost Participants, 1991 (in millions of dollars, excepted those noted otherwise)

Variable	mean	std.dev.	minimum	maximum
Total assets	280	400	8	9,500
Total loans	151	202	3	6,100
Agricultural loans	1.1	4	0	17
Real estate loans	88	101	0	3,633
Commercial loans	53	95	0	950
Consumer loans	22	40	0	505
Fed funds sold	9	12	0	86
Securities owned	86	99	0	4,667
Prem./fixed assets	4.2	4	0.01	176
nonint. deposits	21	21	0	900
Fed funds bought	3.6	18	0	536
Interest income	21	26	0.7	766
noninterest income	4.3	14	0.08	227
NI	0.6	10	-100	86
sal. and benefits	4.2	5.2	0.08	93
occupancy costs	1.2	1.2	0.02	15.3
Loan Loss provision	1.1	5	0.7	49
Officers	32	40	1	1,114
Employees[1]	99	155	3	2,784
Officer cost	59.4	33	4	189
Employee Cost[2]	24.6	17	6	55
Funds Cost[3]	0.51	0.01	0.027	0.075
Loan Price[4]	0.097	0.02	0.057	0.128
Ag Bank?[5]	0.008	0.14	0	0.58

[1] Total, full-time equivalency basis
[2] Annual salary in thousands of dollars
[3] Annual dollar cost per dollar deposits
[4] Annual interest charge per dollar loaned
[5] Proportion of loan portfolio agricultural loans

The underlying advantage of using the Functional Cost data is in their item count variables that better reflect the flow characteristics of banking services. Five services are developed, the data extracted from the Functional Cost tapes, and summaries presented in Table 5.

Table 5 Service Categories, 1990 Functional Cost Participants

Service 1 -	loan applications processed
Service 2 -	Loans serviced
Service 3 -	account closing and/or opening and product sale (i.e., safe deposit box, savings bond, etc.)
Service 4 -	number of accounts serviced
Service 5 -	teller transactions, comprised of account withdrawals, deposits, checks cashed, credit card slips processed, and electronic fund transfer posting.

With heed given to bank's information processing and data storage functions, the computer hours per week for each bank is used as a technological flow of input used in intermediation services. Summaries of these heretofore uninvestigated flow variables of FCA banks are in Table 6.

Table 6 Summary Statistics of Services Functions, 1990 Functional Cost Participants

Variable	mean	maximum	minimum
Service 1	4499	41000	0
Service 2	9347	97654	517
Service 3	12349	208086	76
Service 4	9261	69000	1746
Service 5	4900000	73000000	7200
Bank Offices	5.5	57	1
CPU hours/week	102	168	0

RESULTS

Since no other researchers have included the Functional Cost data along with Call Reports the way this paper has, no prior input-output specifications and standard practices are available against which to compare the above methods and outcomes. Three models share the same output vector novel to FCA users or proprietary (firm level) analysts. The services, or item counts of seemingly equivalent effort tasks, are outputs in Models UF190, UF190A, and UF690. Item counts for all of the inputs - officer, employees, computer hours, ATM machine, and bank offices - are combined to evaluate loan requests, service loans, service bank accounts, sell products, and post transactions, the array of service outputs. The mean efficiency of the 1990 FCA participants under Model UF190 is 60%, with median 56%, and inner quartile range of 33 (76-43). Adding one additional input, point of sale terminals, to the input array of about 3% of the participants's inputs, as expected, reduces mean efficiency to 57% (and median to 53). This is Model UF190A, where efficiency results are highly correlated, 0.89, with Model UF190. Model UF290 shares the common input bundle with Model UF190, but simplifies the output to the Elyasiani and Mehdian choice of revenue. The distributional characteristics of the efficiency results is very similar to Model UF190's results, but correlation of results is only -0.04. The same banks who are good at performing services (a higher efficiency rating in Model UF190), may or may not be good at generating revenue. The services included in the output array may not be priced accurately or even being priced (generating revenue) at all.

