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The profit efficiency of small US commercial banks

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Abstract

This study investigates the profit efficiency (PROFEFF) of small banks (those under $500 million in total assets) for 1990–96. Assuming that small banks and large banks use the same production technology, we find, consistent with Berger and Mester [J. Bank. Finance 21 (1997) 875], that small banks are more profit efficient than large banks. Small banks in non-metropolitan statistical areas (non-MSA) areas are consistently more profit efficient than small banks in MSAs. Cross-sectional analysis of the correlates of the PROFEFF estimates suggests that structure–performance factors, relationship–development factors, and expense-preference behavior play an important role in explaining the PROFEFF of small US commercial banks.

JEL classification: G2; D2; G21; G28; E58; E61; F33
Keywords: Profit efficiency; Commercial banking; Expense preference; Structure–performance; Loan relationships

1. Introduction

Financial economists have long been interested in the financial performance of small banks. This issue is especially important in the current era of bank consolidation. As the industry consolidates, there are concerns that small commercial banks

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may not survive; these banks have traditionally performed the important function of allocating credit to small businesses, an important source of job creation.

One difficulty in evaluating small bank performance relative to other banks is that it is affected by inherent differences in asset composition, liability composition, expenses, non-interest income, capital ratios, competition and access to credit information. The profit efficiency (PROFEFF) analysis used in this paper produces a sophisticated measure of financial performance which takes many of these differences into account. The PROFEFF measure is estimated and then regressed on variables which reflect differences in asset and liability composition, competition, location, organizational structure and other factors. This analysis provides a comprehensive picture of the differences between small banks and other banks for the period 1990–96. [2] We define small banks as those with less than $500 million in total assets.

In addition to the application of PROFEFF analysis, this approach is different because previous studies of small bank performance generally consider all small banks as one group. Forty three percent of small banks are located in metropolitan statistical areas (MSAs) and 57% are located in non-MSA areas. [3] Since both types of small banks are important parts of the banking community, it is important to understand the differences in financial performance between the two sets of small banks.

Assuming that small banks and large banks use the same production frontier, we find that small banks are more profit efficient than large banks, which is consistent with Berger and Mester (1997). Small MSA banks are the least profit efficient of the three types of banks considered. Our results suggest that small bank PROFEFF is reduced by expense-preference (EP) behavior and increased by factors related to market structure and lender–borrower relationship–development (RD).

2. Literature review and hypotheses

At least five theories have been advanced to explain why small bank financial performance may differ from that of other banks. Empirical tests have found some support for most of these theories, but these tests have generally not been conducted using a PROFEFF framework. [4] We do not attempt formal tests of the hypotheses, but we use these hypotheses to characterize our results and to interpret these results.

The oldest theory, the structure–performance (SP) hypothesis (e.g., Gilbert, 1984; Hannan, 1991a, b) suggests that, other things being equal, small banks in small communities can charge higher rates on loans and pay lower rates on deposits than other banks because there is less competition in small banking markets. This hypothesis is consistent with higher PROFEFF at small non-MSA banks.

The EP hypothesis (e.g., Arnould, 1985; Berger and Hannan, 1998; Hannan and Mavinga, 1980; Purroy and Salas, 2000; Rhoades, 1980) suggests that, ceteris pari-

[2] DeYoung and Hasan (1998) also use a PROFEFF approach to evaluate small bank performance, but their analysis deals exclusively with de novo banks.

[3] MSAs generally have total population of 50,000 or above.

[4] Berger and Hannan (1998) use a cost efficiency approach in evaluating the EP hypothesis.

bus, managers of banks in less competitive markets may dissipate part of their advantages by enjoying perquisites such as higher salaries, more assistants, lavish office quarters, etc. This hypothesis would suggest that PROFEFF at small, non-MSA banks would be lower than under the pure SP hypothesis. A variant of the EP hypothesis suggests that bank managers in smaller, less competitive markets may also shift the bank's asset composition to less risky loans and securities out of a desire to enjoy a "quiet life" (e.g., Rhoades and Rutz, 1982; Clark, 1986). Under the quiet life (QL) hypothesis, ceteris paribus, these small banks limit their output of loans, and earn less profits per dollar of assets and equity than under the SP hypothesis. In effect, these banks "cherry pick" potential loans and choose only those with clearly superior risk–return characteristics. In this process, they reject loans that may generate additional profits and value for the bank. However, because PROFEFF is defined as efficiency in producing a given level of output (see Eq. (1)), even if that level of output is low, the QL hypothesis *could* be consistent with reasonably high PROFEFF for small banks in concentrated non-MSA markets. Nonetheless, QL managers probably also engage in shirking behavior, which lowers PROFEFF. In summary, PROFEFF would be expected to be lower at small banks under this theory than under the pure SP hypothesis, because QL banks do not produce an optimal level of output, and shirking increases the cost of producing that output. The direction of the relationship between PROFEFF and QL behavior is thus ambiguous. But whatever the empirical relationship, QL behavior should be more intense in less competitive markets.

The fourth theory, the information advantage (IA) hypothesis (Nakamura, 1993a, b; Mester et al., 1998) suggests that small banks have access to better credit information than large banks (such as daily data on firm cash flows, which is available through monitoring checking accounts). In addition, there is less of an agency problem between the bank and the loan officer at small banks because senior management is closer to both the loan officer and the commercial loan customer. Other things being equal, the IA hypothesis would suggest higher PROFEFF at small banks than at large ones.

Fifth, Petersen and Rajan (1995) argue that there are less incentives to investing in loan relationships in competitive markets because of the greater probability that the loan customer may switch to a competing lender. This theory would suggest greater PROFEFF at small banks in less competitive markets because RD is an important way of reducing asymmetric information problems and increasing firm value (e.g., Diamond, 1984; Boot, 2000), and banks in these markets have a greater incentive to invest in developing these relationships. We call this the RD hypothesis.

