How Efficient Are Third District Banks?

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In recent years banks have had to operate in an increasingly competitive environment. Competitors have come from both within and outside the banking industry. Deregulation has allowed commercial banks to expand beyond their own state's borders; thus banks face competition from other commercial banks entering their market for the first time. Investment banks have also become competitors for some of the commercial bank's most creditworthy customers, who have been able to turn to the commercial paper market as a cheaper funding source than bank loans. Similarly, savers have been funneling their money into mutual funds as opposed to bank deposits in a search for a higher rate of return in the current low-deposit-rate environment. Although banks are still the main financial intermediaries in the United States, providing funding to firms and other borrowers and deposit services to savers, whether they will remain dominant in the face of increased competition depends on how efficiently they produce their outputs, that is, their loans and other financial services. Efficient banks will be able to offer more attractive loan and deposit rates to their customers and still

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make a normal rate of return, while inefficient banks won't be able to follow suit and will, therefore, lose business. Inefficiently run banks will have to shape up, or they will be driven out of the market or acquired by other banks; indeed mergers between efficient and inefficient banks have the potential for substantial social gains via cost savings.[1] And banks that operate with lower costs can pass these savings on to their borrowers and depositors.

What can we expect for banks operating in the Third Federal Reserve District, which comprises the eastern two-thirds of Pennsylvania, the southern half of New Jersey, and Delaware? Are they operating at a high level of efficiency, or is there room for substantial improvement? Can we expect a lot of restructuring in our District as inefficient banks are driven from the market? Measuring our banks' efficiency will give us some indication of how they are likely to fare in an increasingly competitive environment.

WHAT DO WE MEAN BY EFFICIENCY?

When economists consider efficiency they typically focus on *scale* and *scope efficiency*, which concerns a bank's choice of outputs, and *X-efficiency*, which concerns a bank's use of inputs. There has been substantially more study of scale and scope efficiency in the banking and financial services industry than of X-efficiency.

Scale Efficiency. Scale efficiency refers to whether a firm is providing the most cost-efficient *level* of outputs. Let's consider a hypothetical example. Suppose firms are demanding $500 million of credit in total, and that it costs one bank $25 million to produce this volume of loans and $10 million to produce $250 million in loans. (Producing a loan involves the credit evaluation the bank must perform to determine the credit quality of the borrower along with funding the loan and monitoring the loan over its length of maturity.) Then it is more efficient to supply the $500 million of credit to the market by having two banks each produce $250 million of the loans than by having one bank produce all $500 million—the average cost of production, that is, the cost per dollar of loan, is less (4¢ versus 5¢) when each bank produces $250 million of loans than when one bank produces $500 million of loans. Society is better off with two banks producing the output rather than one bank, since the $5 million saved could be used for some other productive activity. And a bank trying to produce all $500 million of loans would find itself at a competitive disadvantage if another bank entered the market producing only $250 million of loans, because the second bank would be able to charge a lower interest rate on its loans, since its per unit production cost would be lower.

A bank is said to be producing with *constant returns to scale* if, for a given mix of products, a proportionate increase in all its outputs would increase its costs in the same proportion; this is also the point where the average cost of production is the least. A bank is operating with *scale economies* if a proportionate increase in its outputs would lead to a less than proportionate increase in cost—the bank could produce more efficiently by increasing its output level. A bank is operating with *scale diseconomies* if a proportionate decrease in its outputs would lead to a more than proportionate decrease in costs—the bank could produce more efficiently by reducing its output level.

At output levels where there are scale economies, an increase in outputs would reduce the average cost of production, since it costs proportionately less to produce at a larger scale.

[1] Although Berger and Humphrey (1992b) found little in the way of cost-efficiency benefits on average from mergers in the 1980s between banks with assets over $1 billion, as they discuss, this is likely because the aim of such mergers was to increase asset growth and geographic market extension rather than to increase cost efficiency. This seems to be changing in the 1990s, as merger participants have been setting cost-cutting goals when announcing their mergers.

One reason it might cost less per unit to produce at a larger scale is that there may be large fixed costs in the production technology that are independent of the level of output produced. For example, in banking, the cost of the computers used to keep track of accounts can be spread over a larger number of accounts as the scale of operations increases, so that the per unit cost of production falls. Another potential source of scale economies is specialization. Larger firms may permit employees to specialize in one task, and this specialization may also lead to more efficient production.[2] In most industries, including banking, firms find that at a certain output volume (for a given mix of products), average cost stops declining. For example, at a large enough volume, the fixed costs of production will become insignificant relative to the cost of producing additional units of output, so that scale economies are exhausted. And if scale is increased beyond a certain level, average costs begin to rise. Of course, depending on the production technology, there may be a broad range of output levels (for any product mix) that firms can produce at minimum average cost. In other words, banks of different asset sizes may be equally competitive with one another, since their average costs are similar.