Table 7 Overall Efficiency Results, 1990 FCA Sample

	Model					
	UF190A	UF190	UF290	UF390	UF490	UF690
Mean efficiency	57	60	63	71	70	47
Median efficiency	53	56	58	70	69	43
std. dev.	24	24	20	20	19	32
Q_1	41	43	47	57	56	15
Q_3	71	76	76	86	85	71

Table 8 Overall Efficiency Correlations, 1990 FCA Sample

	Model				
	UF190A	UF190	UF290	UF390	UF490
UF190	0.89				
UF290	-0.14	-0.04			
UF390	0.40	0.35	0.28		
UF490	-0.11	0.08	0.65	0	
UF690	0.38	0.35	-0.12	0.21	0.24

In addition, the services included in Model UF190's output bundle are not the major sources of funds for banks. Interest and investment income collections are not necessarily linked to the number of loans processed and serviced, number of accounts serviced, opened, closed, or bonds sold, and transactions recorded. Thus it is not surprising that revenue and services are produced by the FCA participants with roughly the same efficiency, but by different banks. Model UF690 also measures bank's ability to provide service, but with a more intermediary input set. Using officers, employees, offices, their costs, and loan funds, banks provide services with less than encouraging efficiency. The mean efficiency result is

47% (median 43) in Model UF690, with weakly positive correlations with Model UF190A, UF190, UF390, and UF490 overall efficiency results.

Models UF390 and UF490 share a simplified production oriented input bundle, namely officers, employees, and technology per employee to generate intermediatory dollar denominated outputs. In Model UF390, real estate loans, consumer loans, commercial loans, other loans, and demand deposits are produced with an average 71% efficiency (70% median), with moderately positive efficiency correlations with production models UF190A, UF190, and UF290, and no detectable relationship with Model UF490, although their input arrays are identical. In Model UF490, noninterest and interest revenue are the outputs that officers, employees, and capital (technology) are to generate. The efficiency mean result is 70% (median 69), and results most highly correlated with Model UF290, sharer of two inputs in generating revenue, the sum of Model UF490's noninterest and interest revenue.

Functional Cost data are used in Models UF191, UF291, and UF391. The value-added of a bank's safe keeping of depositor's funds, making them readily accessible, and emitting them in loan or securities portfolios is used by some analysts in describing what a bank does. In Model UF191 all transaction deposits and all non- transaction deposits, ordinarily viewed as inputs to a bank are viewed as products (output) depositors desire. In addition, banks make loans and investments. Inputs include premises and fixed asset resources, officer, employees, other expenses, and loan funds. Mean efficiency is 58% (median 59). Changing slightly the output specifications in Model UF291, to include regular demand deposits and regular savings deposits in lieu of all deposits in the prior model, mean efficiency rose to 61% (median 60). The correlation between the two model's efficiency results is 0.83. In Model UF391, officers, employees, noninterest expenses and interest expenses aim to produce demand and savings services, loans, and investments. Mean efficiency level is 56%, and quartile boundaries fall slightly in Model UF391 versus Model UF291. The correlation between Model UF291 and UF391 overall efficiency score is 0.90.

Table 9 Overall Efficiency Results, 1991 FCA Sample

	Model		
	UF191	UF291	UF391
Mean eff'cy	61	58	56
Median eff'cy	60	59	57
std. dev.	27	27	26
Q_1	40	36	37
Q_3	83	80	76

Table 10 Overall Efficiency Correlations, 1991 FCA Sample

	Model UF191	UF291
UF291	0.83	
UF391	0.78	0.90

Table 11 Mean Efficiency Estimates, 1990 FCA Banks

	Model					
	UF190A	UF190	UF290	UF390	UF490	UF690
OE	57	60	63	71	70	47
A	92	94	66	77	77	56
T	62	64	95	92	91	80
S	88	86	98	99	100	99