In summary, one of the five theories (IA) suggests that PROFEFF may be higher at small banks on average than at large ones. At least two theories (SP and RD) suggest that PROFEFF should be greater for small banks in non-MSA areas than at small banks in MSAs. However, the QL and EP hypotheses suggest that small banks with an SP advantage may dissipate some of this advantage with higher expenses or shirking. While testing these theories is beyond the scope of this paper, a given set of PROFEFF results would be more consistent with some theories than others. For example, a finding of high PROFEFF at small banks in less competitive, non-metropolitan markets relative to small banks in MSA markets would be more consistent with the SP and RD hypotheses than with the others.

Both EP and QL behavior reflect agency problems between owners and managers. DeYoung et al. (2001) find interesting evidence that PROFEFF at a sample of small banks with hired managers improves when the interests of the outside manager are aligned with those of the primary owners. Specifically, PROFEFF has an inverted U-shaped relationship with the ownership share of the hired manager. PROFEFF is low when managers have little or no ownership stake; it becomes much greater as the outside manager's share increases; but it declines as the hired manager becomes entrenched. The first and third outcomes reflect EP and/or QL behavior.

Most studies of bank performance report that small banks have higher returns on assets (but not necessarily equity [5]) than large ones. Most of these studies attribute this effect at least partly to SP factors, although other factors, such as lower expenses, are also noted. For example, Boyd and Runkle (1993) report an inverse relationship between bank size and return on assets, which they attribute to monopoly rents. However, they do not consider banks under $1 billion in assets. Since over 40% of small banks are located in MSAs, where competition is generally strong, a pure SP explanation of higher ROAs at small banks is inadequate. Yellin (1995) reports that most Federal Reserve studies indicate that the performance of small banks compares very favorably with that of other banks. Berger and Mester (1997) report greater PROFEFF at small banks than at large ones. However, Elyasiani and Mehdian (1995) suggest that, because of deregulation, the future survival of small banks is in serious question. In a recent paper on the IA notion, McNulty et al. (2001) find no consistent evidence of superior loan quality at small banks, but the analysis is restricted to one large state (Florida).

3. Methodology

We examine the way in which bank PROFEFF may be affected by the aforementioned types of behavior by comparing the PROFEFF of three sets of banks—large banks, small banks in MSAs, and small non-MSA banks—and by analyzing the correlates of the PROFEFF measures. First we estimate the PROFEFF function for all US banks for 1990, 1992, 1994 and 1996. This single-frontier approach is the one most suited to address the issues noted in the introduction about the viability of small banks.

The sample includes all banks in the report of condition and income database on the Federal Reserve Bank of Chicago's web page (www.frbchi.org) for which at least one year of data are available, including newly chartered banks. We analyze the differences between the two sets of PROFEFF estimates in Section 5 to evaluate our

[5] Small banks generally have higher capital ratios, which, ceteris paribus, would give them lower interest expense and higher returns on assets, but lower returns on equity because of the smaller amount of leverage.

results relative to Berger and Mester (1997). We analyze the correlates of our PROFEFF measures in Section 6 to compare the performance of these two types of small banks and to evaluate this performance in relation to the five theories outlined in the previous section.

We also consider the possibility, noted by DeYoung and Hasan (1998), that small banks may employ different production technologies and management strategies than large banks. [6] We thus fit a separate PROFEFF function to data for small banks and large banks to answer the following question: If the assumption of different production technologies is warranted, do small banks or large banks operate closer to their respective production frontiers?

PROFEFF measures how actual financial performance compares to the best-practice frontier. It is measured as a percentage of the PROFEFF of the best-practice bank. For example, a PROFEFF measure of 0.75 means that a bank is 75% as profit efficient as the best-practice bank. The frontier is estimated separately for each year using a non-standard, Fourier-flexible form, as follows:

$$\begin{aligned}
\text{PREROA} = {} & \alpha_0 + \sum_i^3 \beta_i Y_i + \frac{1}{2}\sum_i^3\sum_j^3 \beta_{ij} Y_i Y_j + \sum_m^3 \gamma_m W_m + \frac{1}{2}\sum_m^3\sum_n^3 \gamma_{mn} W_m W_n \\
& + \sum_k^3 \phi_k Z_k + \frac{1}{2}\sum_k^3\sum_l^3 \phi_{kl} Z_k Z_l + \sum_i^3\sum_m^3 \rho_{im} Y_i W_m + \sum_i^3\sum_k^3 \phi_{ik} Y_i Z_k \\
& + \sum_m^3\sum_k^3 \phi_{mk} W_m Z_k + \sum_{i=1}^9 [\delta_i \cos X_i + \theta_i \sin X_i] \\
& + \sum_{i=1}^9\sum_{j=1}^9 [\delta_{ij} \cos(X_i + X_j) + \phi_{ij} \sin(X_i + X_j)] \\
& + \sum_{i=1}^9\sum_{j=i}^9\sum_{k=j}^9 [\delta_{ijk} \cos(X_i + X_j + X_k) + \phi_{ijk} \sin(X_i + X_j + X_k)] \\
& + v + \mu.
\end{aligned} \tag{1}$$

PREROA is operating profits (earnings before taxes, extraordinary items, and loan losses) as a percent of total assets. Y is a vector of three outputs which are defined at the bank level: (1) total loans (commercial, industrial and real estate loans), (2) retail deposits (demand deposits, time deposits and savings deposits), and (3) fee-based financial services (non-interest income). W is a vector of three market prices for