Scope Efficiency. Scope efficiency refers to whether a firm is producing the most cost-efficient *combination* of products. Banks produce more than one product—for example, most commercial banks produce a variety of different loans, like commercial and industrial loans, commercial real estate loans, residential mortgages, student loans, etc. To the extent that different types of loans have different default rates or other characteristics and to the extent that they aren't used to fund the same activities, they constitute different outputs of the bank.[3] Thus, in addition to choosing the most cost-efficient scale of operations, the bank must also choose the combination of products it will produce. For a given level of outputs, the per unit cost of production may be smaller if the bank produces all of the products rather than specializing in just a few of them, or it might be more efficient to specialize. There are *scope economies* if the cost of producing a given level of outputs is lower when a bank produces all the products than if the products are divided up into specialized banks. There are *scope diseconomies* if the costs are lower when specialized banks produce the various outputs.

There are several potential sources of scope economies.[4] One is the sharing of inputs to produce several outputs. For example, the same group of tellers might handle both checking and savings accounts, or information on a firm produced in a credit evaluation for a mortgage can be used if the firm wants a business loan as well. Therefore, it would be cheaper for the same bank to handle both types of accounts and to extend both loans than to duplicate the tellers and credit check at another bank. Similarly, excess capacity on the bank's computer may allow it to increase the scope of products it produces as well as its scale. Thus, there is an interconnection between scale and scope economies—the fact that the bank is able to process various types of loans on its computer (many products) enables it to increase its scale and take advantage of any scale economies. Of course, there may be a point at which producing many products will increase the bank's unit costs. For example, it may take a more elaborate hierarchical management structure to produce different product lines (some-

[2] Mester (1987) discusses the sources of scale economies in more detail.

[3] Large banks also engage in many off-balance-sheet activities, like underwriting, letters of credit, and loan guarantees.

[4] Mester (1987) describes the sources of scope economies in more detail.

times this is mandated by regulation—e.g., equities underwriting and commercial lending must be done in separate subsidiaries of a bank holding company), and this hierarchical structure can increase production costs.[5]

X-Efficiency. If all firms in the industry are producing the level and combination of outputs that minimize the average cost of production, the total cost of producing the industry's output is minimized, and the industry is producing an efficient combination and level of products, *provided each firm is using its inputs efficiently. X-efficiency* refers to whether a firm is using its inputs, like labor and capital, in a cost-effective manner—that is, for a given level and mix of outputs, is a bank producing them in the cheapest way possible? If not, the bank is either wasting some of the inputs it has purchased, or it is using the wrong combination of inputs to produce its outputs. *Technical inefficiency* refers to using proportionately too much of all inputs and is just pure waste. For example, the bank may be using too many tellers and too many branches to produce its products—it might be able to scale back its inputs and produce the same amount of service. A bank that is technically inefficient is said to be operating within its "production possibility frontier." (The production possibility frontier indicates the maximum amount of output that can be produced with a given amount of inputs.) But wasting resources is not the only way to inefficiently use inputs. A bank might be able to produce a given amount of loans and other financial services by combining its inputs—including labor, physical capital, and deposits—in different proportions than it currently is doing. For example, a large bank might be able to supply its output more cheaply by substituting ATMs for tellers—while the fixed costs of setting up an ATM are high, the cost per transaction for an ATM is lower than that for a human teller—so larger banks might benefit by using more ATMs than tellers. *Allocative inefficiency* refers to using the wrong combination of inputs to produce a given output level and product mix—an allocatively inefficient bank is operating on its production possibility frontier—that is, given the inputs it has chosen, it is producing as much output as possible—but the bank could lower its costs of producing that output by selecting a different input mix. Of course, a bank can be both technically and allocatively inefficient.

A bank that is operating in an inefficient manner might be doing so because its manager isn't on top of things, but managerial inability isn't the only source of X-inefficiency. It's possible that a bank manager has goals that differ from those of the bank's shareholders. Shareholders want to maximize the stock market value of the bank, and so its long-run profits. Thus, shareholders want the bank to minimize its cost of production. But bank managers might be interested in something other than cost-minimization. For example, managers might desire a larger staff because they think it gives them more prestige within the banking community. Thus, a bank might use an inefficient combination of inputs (more labor than is necessary) to produce its services. Such "expense-preference" behavior on the part of managers has been found in studies of commercial banks and savings and loans.[6] The bank's choice of the products it wishes to produce might also be driven less by cost considerations than by managerial desires to run a particular type of bank.