The 1990 Functional Cost participant's efficiency results are summarized in Table 11. Model UF190A and UF190 are virtually identical in input-output specifications except the seven banks with point-of-sale terminals have this added input, a technology placed into its input array in Model UF190A. Since the service output available given the FCA data is the same for each bank in the two models, the overall efficiency especially of those banks with POS inputs, declines. The banks, though, are generally more allocatively efficient in provision of services than in the provision or production of interest revenue, noninterest revenue, or any other dollar denominated output. This result is consistent with Ferrier and Lovell's findings also using FCA data. When a more production oriented input-output specification is adopted, with flow variables and items counts, technical inefficiency tends to dominate allocative inefficiency. Model UF290 results with item count input and revenue the sole output, more closely resemble Models UF390, UF490, and UF690 in that constant cost scale economics are computed and allocative inefficiency, representing the wrong mixture of inputs, more heavily influences bank's operational efficiency than technical efficiency. The magnitudes of the overall efficiency levels are quite similar to those found using Call Reports but are slightly lower than those derived econometrically. No significant relationship exists between the ranking of banks in their cost efficiency using the translog estimation techniques and programming method. At best, the ranking of the 208 FCA participating banks from 1990 is not in disagreement with the cost frontier construct. At worst, they do not agree either.

Table 12 Mean Efficiency Estimates, 1991 FCA Banks

	Model		
	UF191	UF291	UF391
OE	61	58	56
A	68	64	61
T	88	92	95
S	87	90	91

The 399 analyzed 1991 Functional Cost participating banks efficiency summaries are presented in Table 12. Again, large amounts of improvement can be made to the average firm in either using less resources or using a more correct combination of inputs to emulate those best practice banks among the FCA participants.

This points to one of the many dangers of using deposits, for which banks pay, as an output. Griffel-Tatjé, et al. note this phenomena in their examination of efficiency sensitivity to variable specification. Measured efficiency increases when deposits are treated as inputs as opposed to when treated as outputs or omitted. Not only does the sample's mean efficiency rating increase, but the number of banks in the lowest areas of the ratings distribution is reduced. They show how mean efficiency levels can improve some 20-25% and minimum levels of bank efficiency can nearly double when deposit or other loan fund variables are included as an input using DEA. But the inability of differing input-output specifications to clearly identify the best practice banks from the worst practice banks is disheartening. Even if deposits are included as inputs, as in Elyasiani and Mehdian, and Domenech, the remaining inputs and/or differing output specifications are different enough that little agreement exists in choosing best practice and worst practice entities.

Mean efficiency levels of the 208 Functional Cost participants in 1990 are summarized in Table 13.

Table 13 Mean Overall Efficiency Measures by Bank Size, 1990 FCA Banks

		Model				
Banks	Size	UF190A	UF190	UF290	UF390	UF490
44	Large	59	63	58	74	70
92	Inter.	58	61	62	68	71
45	Small	56	58	66	72	68
27	Very Small	47	50	70	74	75

The mostly production approach to input-output specification and reliance upon flow measures of output tend to somewhat contradict the prefound tendency of the large(r) banks likely being more efficient than the small(er) institutions. Although six of seven model's F-test in the ANOVA procedure is significantly greater then the critical values @α=0.10 (and two of the six at α=0.05), uniformity among bank size-efficiency relationship is absent. Very small banks lag in efficiency under the (very) strict production specifications, using the item counts of services array as the output vector (e.g., Models UF190A, UF190, UF690). This may be due, in part, to the tendency among very small banks to have others (possibly large(r) banks) perform many data intensive tasks for them (e.g. account posting, credit card processing). Similarly, any reliance that very small banks might have upon large(r) banks through a correspondent relationship may be captured in only the small(er) bank's input array and in the large(r) bank's input and output vectors. Yet, when (mostly) item counts as inputs are used and dollar denominated outputs are chosen, the very small banks perform the same if not significantly better than large, intermediate, and small banks (e.g., Models UF290, UF390, UF490).