[6] Ninety five percent of our total observations are on banks under $500 million in assets. If small and large banks use different production technologies, it may not be appropriate to use a PROFEFF function estimated on a sample dominated by small banks to estimate large bank PROFEFF.

inputs, which we compute as county averages of bank level prices: (1) the wage rate for labor; (2) the interest rate for borrowed funds; and (3) the price of physical capital. [7] The Z vector is a set of three variables: (1) equity capital (defined at the bank level) to control, in a very rough fashion, [8] for the potential increased cost of funds due to financial risk. (2) a Hirschman–Herfindahl index (HHI; defined at the county level) to control for differences in competitive conditions across markets), [9] and (3) the average non-performing loan ratio (defined at the county level) to control for differences in economic conditions across markets. X is a set of nine variables that transform the output (Y) variables so that they fall on the interval from 0 to 2π. [10]

As Eq. (1) indicates, the non-standard Fourier is a hybrid form since it contains both a quadratic profit function and a series of trigonometric (Fourier) terms. Like DeYoung and Hasan, because of software limitations and limitations on the number of observations, we estimate a modified version of this function. Our function contains 18 trigonometric terms and 54 other terms for a total of 72 independent variables. This procedure of limiting the number of terms (especially the third-order terms) has been applied in most other recent PROFEFF studies (e.g., DeYoung and Hasan, 1998; Berger and Mester, 1997, 1999; DeYoung et al., 2001).

The Fourier function has been used in a number of recent efficiency studies (e.g., Berger and Mester, 1997, 1999; DeYoung and Hasan, 1998; DeYoung and Nolle, 1996; McAllister and McManus, 1993; Mitchell and Onvurall, 1996). The Fourier form is generally considered to provide a better fit than other functions (e.g., the translog) for banks with values of Y, W and Z that differ substantially from the sample mean. The non-standard Fourier form assumes that banks have some control over output prices (e.g., DeYoung and Hasan, 1998; Humphrey and Pulley, 1997). This is a reasonable assumption for loans, deposits and fee-based services. Because output prices are not exogenous under these assumptions, profit is assumed to depend on input prices and output quantities.

Eq. (1) is very similar to the function used by DeYoung and Hasan (1998). They argue, and we agree, that this function is appropriate because: (1) it avoids the difficulty in measuring output prices and (2) output quantities (rather than output prices) are allowed to explain a larger portion of the variation in profitability, which is consistent with what we know about banking practice. We differ from DeYoung and Hasan, 1998 in that we analyze the financial performance of all small banks, rather than just de novos. In addition, our specification of input prices, output quan-

[7] The wage rate equals total salaries and benefits divided by the number of full-time employees. The price of capital equals expenses of premises and equipment divided by premises and fixed assets. The price of deposits and purchased funds equals total interest expense divided by total deposits and purchased funds.

[8] Hughes et al. (2000) deal with the effect of risk in efficiency studies and provide a more detailed discussion of the potential implications of incorporating risk considerations directly into the equations. While the context of their discussion is cost efficiency, the same general considerations apply to PROFEFF studies.

[9] The HHI was calculated using the FDIC's summary of deposits (branch office) data.

[10] The methodology for performing these transformations is described in Berger and Mester (1997, 1999, p. 917n).

tities and other exogenous (Z) variables, described above, is different from theirs. Some of the variables used to construct the PROFEFF function are also used later as correlates. This procedure is justified because all theoretically important determinants of profitability should be included in the PROFEFF function. Other PROFEFF studies follow a similar approach. [11]

We employ the stochastic frontier approach proposed by Jondrow et al. (1982) and used by DeYoung and Hasan (1998) to measure each bank's divergence from the best-practice frontier. The stochastic frontier approach assumes that deviations from the frontier include inefficiencies (profit inefficiencies in our case) and random errors. Inefficiencies are assumed to follow an asymmetric, half normal distribution, and the random errors follow a symmetric normal distribution. We estimate the inefficiency term as the expected value of the profit inefficiency conditional on the residuals from each year's profit function.

We estimate a separate PROFEFF function for each year—1990, 1992, 1994, and 1996. This approach allows the regression coefficients and the efficiency measures to vary over time, thereby allowing maximum flexibility in the estimation procedure. The technique produces up to four PROFEFF measures for each bank (the actual number depends on the number of years of available data).

We define POTENTIAL PREROA as the estimated profitability of the bank if it operated on the best-practice frontier. Since efficiency cannot be negative, we follow other PROFEFF studies (e.g., DeYoung and Hasan, 1998) and define:

$$\begin{aligned}\text{PROFEFF} &= (\text{ACTUAL PREROA}/\text{POTENTIAL PREROA}) \\ &\qquad \text{if PREROA} > 0, \\ \text{PROFEFF} &= 0 \quad \text{if PREROA} < 0.\end{aligned}$$

POTENTIAL PREROA thus equals actual PREROA plus inefficiency. PROFEFF is an efficiency measure which ranges from zero for banks experiencing losses to one for banks operating on the best-practice frontier.

4. Descriptive statistics

Table 1 presents the descriptive statistics for the banks in the sample. There are 35,807 observations (34,104 for small banks and 1703 for large banks) for the four years. The first two columns of data indicate that, relative to large banks, the small banks: (1) are slightly younger; (2) are operating in markets with slightly larger non-performing loan ratios (MKTNPL); (3) are much less likely to belong to a MBHC; (4) are much more likely to be state-chartered; (5) have non-performing loan ratios (RELNPL) approximately equal to their market averages (by definition); (6) grow about half as fast; (7) have fee income/total revenue ratios less than two-thirds as high; (8) have lower demand deposits/assets; (9) have less large deposits; [12] (10)

[11] See DeYoung and Hasan (1998, p. 580n) for an explanation of and justification for this procedure.