EFFICIENCY, PROFITABILITY, AND CONCENTRATION

Several profit-concentration studies have noted a mixed set of results in examining their link and suffer from the indistinguishability between market power and efficiency as a source of concentration and profitability (Demsetz and Peltzman). This work's separation, or at least recognition, of reported profitability (albeit influenced by tax rules, accounting practices, and financial strategies) and productive efficiency into two measures is an improvement over most previous research. A bank may intermediate either at a lower cost or provide a differentiated product sufficient enough to gain market share at the expense of smaller competitors, further concentrating the market. Or, the market's most efficient firm could be making the most (high profitability) and have a growing market share (increasing concentration). Yet consumers benefit in either case. The identification of bank's productive efficiency, profitability, and market power, then aids in examining the performance of banks under different structures or concentration regimes.

The market concentration and market power of each of the Call Report banks in the 1990 sample is represented by the HHI of the banking market in which the firm is located and their respective share of the market (MS) (summarized in Table 14). These two statistics are then examined with the efficiency and profitability in testing hypotheses six, a positive relationship between bank profitability, efficiency, and competition.

Table 14 Market Share and Herfindahl-Hirshmann Summaries, 1990 Call Report Banks

	MS	HHI
mean	14.92	2051
median	6.86	1607
std.dev.	19.9	1485
minimum	.01	499
maximum	100	10000

The Pearson product-moment correlation coefficients between overall efficiency (calculated in the various models), profitability (ROA), market share (MS), and market concentration (HHI) are presented in Table 15. Only three of the efficiency-profitability correlations are significant at $\geq$ 0.10. Model FL90, positively correlated, and Model U190 and TL, negatively correlated, are different enough from zero to reject the null hypothesis of no relationship between efficiency and profitability populations.

Table 15 Correlations Between Efficiency, Profitability, Market Share, and Concentration, 1990 Call Report Banks

Overall Efficiency

	U190	U290	U390	A90	FL90	EM90	Y90	TL	ROA	MS
ROA	-.12	-.08	.02	.01	.10	-.07	.08	-.21		
MS	$.20^{c}$	$.22^{c}$	$.14^{b}$	$.16^{b}$	$.12^{b}$	$.13^{b}$	-.07	-.09	$.11^{a}$	
HHI	$.18^{c}$	$.19^{c}$	$.11^{a}$	$.21^{c}$	$.13^{b}$	$.18^{c}$	$-.10^{a}$	-.03	.06	$.84^{c}$

^{a} significant @ $\alpha = 0.10$ ^{b} significant @ α=0.05 ^{c} significant @ α=0.01

With Model Y90 and the econometric translog the exceptions, there is a significant positive relationship between the measured overall efficiency of the sampled banks and their respective market share. Market shares may tend to be larger among the most efficient banks because of their operational efficiency and ability to provide services to consumers at (more) competitive prices. Or, the banks with large(r) market shares might be more willing and/or able to concentrate and improve upon operational efficiency at the expense of customer relations, service proliferation, or increased market penetration. Similarly, the HHI is positively related to the efficiency metric in six of the seven programming models, in each, at α =0.10, and in four of the models at α = 0.01. Also, the coefficient expressing relationship between market share and profitability is significantly different from zero at α = 0.10. Although a very high, and positive relationship is expressed between market share of individual banks and the bank's market HHI, the concentration of a banking market is not significantly related to the profitability of the bank(s) operating in the market. Several of the sample banks are sole players, or at least dominant providers (e.g., MS > 0.50) of banking services in their market. These markets are (generally) characterized by an HHI in excess of 4000. Nonetheless, their profitability is by no means greater than, nor even noticeably different than the profitability of banks located in much less concentrated markets.

Table 16 Correlations Between Efficiency and Profitability 1991 Call Report Banks

	Overall Efficiency							
	U191	U291	U391	A91	FL91	EM91	Y91	TL
ROA	-.01	.01	-.03	-.03	.08	.01	.10[a]	-.08

[a] significant @ $\alpha = 0.10$ [b] significant @ $\alpha=0.05$ [c] significant @ $\alpha=0.01$

Table 16 lists the correlation coefficients measured between the overall efficiency of banks in the eight models listed with the profitability (ROA) each reported. Only one of the model's measured efficiency metrics is significantly related to bank profitability, that of Model Y90. The relatively low correlations of the other models leads one to doubt a positive relationship between the profitability and productive efficiency of the sampled banks. Similar inferences can be reached using the 1990 FCA banks, as exhibited in Table 17.

Table 17 Correlations Between Efficiency and Profitability, 1990 FCA Banks

	UF190A	UF190	UF290	UF390	UF490	UF690	TL
ROA	-.05	.00	.03	-.07	-.05	.07	-.03

EFFECTS OF INTEREST RATE SPREAD AND LOAN DIVERSITY

In this, the last section of this paper, each bank's efficiency, profitability, market share, and concentration are examined along with two measures of local economic conditions. These bank-specific measures might be the result of implemented managerial strategies or prior to financial deregulation, influenced quite heavily by legislative and regulatory mandates upon lending. The loan diversity measure (LD) is calculated to represent the breadth of most bank's primary earning asset, its loan portfolio. The bank-specific spread (SP) is the simple difference between the average annual interest rate earned on the bank's loan portfolio and the bank's cost of deposits. Summary statistics of the loan diversity (LD) and spread (SP) for those data sources included in the analysis are in Table 18.

The loan diversity of each bank is quantified in an HHI-type way, squaring, and then summing the proportion of each bank's loan portfolio in various loan categories. Operationally, a single purpose lender might be able to more easily capture the economies of scale associated with a particular loan activity if it is concentrated in that area. Whereas, for risk management or other purposes, a well diversified loan portfolio might be chosen by a bank, not necessarily the most cost effective strategy in asset management, but expected utility maximizing nonetheless. The spread attempts to reflect the lack of competitiveness in lending markets or in the offering of depository services. If abnormally low interest rates received on loans are reported by banks, and their cost of funds via deposit taking is normal, a lower than average spread should reflect the situation. If above normal rates are paid to attract deposits, and loans do not yield above standard returns for banks, the spread is assumed to be smaller than would be if the depository markets were not such an expensive source of loanable funds. In contrast, the spread should be higher than normal in markets with a loyal core of deposits and little competition for the lender in loan granting.

Table 18 Loan Diversity and Spread, All Data Sources

	LD				SP		
	CR90	CR91	FCA90	FCA91	CR90	CR91	FCA90
mean	4389	4842	4723	6839	.054	.053	.049
median	4012	4313	4213	6608	.053	.053	.049
std.dev.	1690	1809	1601	2189	.016	.017	.011
minimum	1822	1981	2750	0	.003	-.04	.021
maximum	10000	10000	9753	10000	.106	.125	.078

As can be seen, the loan portfolios among the sample's banks are rather diverse. Of banks granting loans, 1667 is the minimum LD obtainable, and 10000 is the maximum for a special purpose lender. One participating bank in the 1991 FCA sample chose not to grant loans, explaining the zero LD measure. Instead the institution invested heavily in money market instruments, securities, and the federal funds market. The mean spreads calculated for the samples' banks are very similar to those reported by the FDIC in their summary reports, 1990 and 1991. The negative spread calculated as the 1991 Call Report sample's minimum is the result of rather large loan losses impairing the bank's ability to report net earnings on its loan portfolio.

One might guess that banks offering an array of loans to a variety of client-types may not be as operationally efficient in the administration of their loan portfolio as is a single-purpose lender. Saddled with higher information, personnel, and other expenses than if the firm chose to make one type of loan, to one type of customer, a positive relationship should exist between a bank's LD and overall productive efficiency. Similarly, an elevated spread should translate into higher profits. If lack of competition or market power associated with a large(r) bank is reflected in their ability to procure funds at a lower cost or make loans at higher interest rates than is normal, spread and the bank's MS and/or HHI should also be positively related. Loan diversity is examined with efficiency, profitability, and competitiveness measures using Pearson's r, the correlation coefficient, with significant relationships further analyzed using simple linear regression. Table 19 summarizes the findings using the 1990 Call Report sample.