[12] Federal funds purchased are excluded from this calculation.

Table 1
Descriptive statistics for the sample

	Variable	(1) Large	(2) Small	(3) Small MSA	(4) Small non-MSA
	Number of observations	1703	34104	14793	19311
1	AGE	76.9880***	61.2240	46.9860	72.1320***
		(39.9560)	(36.8570)	(38.4350)	(31.5140)
2	MKTNPL	0.0092***	0.0100***	0.0098	0.0101***
		(0.0071)	(0.0119)	(0.0085)	(0.0139)
3	MBHC	0.6794***	0.2911	0.2931	0.2896
		(0.4668)	(0.4543)	(0.4552)	(0.4536)
4	NATIONAL	0.4844***	0.2990	0.3272***	0.2773
		(0.4999)	(0.4578)	(0.4692)	(0.4477)
5	RELNPL	0.0009	0.0001	0.0001	0.0001
		(0.0102)	(0.0143)	(0.0139)	(0.0146)
6	GROWTH	0.3148	0.1563	0.1947***	0.1268
		(1.3277)	(0.3658)	(0.4667)	(0.2598)
7	FEEREV	0.1376***	0.0910	0.1095***	0.0768
		(0.0743)	(0.0596)	(0.0726)	(0.0421)
8	DEMDEP	0.1845***	0.1504	0.1770***	0.1301
		(0.0750)	(0.0655)	(0.0758)	(0.0470)
9	LARGEDEP	0.1052***	0.0956	0.1025***	0.0904
		(0.0866)	(0.0659)	(0.0724)	(0.0600)
10	ASSETS	1596.8000***	86.9350	112.1400***	67.6260
		(1771.7000)	(86.4090)	(103.1800)	(64.5850)
11	HHI	0.2327	0.3978***	0.2494	0.5115***
		(0.1012)	(0.2494)	(0.1444)	(0.2532)
12	NONMSA	0.0711	0.5662***	–	–
		(0.2570)	(0.4956)		
13	1 – TOTLOANS	0.3765	0.4505***	0.4267	0.4686***
		(0.1349)	(0.1422)	(0.1406)	(0.1408)
14	SALARY	0.0143	0.0161***	0.0175***	0.0151
		(0.0052)	(0.0056)	(0.0066)	(0.0044)
15	PREROA	0.0130	0.0131	0.0117	0.0142***
		(0.0094)	(0.0087)	(0.0111)	(0.0059)
16	PREROE	0.1899***	0.1226	0.0893	0.1480*
		(0.3870)	(3.0889)	(4.3760)	(1.4764)

The variables are defined in Sections 6.2 and 6.3. There are two significance tests for each variable. The first (columns (1) and (2)) tests differences between small and large banks (columns (1) and (2)). The second (columns (3) and (4)) tests differences between small banks in MSAs and those outside MSAs (columns (3) and (4)). The asterisks are placed at the larger variable when the difference is significant. The numbers in parenthesis are standard deviations.
*Significant at the 10% level.
**Significant at the 5% level.
***Significant at the 1% level.

average \$86.9 million in total assets vs. \$1.6 billion for large banks; (11) operate in markets with HHIs averaging 0.3979 (vs. 0.2327 for large banks); (12) are much more likely to be in a non-metropolitan area; (13) have a higher proportion of their assets in securities and other non-loan assets; (14) have higher ratios of salaries to total assets. In addition, relative to the large banks, the small banks have similar ratios of PREROA to assets but lower ratios of PREROA to equity.

The last two columns of Table 1 indicate that 43.3% (14,793 out of 34,104) of the small bank observations are on banks in MSAs. Relative to their counterparts in MSAs, non-MSA banks: (1) are older; (2) operate in markets with higher non-performing loan ratios; (3) are equally likely to belong to a MBHC; (4) are less likely to be national banks; (5) have non-performing loan ratios (RELNPL) approximately equal to their market averages (by definition); (6) grow about two thirds as fast; (7) have non-performing loan ratios (RELNPL) approximately equal to their market averages (by definition, as above); (8) have lower demand deposits/assets ratios; (9) have lower large deposits; (10) are smaller; (11) have much higher HHI's; (12) not applicable; (13) have higher ratios of non-loan assets/total assets (14) have lower ratios of salaries/assets; (15) have higher PREROA and PREROE.

5. Profit efficiency measures

Table 2 shows our PROFEFF estimates for various classes of banks for each year. Panel A shows the results when a single frontier is used. As noted, this is the approach most suited for answering questions about the viability of small banks. For the period as a whole, for all small banks, estimated PROFEFF is 74.74% (Panel A). Put differently, the average small bank in the sample is 74.74% as efficient as the best-practice bank in the sample for the period 1990–96. This is within the general range of the estimates produced in other PROFEFF studies.

The single-frontier results in Panel A show that small banks are more profit efficient than large banks for the period as a whole. However, this is entirely due to the first two years, when large bank profitability was especially weak because of macroeconomic conditions. Small and large bank profitability is not significantly different for 1994 and 1996. This finding of significantly greater PROFEFF for small banks based on a single frontier is consistent with Berger and Mester (1997). They also report, using two different PROFEFF methodologies, that small banks are more profit efficient. The result in Panel A that small bank PROFEFF is greater than large when a single frontier is used is consistent with the IA hypothesis. The PROFEFF results for small and large banks are in contrast to the PREROA statistics in Table 1 which show no significant difference between small and large banks. As discussed earlier, PROFEFF is a much more sophisticated performance measure than return on assets.