Table 19 Correlation Coefficients and Relational Results Between Efficiency, Profitability, Competitiveness, Loan Diversity, and Spread, 1990 Call Report Banks

	U190	U290	U390	A90	FL90	EM90	Y90	TL	ROA	MS	HHI
LD	.20[c]	.19[c]	.17[c]	.06	.02	.02	-.02	.08c	-.26[c]	.12[b]	.09
SP	-.20[c]	-.23[c]	-.21[c]	-.14[b]	-.11[a]	-.11[a]	-.03	-.13[b]	.16[b]	-.05	-.05

[a] significant @ $\alpha = 0.10$ [b] significant @ α=0.05 [c] significant @ α=0.01

In three of the seven models using 1990 Call Report banks and the nonparametric frontier analytic technique, loan diversity is significantly related to overall efficiency. In Model U190, U290, and U390, loan diversity is positively correlated with overall efficiency. Each coefficient is significantly different from zero at α=0.01, suggesting that the population distribution of bank efficiency is related to the distribution of bank loan diversity. Regression results of efficiency being dependent upon loan diversity support the positive relationship between loan specialization and productive efficiency. P-values on the slope coefficient in the three regression models are 0.013, 0.012, and 0.012, respectively. The least diversified banks (with respect to loans) are noted with higher operational efficiency measures. The loan diversity measure is negatively related to profitability (r=-0.264), is significantly different from zero at α=0.01, and is supported using regression analysis (t=3.85, p-value=0.011). This implies that single purpose lenders tend to lag in profitability versus the diversified banks.

The correlation of spread with Models U190, U290, and U390 overall efficiency estimates are significant. But the interpretation is not like that expressed previously regarding the loan diversity measure. The negative correlations imply that large(r) net interest spreads are affiliated with low(er) levels of efficiency. One possible explanation may be in examining spread's correlation with loan diversity (LD). Their correlation coefficient is significant, and also negative, meaning that single purpose lenders, those with the attributed high(er) efficiency scores, are characterized by low(er) spreads. Those lenders with well diversified loan portfolios, while not normally the most efficient, receive higher net interest spreads. The ultimate outcome may be summarized in examining the LD and SP measures with profitability (ROA). Banks with large spreads, not typically the most highly efficient banks, have a significant positive relationship with profitability (r=.16). In contrast, the special purpose lenders with little loan diversity have a negative relationship with profitability (r=-.26), yet are among the most efficient banks.

Relational results utilizing the 1991 Call Report sample are contained in Table 20. Loan diversity is negatively correlated with profitability (ROA). This is consistent with the prior year's findings. Single purpose lenders tend to lag in profitability relative to banks with (more) diversified portfolios. Spread, as in the previous paragraph, is positively related to profitability, and negatively related to loan diversity (LD). Each of the above three correlations are significantly different from zero, implying that the populations of bank profitability, loan diversity, and interest rate spreads are not independent of each other.

Table 20 Correlation Coefficients and Relational Results Between Efficiency, Profitability, Loan Diversity, and Spread, 1991 Call Report Banks

	U191	U291	U391	A91	FL91	EM91	Y91	TL	ROA
LD	-.02	.01	-.03	-.01	-.02	.00	-.01	.11[a]	-.27[c]
SP	.19[c]	.15[b]	.15[b]	.18[a]	.17[a]	.13[b]	.14[b]	-.04	.27[c]

[a] significant @ $\alpha = 0.10$ [b] significant @ α=0.05 [c] significant @ α=0.01

Loan diversity, when compared to the efficiency, profitability and spread measures of the 1990 and 1991 Functional Cost participants, produces similar results. In Model UF290, the overall efficiency measure and loan diversity are positively related (r=.16), meaning that special purpose lenders, with a high concentration of loans in a few classes, operate more efficiently. The correlation coefficient is significantly different from zero at α=.05. Regression analysis assesses the slope coefficient on loan diversity as also significantly different from zero, with a p-value of 0.063.