Reflecting the very low level of large bank PROFEFF in 1990 (only 55.85%), PROFEFF based on the single-frontier approach improved more over the period for large banks than for small ones, by approximately 25 percentage points (from 0.5585 to 0.8093) for large banks vs. 14 (from 0.6626 to 0.8024) for small ones. This is consistent with the observation that many large banks experienced major restructuring and cost cutting in the mid 1990s, which apparently improved their PROFEFF. In addition, in 1990 many banks, particularly large ones, were experiencing major loan losses and loan quality problems. (Large banks have higher ratios of

Table 2
Summary statistics for profit efficiency

Year	Small banks			Large banks			Difference	
	N	Mean	Std	*N*	Mean	Std	Mean	*t*-stat
Panel A: Small versus large banks using a single frontier for all banks								
1990	9757	0.6626	0.2882	401	0.5585	0.3355	0.1041	6.13***
1992	8934	0.7566	0.2204	407	0.7241	0.2488	0.0325	2.59***
1994	8153	0.7898	0.1692	427	0.7903	0.1733	−0.0005	0.06
1996	7260	0.8024	0.1588	468	0.8093	0.153	−0.0069	0.94
1990–96	34104	0.7474	0.2277	1703	0.7251	0.2544	0.0223	3.55***
Panel B: Small versus large banks using separate frontiers								
1990	9757	0.6567	0.2929	401	0.6412	0.3426	0.0155	0.9
1992	8934	0.7514	0.2257	407	0.7587	0.2615	−0.0073	0.56
1994	8153	0.7853	0.1769	427	0.8439	0.1575	−0.0586	7.58***
1996	7260	0.7877	0.1861	468	0.8546	0.1355	−0.0669	10.24***
1990–96	34104	0.7404	0.2358	1703	0.7795	0.2489	−0.0391	6.42***
Panel C: Small MSA versus small non-MSA banks using a single frontier for all banks								
1990	4218	0.5818	0.328	5539	0.7242	0.2358	−0.1424	23.88***
1992	3981	0.7014	0.2636	4953	0.801	0.1653	−0.0996	20.78***
1994	3547	0.7579	0.1994	4606	0.8143	0.1366	−0.0564	14.43***
1996	3047	0.7785	0.1801	4213	0.8198	0.1389	−0.0413	10.59***
1990–96	14793	0.6967	0.2677	19311	0.7862	0.1822	−0.0895	34.95***

This table presents our PROFEFF estimates for three classes of banks for the period 1990–96. PROFEFF is a sophisticated performance measure which takes differences in asset composition, liability composition, competition and other factors into consideration. PROFEFF ranges from zero for the least efficient banks to one for banks which are operating on the best-practice frontier. Panel A presents the results when a single PROFEFF frontier is estimated for small banks and large banks. Panel B presents the results when separate PROFEFF frontiers are estimated for small banks and large banks. Panel C presents the results when the small bank estimates are dis-aggregated by geographic area.
***Significant at the 1% level.

loans to assets and would thus be expected to do worse in a recession.) In contrast, by the mid 1990s, loan quality and provisions for loan losses were at extremely low levels. [13] Since not all banks were experiencing these problems in 1990, the standard deviation of PROFEFF also dropped considerably (especially for large banks) between 1990 and 1996, as the economy strengthened.

Panel B shows the results when the PROFEFF function is estimated separately for small banks and large banks. We present these results because of the possibility that small and large banks may use different production technologies. According to these estimates, PROFEFF is significantly greater on average for large banks for the

[13] A convenient statistical summary of these dramatic differences is shown in Madura (2001, p. 525).

period as a whole—0.7795 vs. 0.7404, and two of the differences are statistically significant at the 1% level. This result suggests that, if small and large banks do use different production technologies, the average large bank operates closer to its efficient frontier than the average small bank. The separate-frontier results in panel B show the same pattern as in Panel A—large bank PROFEFF improves relative to that of small banks from 1990 to 1996.

Panel C reports the small bank estimates (based on the single frontier approach) separately for MSA and non-MSA banks. These results indicate that small banks in non-MSA areas are *consistently* more profit efficient than small banks in MSAs. The difference was as great as 14.2 percentage points in 1990 (0.7242 vs. 0.5818), but it shrinks gradually to 4.1 percentage points in 1996. Importantly, the PROFEFF advantages of the small non-MSA banks *in each year* are significant at the 1% level. We attribute this difference to SP and RD factors. Finally, small banks in MSAs are the least profit efficient (0.6967 for the period as a whole) of the three types of banks considered.

6. Correlates of the profit efficiency measures

As discussed in the literature review, small bank PROFEFF is affected by a number of factors related to competition and location, as well as the bank's asset and liability composition. We explore some of these relationships in detail here. As discussed in more detail in Section 7, we construct five models to consider the factors discussed in this section.

6.1. Factors related to structure–performance, relationship—development and information advantage

As noted, the SP and RD hypotheses both suggest that, ceteris paribus, PROFEFF should be greater in more concentrated markets. The RD hypothesis is relatively new (Petersen and Rajan, 1995) so it was not considered in earlier studies of bank performance. Many studies include the HHI in a regression equation to estimate the SP effect, and we do this as well. However, since most concentrated markets are located outside of MSAs, the HHI by itself will pick up location factors (e.g., differences in market characteristics, such as income levels) as well as competitive and RD factors. Thus we also use the interaction term NONMSA $*$ HHI. NONMSA equals one for non-MSA markets (counties) and zero otherwise.

The IA and RD hypotheses stress the importance of lender–borrower relationships to small bank success in increasing shareholder value. To the extent that smaller banks rely more on developing and maintaining these relationships than banks that are larger (but are still under $500 million in total assets), these hypotheses suggest that PROFEFF may decline as size increases. We include a size variable, LNASSETS, the natural log of total assets, to test for this effect. LNASSETS is also an important control variable used in other studies.

6.2. Quiet-life and expense-preference behavior

As noted, banks in non-competitive markets may dissipate this advantage through QL behavior (e.g., a less than optimal asset composition (less loans and more securities) and shirking) and through EP behavior. To determine if PROFEFF is negatively affected by QL behavior, we include the variable (1 − TOTLOANS). We also interact this variable with the HHI to produce the variable (1− TOTLOANS) ∗ HHI. Banks with higher levels of non-loan assets operating in markets with higher HHIs might be expected to have lower PROFEFF if the QL theory accurately reflects small bank behavior. Thus, we expect the coefficient of this term to be negative.

To determine if the results reflect EP behavior, we include the variable SALARY ∗ HHI, where SALARY is the ratio of salaries to total assets. EP behavior lowers PROFEFF. Thus, we expect the coefficient of this interaction term to be negative since other studies (e.g., Berger and Hannan, 1998) have found major evidence of EP behavior at commercial banks. We also include SALARY as a separate variable.

6.3. Regression analysis of the correlates of the PROFEFF function

Table 3 presents the results of estimating five equations based on the general model shown below:

$$\begin{aligned}\text{PROFEFF} = f(&\text{AGE}, \text{MKTNPL}, \text{MBHC}, \text{NATIONAL}, \text{RELNPL},\\ &\text{GROWTH}, \text{FEEREV}, \text{DEMDEP}, \text{LARGEDEP}, \text{LNASSETS},\\ &\text{YEAR92}, \text{YEAR94}, \text{YEAR96}, \text{HHI}, \text{NONMSA},\\ &(1-\text{TOTLOANS}), \text{SALARY}, \text{NONMSA} * \text{HHI},\\ &(1-\text{TOTLOANS}) * \text{HHI}, \text{SALARY} * \text{HHI})\end{aligned} \tag{2}$$

where

- PROFEFF = our single-frontier estimate of profit efficiency;
- AGE = bank age (in years);
- MKTNPL = the non-performing loan ratio for all banks in the market (i.e., county), a measure of aggregate credit risk;
- MBHC = 1 for banks affiliated with a multibank holding company (otherwise zero);
- NATIONAL = 1 for national banks (otherwise zero);
- RELNPL = the relative non-performing loan ratio, i.e., the difference between the non-performing loan ratio for the bank and that for the county as a whole (MKTNPL), a measure of firm-specific credit risk;
- GROWTH = asset growth over the previous year;
- FEEREV = total non-interest income/total revenue;
- DEMDEP = demand deposits/total deposits;
- LARGEDEP = large (over $100,000) deposits/total deposits;
- LNASSETS = the natural logarithm of total assets;

Table 3
Tobit regression results for small banks

Variable	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]		Model 5[e]	
	Coefficient	Chi-sq	Coeff.	Chi-sq	Coefficient	Chi-sq	Coefficient	Chi-sq	Coefficient	Chi-sq
INTERCEPT	−0.3348	1275.95***	−0.3452	1230.06***	−0.3515	1094.94***	−0.3444	1109.46***	−0.3776	940.97***
AGE	0.0151	174.03***	0.0149	166.64***	0.0149	169.95***	0.0152	175.13***	0.0147	164.27***
MKTNPL	−0.5833	238.65***	−0.5823	235.54***	−0.5794	233.28***	−0.5819	238.26***	−0.5759	229.33***
MBHC	−0.0175	70.93***	−0.0177	72.51***	−0.0177	72.42***	−0.0175	70.29***	−0.0178	73.13***
NATIONAL	−0.0086	17.95***	−0.0083	16.92***	−0.0085	17.81***	−0.0086	18.03***	−0.0083	16.93***
RELNPL	−0.0254	0.48	−0.0255	0.48	−0.0258	0.49	−0.0225	0.38	−0.0218	0.35
GROWTH	−0.0007	0.06	−0.0009	0.09	−0.0008	0.06	−0.0006	0.04	−0.0008	0.07
FEEREV	0.0287	1.70	0.0271	1.51	0.0260	1.39	0.0233	1.11	0.0160	0.52
DEMDEP	0.0422	5.66***	0.0507	8.01***	0.0417	5.54***	0.0427	5.77***	0.0505	7.92***
LARGEDEP	−0.1239	67.48***	−0.1203	63.34***	−0.1225	66.04***	−0.1249	68.49***	−0.1205	63.52***
LNASSETS	0.0144	144.15***	0.0146	147.98***	0.0147	148.57***	0.0143	140.85***	0.0147	148.27***
YEAR92	0.0249	97.19***	0.0249	97.12***	0.0247	95.68***	0.0251	98.80***	0.0250	97.93***
YEAR94	0.0236	107.26***	0.0273	106.89***	0.0270	104.60***	0.0276	109.25***	0.0273	107.06***
YEAR96	0.0356	175.03***	0.0355	174.26***	0.0350	171.05***	0.0359	177.45***	0.0355	173.77***
HHI	0.0479	119.82***	0.0783	62.78***	0.0899	45.65***	0.0767	31.30***	0.1669	54.78***
NONMSA	0.0130	31.97***	0.0252	36.02***	0.0129	31.30***	0.0132	32.67***	0.0248	34.33***
1 − TOTLOANS	0.0363	25.67***	0.0377	27.62***	0.0721	31.37***	0.0353	24.10***	0.0760	34.22***
SALARY	−0.3595	1.95	−0.3357	1.70	−0.3429	1.78	0.3087	0.60	0.6742	2.79*
NONMSA ∗ HHI	–	–	−0.0378	11.93***	–	–	–	–	−0.0363	10.80***
(1 − TOTLOANS) ∗ HHI	–	–	–	–	−0.0881	11.25***	–	–	−0.0986	13.32***
SALARY ∗ HHI	–	–	–	–	–	–	−1.8522	4.94**	−2.7511	10.40***