The expected negative correlation between LD and ROA is significant at α=.01 in the 1990 FCA sample. Spread is positively related to profitability (r=.25 and significant @ α=.01) and negatively related to loan diversity (r=-.25, also significant @ α=.01).

Model UF690, though, has an unexpected result in that loan diversity or lack thereof, is not associated with a high(er) level of overall efficiency. The correlation coefficient of -0.195 is significantly different from zero at α=0.01, with the result of loan diversity being regressed upon efficiency being t =2.72 and p-value = 0.10 on the slope coefficient. The item count (production) outputs in Model UF690's specification may lend itself to this result, as the number of loans analyzed and services performed (i.e., loan payments and remittances, advances on a credit line, etc.) are deemed production in the output bundle in UF690.

In Model UF191, utilizing the 399 institutions contributing to the 1991 Functional Cost sample, loan diversity is as expected, positively related to overall efficiency, implying that banks with less loan diversity, and thus a higher diversity ranking, tend to have the high(er) overall efficiency levels. The Pearson's r is 0.09, significantly different from zero at α=0.05, with regression analysis producing a p-value on the diversity beta of 0.06.

Correlation summaries using the 1990 Functional Cost participants are in Table 21.

Table 21 Correlation Coefficients and Relational Results Between Efficiency, Profitability, Loan Diversity,and Spread, 1990 FCA Banks

	UF190A	UF190	UF290	UF390	UF490	UF690	TL	ROA
LD	.03	-.04	.16[b]	.05	.10[a]	-.19[c]	-.09	-.22[c]
SP	.01	-.01	.02	-.05	-.14[b]	.04	.12[b]	.25[c]

[a] significant @ $\alpha = 0.10$ [b] significant @ $\alpha=0.05$ [c] significant @ $\alpha=0.01$

SUMMARY

Generally, the findings herein are very consistent with those of most who have performed similar analysis. The models patterned after Aly et al., who analyzed 322 Call Report institutions, find scale efficiency in excess of both technical and allocative efficiency, as did they. Technical efficiency is positively related to both bank size and degree of urbanization in Aly et al. Similarly, large(r) banks are found more efficient than both the small and very small banks and the variability of large banks efficiency measures is greater than is the variability of small banks. No difference is noted between the operational performance of single-office and multi-office banks, just as Aly et al. found in comparing branch and non-branch banks. Likewise, no significant difference is noted between the performance of agricultural and nonagricultural banks.

Ferrier and Lovell utilize Functional Cost data from 575 banks in concluding that costs are about 25-30% higher than need be, on average, and that the smallest banks in their analysis are the most efficient. This work disputes the latter finding, identifying large(r) banks as those most efficient. The correlation of bank rankings under the linear programming technique and econometric estimation in this work, like Ferrier and Lovell's, is unable to agree upon the best practice, or frontier firms. But the results of Models FL90 and FL91 agree very strongly and are highly correlated with other input-output specifications, namely U190, U290, A90, U191, U291, and A91. Agricultural and nonagricultural banks cannot be distinguished from each other in examining their overall efficiency levels.

Elyasiani and Mehdian analyze 144 Call Report banks, finding the largest institutions more efficient than are the smaller ones, similar to this work's results when using similar input-output specifications. They, like these results, site no difference in the overall performance of single-office and multi-office banks, but conclude that locational product and service differentiation enable small, boutique banks to operate successfully alongside larger, more efficient banks.

Yue's study of 60 banks in Missouri concludes that scale inefficiency is not important in banks relative performance. Technical and allocative inefficiencies cost banks much more than does operating at an incorrect scale, as evident in Model Y90 and Y91 results. The only coincident input in all the other models, labor, is not specifically recognized by Yue. Generating flows of revenue and managing flows of expenses comprise the role of banks. This somewhat unusual input-output specification of Yue results in significantly contrary efficiency correlations between Models Y90 and Y91 and all other models.