Table 3 (*continued*)

Variable	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]		Model 5[e]	
	Coefficient	Chi-sq	Coeff.	Chi-sq	Coefficient	Chi-sq	Coefficient	Chi-sq	Coefficient	Chi-sq
Sample size	34104		34104		34104		34104		34104	
No. of observations	32607		32607		32607		32607		32607	
Missing values	1497		1497		1497		1497		1497	
Log likelihood	5337.18		5343.23		5342.79		5339.64		5353.95	

This table presents the results of the five models. The variables are as defined in Section 6. The equations are estimated using a Tobit regression because PROFEFF is bounded so that all observations fall in the interval (0,1).

*Significant at the 10% level.

** Significant at the 5% level.

***Significant at the 1% level.

[a] Model 1: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1 – TOTLOANS), SALARY).

[b] Model 2: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1 – TOTLOANS), SALARY, NONMSA ∗ HHI).

[c] Model 3: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1 – TOTLOANS), SALARY, (1 – TOTLOANS) ∗ HHI).

[d] Model 4: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI ∗ NONMSA, (1 – TOTLOANS), SALARY, SALARY ∗ HHI).

[e] Model 5: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1 – TOTLOANS), SALARY, NONMSA ∗ HHI, (1 – TOTLOANS) ∗ HHI, SALARY ∗ HHI).

Table 4
Derivatives of the profit efficiency equations

	Model 1[a]	Model 2[b]	Model 3[c]	Model 4[d]	Model 5[e]
δ PROFEFF/δ HHI	0.0479***	0.0569***	0.0502***	0.0469***	0.0576***
δ PROFEFF/δ NONMSA	0.0130***	0.0102***	0.0129***	0.0132***	0.0104***
δ PROFEFF/δ TOTLOANS	0.0363***	0.0377***	0.0371***	0.0353***	0.0368***
δ PROFEFF/δ SALARY	−0.3595	−0.3357	−0.3429	−0.4281***	−0.4202***

*** Significant at the 1% level.

[a] Model 1: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1−TOTLOANS), SALARY).

[b] Model 2: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1−TOTLOANS), SALARY, NONMSA ∗ HHI).

[c] Model 3: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1−TOTLOANS), SALARY, (1 − TOTLOANS) ∗ HHI).

[d] Model 4: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI ∗ NONMSA, (1−TOTLOANS), SALARY, SALARY ∗ HHI).

[e] Model 5: PROFEFF = *f*(AGE, MKTNPL, MBHC, NATIONAL, RELNPL, GROWTH, FEEREV, DEMDEP, LARGEDEP, LNASSETS, YEAR92, YEAR94, YEAR96, HHI, NONMSA, (1−TOTLOANS), SALARY, NONMSA ∗ HHI, (1 − TOTLOANS) ∗ HHI, SALARY ∗ HHI).

- HHI = the Hirshman–Herfindahl index of market concentration for the county; [14]
- NONMSA = 1 for banks headquartered in non-metropolitan counties;
- 1 − TOTLOANS = 1 − total loans/total assets;
- SALARY = total salaries/total assets;

We also include indicator variables for each year (YEAR92, YEAR94 and YEAR96) to control for differences in the condition of the banking industry. [15] Eq. (2) is estimated using a Tobit regression because PROFEFF is bounded so that all observations fall in the interval (0,1).

We first estimate the equation without the interaction terms to allow the full effect of each variable to be captured by one coefficient, thus minimizing any collinearity problems. This approach allows us to test the significance of one coefficient representing each of the three effects. We then add each interaction term separately; finally we include all the interaction terms in one equation. This produces five separate sets of estimates. To compare the estimates and test the robustness of the results, we present the derivatives of the PROFEFF equation with respect to HHI, NONMSA, (1 − TOTLOANS) and SALARY in Table 4.

[14] The HHI was computed using the FDIC's branch office survey.

[15] Only YEAR92, YEAR94 and YEAR96 are included in the regression equation. If we were to use all four indicator variables for the four years, as well as an intercept term, there would be perfect multicollinearity. To avoid this problem, we exclude the YEAR90 variable.

We first consider the control variables (all variables except the following (since they are considered in connection with the hypotheses): HHI, NONMSA, (1− TOTLOANS) and SALARY. As Table 3 indicates, the results for most of the control variables are consistent across the five equations. PROFEFF is (significantly) positively related to bank age, and demand deposits/total deposits. The positive relationship to AGE is as expected since DeYoung and Hasan (1998) find that the PROFEFF of recently chartered banks is substantially below average. The positive relationship to DEMDEP is also as expected since demand deposits are a low cost source of funds which also generate fee income. Small bank PROFEFF is (significantly) negatively related to the market non-performing loan ratio, the existence of a multibank holding company relationship, the presence of a national bank charter, and large deposits/total deposits. These results are also as expected—non-performing loans reduce profits and PROFEFF; large deposits are more expensive than retail deposits. The reasons for the negative signs on the coefficients of MBHC and NATIONAL are not apparent.

The positive coefficient of LNASSETS indicates that as bank size increases, but remains under \$500 million in total assets, PROFEFF increases. This result is inconsistent with the IA and RD hypotheses. As discussed in Section 6, these hypotheses stress the importance of lender–borrower relationships to small bank profitability. These hypotheses would thus suggest that PROFEFF might be largest for the smallest banks.