Consistent with the findings of Grifell-Tatjé et al., as input-output specifications are radically altered, the ability of analysts to predictably identify best and worst practice firms diminishes markedly. The overall efficiency results of Models A90, FL90, EM90, U190, and U290, all reliant upon the 1990 Call Report sample, are highly correlated. Likewise, the models using the 1991 Functional Cost data are highly correlated, since only slight changes are made in specifications across the models. The most discouraging is in the item count (production) and volume of funds (intermediation) disagreement. The results of Models UF190A, UF190, and UF690, with the item count service outputs, are highly correlated. But when input-output specifications are changed to include a mixture of item count inputs and intermediary outputs, any agreement as to consistency in identifying the best practice and worst practice banks disappears. Grifell-Tatjé et al. utilized proprietary data from 58 Spanish savings banks in demonstrating the sensitivity of efficiency scores to variable specification. The findings here are as disturbing in that agreement on a common core of the best and worst practice banks cannot be reached among such varied specifications.

Ellinger and Neff examine 500 rural, agricultural banks from Call Reports to conclude that large doses of (relative) inefficiency are common in banking, and that measured efficiency as well as rankings by performance change across specifications. They note the inclusion of deposits as inputs in some applications, as outputs in others. Their sample banks have an average market share of nearly 23% and operate in fairly concentrated markets, with average HHI of 2708. This study's average market share among the Call Report institutions is only 15%, and average HHI about 2000. But like Ellinger and Neff, significant amounts of efficiency can be gained if firms can emulate the best practice firms. Improper scale is not the prime component of inefficiency, even among very small banks. Instead, an improper mix of resources, and overuse of resources relative to the frontier firm's standards comprise the bulk of calculated inefficiencies.

Neff et al. estimate both a parametric translog cost frontier and variable profit model using the Fuss normalized quadratic functional form from Call Report data of 1,913 rural, agricultural banks. Interestingly, no significant correlation between the rankings of banks in their cost efficiency and revenue efficiency exists. Banks with large portions of their loan portfolios in agricultural loans are found to be less profitable. Their finding is somewhat consistent with the analysis regarding hypotheses six in that those banks with a less diversified loan portfolio, and thus high(er) LD measure, while possibly very operationally efficient, lag in profitability. Neff et al. findings are also supported by this work in acknowledging a positive link between market share and efficiency. Likewise, Neff's link between a market's

HHI and profitability of the market's bank(s) is consistent with the market share, concentration, and efficiency correlations found using the 1990 Call Report sample. Results of the translog cost estimation in this work detect no difference in relative efficiency across bank sizes, single-office or multi-office designation, or agricultural versus nonagricultural focus. Efficiency levels are extremely sensitive to choice of cost or profit measures in Neff et al. The item count opportunities permitted using the Functional Cost data squelch much of the efficiency disparity evident in the more intermediary-type models.

An expected positive relationship between operational efficiency and profitability is not substantiated by the data. The most efficient banks are not the most profitable. Efficiency, though, is positively paired with a bank's market share and also the concentration of the bank's market, as expressed by the Herfindahl-Hirshmann Index. Efficiency is also most noticeable among the focused lenders, those banks with a less than fully diversified loan portfolio. The single purpose lenders tend to be operationally more efficient, yet are not the most profitable banks. The more diversified lenders tend to generate higher earnings. Surprisingly, net interest spread is not related to a bank's market share nor the (lack of) competition in a banking market, but is positively related to the profitability of analyzed banks. And banks with larger market shares are also more likely to generate higher profits.

CONCLUSION

The use of a bank's efficiency metric by examiners in quantifying the management component in the CAMEL rating would be foolhardy. Knowing that, as analyzed, the most efficient firms are not the most profitable, and that retained profits are the primary source of bank capital, the cushion against which losses are absorbed, the (potential) safety and soundness of a bank is less so if the bank behaves as a cost minimizer. The efficiency measure can be used as an internal assessment vehicle, to rate an operation manager's performance, or to identify, just for operational comparisons, the most (cost) efficient branch or office, given the candidates have the same output components (or product lines) with similar product mixes.

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