We now consider the other three coefficients in model 1. (As noted, model 1 has no interaction terms.) The coefficient of the HHI is positive and significant in model 1, indicating that, as expected, PROFEFF is greater for banks in more concentrated markets. Ceteris paribus, an increase in the HHI from the median (0.3206) to the 75th percentile (0.5078) raises PROFEFF by 0.90 percentage points.

The coefficient of NONMSA is positive and significant, and it indicates that PROFEFF is approximately 1.3 percentage points higher for banks in non-metropolitan counties. Since the HHI may not fully capture all the complex effects of competition on bank performance, it is possible that this is a residual SP effect. The coefficient of (1 − TOTLOAN) is also positive and significant. This result indicates that banks with higher levels of non-loan assets actually have higher levels of PROFEFF. The QL hypothesis predicts that these banks would have lower profits and hence lower PROFEFF. There are two reasonable explanations for the positive coefficient, which, it should be noted, is small. First, it reflects the effects of conservative lending strategies, which would be expected to raise PROFEFF. Second, as also noted earlier, PROFEFF is defined as efficiency in producing a given level of output, even if that level of output (loans [16]) is low.

Focusing on the derivatives in Table 4 shows the range of estimates for the effect on PROFEFF of the four variables under consideration. (Most of the derivatives are significant at the 1% level.) The most important finding from Table 4 is that the results are extremely robust. The effect of an increase in the HHI from zero to one would be to raise PROFEFF by between 4.69 and 5.76 percentage points. Thus a more normal

[16] There are three outputs, but for most banks loans generate the most revenue.

change in the HHI, say from 0.40 to 0.50, would be one-tenths of the above amounts, or between 47 and 58 basis points. This may reflect a combination of SP and RD factors. The effect of non-metropolitan location is an increase of between 1.02 and 1.30 percentage points, which probably reflects these same factors. The effect of an increase in the ratio of non-loan assets to total assets from zero to one is an increase in PROFEFF of between 3.53 and 3.77 percentage points. A more normal increase of, say, 10 percentage points would thus produce an increase in PROFEFF of 35 to 38 basis points. As noted, this is probably the result of conservative lending strategies, particularly since the equations were estimated using data for two years when bank profits were below normal because of loan quality problems (1990 and, to a lesser extent, 1992) at some banks. There is more variability with respect to the estimates of the fourth derivative, the ratio of salaries to total assets. Nonetheless, there is evidence from models 4 and 5 that EP behavior lowers PROFEFF.

In summary, PROFEFF is increased by SP and RD factors (which cannot be separated empirically). It is difficult to quantify the effect of QL factors because these are confounded by the effects of conservative lending strategies. Likewise, while there is evidence in the literature of substantial EP behavior, the effects of this behavior on PROFEFF are not apparent from the detailed analysis of the correlates of the PROFEFF function conducted here.

We test the possibility that the results may be influenced by different input prices. The input prices used to estimate the PROFEFF function (the W's in Eq. (1)) could be influenced by EP and/or QL behavior because they are estimated from bank call reports. [7] For example, bank managers following an EP style may dissipate profits in excess expenditures on both salaries and premises, which would distort the wage rate. In addition, QL managers may not bid aggressively for deposits and purchased funds, even in rapid growth areas, which would distort the price of deposits and purchased funds. To deal with these possibilities, we estimate a separate PROFEFF function with three *external* input price variables: (a) the price of labor is the county wage rate estimated from the Census Bureau's County Business Patterns by dividing total payrolls by the number of employees; (b) a proxy for the price of capital, per-capita income, used because rents and prices of commercial property would be expected to be highly correlated with per-capita income and (c) a proxy for the price of deposits and purchased funds. This last variable is equal to the growth in total personal income (the broadest measure of local economic activity) for the period 1980–92. The reasoning is that the demand for funds would be greater in rapid growth areas. While the connection is loose, this is the best proxy variable available. [17] Importantly, both the PROFEFF estimates and the regression analysis of the correlates (not shown here) are substantially unaffected by this procedure. In fact, the average PROFEFF estimates for each bank group are precisely the same. Thus, the results presented here are extremely robust with respect to the specification of input prices.

[17] This procedure of evaluating the robustness of the results by using external input prices was suggested by the comments of an anonymous reviewer who called attention to these potential limitations of "internal" input prices.

7. Summary and conclusions

We apply separate PROFEFF functions to data for small banks (those under \$500 million in assets) and large banks for 1990, 1992, 1994 and 1996. Assuming that small and large banks use the same production technology, we find, consistent with Berger and Mester (1997) results for an earlier period, that small banks are more profit efficient than large banks for the period as a whole.

Over 40% of small banks are located in MSAs, where competition is generally strong, so a pure SP explanation of small bank profitability (e.g., Boyd and Runkle, 1993) is inadequate. Small banks in MSAs are the least profit efficient of the three categories of banks considered. Based on the single-frontier approach, we find the PROFEFF of small non-MSA banks to be 0.7862 vs. only 0.6967 for small banks in MSAs for this period as a whole. The difference is significant at the 1% level; we attribute it to both SP and RD factors (Petersen and Rajan, 1995).

Regression analysis of the correlates of the PROFEFF estimates for small banks indicates that PROFEFF increases as bank size increases, for banks under \$500 million in total assets. In addition, PROFEFF is negatively related to conditions associated with EP behavior. We find that, ceteris paribus, when the HHI increases from the median to the 75th percentile, PROFEFF increases by 0.90 percentage points. We attribute this increase to a combination of SP and RD factors. In general, we conclude that EP, SP and RD factors each play an important role in explaining the PROFEFF of small US commercial banks.

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