Survival. One might question how inefficient banks are able to continue operating. In the usual economic models of competitive markets; competitive forces are thought to drive

[5] See Mester (1991) for further discussion of diseconomies of scope in hierarchies.

[6] Mester (1989) discusses the conflicts between owners and managers in financial firms and the empirical evidence.

such inefficient banks out of the market. More efficient banks are able to produce at a lower cost. In a competitive market, the efficient bank would share its cost savings with its customers in the form of lower interest rates on loans and/or higher deposit rates. This would attract borrowers and depositors away from inefficient banks, since the inefficient banks couldn't match the lower prices without making a loss. The inefficient banks would eventually be forced out of the market.

But banking has been a regulated industry; competitive pressures have not been as strong as they might have been. For example, prior to the 1980s, regulations restricted bank holding companies from establishing banks in more than one state, and there are still restrictions on banks establishing branches across state lines. Such restrictions reduce the number of potential competitors, making it easier for inefficient banks to survive.[7] Similarly, laws that restrict hostile takeovers make it less easy for more efficient banks to gain control of their less efficient counterparts. On the customer side, there is empirical evidence that bank customers have found it costly to switch banks (see Calem and Mester, 1993); thus, it has been difficult for efficient banks to attract customers with lower prices.

But inefficient banks will find it less easy to survive in the future as entry barriers fall. States began passing laws in the 1980s that authorize interstate banking for bank holding companies. All but two states (Hawaii and Montana) now allow bank holding companies from at least some other states to acquire in-state banks. In April 1992, the Office of Thrift Supervision adopted a rule allowing full nationwide branching for healthy federally chartered savings and loans. According to the *American Banker* (August 2, 1993) four states—New York, North Carolina, Oregon, and Alaska—have passed reciprocal interstate branching laws permitting a state-chartered commercial bank that is not a member of the Federal Reserve System to become a branch of a bank in any other state that has an identical law. Although interstate branching hasn't been authorized for national banks as yet, Congress has considered several proposals to permit it, and the topic is likely to remain on the agenda. In addition, the Federal Reserve has taken the position that it will treat hostile bids no differently from friendly bids in assessing whether to permit a takeover. Nonbank competition is also picking up. According to the flow of funds accounts, banks' share of total U.S. financial assets has shrunk to less than 25 percent from over 35 percent in 1977.[8] And foreign bank competition is heating up too; the North American Free Trade Agreement (NAFTA) should also increase competition. Increased competitive pressures will make it more difficult for inefficient banks to survive, as will anything that reduces the costs customers face in switching to low-cost banks. For example, the Truth in Savings Act, part of the Federal Deposit Insurance Corporation Improvement Act of 1991, requires banks to report the terms of their deposit accounts in all advertisements for these accounts, making it easier for customers to shop for the best rates. Inefficient banks will find it more difficult to keep well-informed customers.

MEASURING EFFICIENCY: THE METHODOLOGY

Outputs and Inputs. Studies of bank efficiency are based on an analysis of banks' cost structure, that is, the relationship between

[7] Calem (1993) discusses the benefits of allowing banks to branch across state lines.

[8] The flow of funds accounts, published by the Board of Governors of the Federal Reserve System, provide data on financial assets and liabilities outstanding by sectors of the economy and by type of transaction.

banks' costs and their output levels, given the input prices they face. Thus, the first step in measuring efficiency in banking—scale and scope efficiency and X-efficiency—is to determine a bank's outputs and inputs. There is some disagreement in the literature over what a commercial bank is actually producing. Two general approaches have been taken: the "production" approach and the "intermediation" approach (also called the "asset" approach). The production approach focuses on the bank's operating costs, that is, the costs of labor (employees) and physical capital (plant and equipment). The bank's outputs are measured by the *number* of each type of account, like commercial and industrial loans, mortgages, deposits, because it is thought that most of the operating costs are incurred by processing account documents and debiting and crediting accounts; inputs are labor and physical capital. The intermediation approach considers a financial firm's production process to be one of financial intermediation (the borrowing of funds and the subsequent lending of those funds). Thus, the focus is on total costs, including both interest and operating expenses. Outputs are measured by the dollar volume of each of the bank's different types of loans, and inputs are labor, physical capital, and deposits and other borrowed funds.[9] Luckily, the empirical results on scale and scope efficiency do not seem to be very sensitive to which approach is taken.

Theoretically, to compare one bank's efficiency to another's, we would like to compare each bank's cost of producing the *same* outputs. For banks, significant characteristics of loans are their quality, which reflects the amount of monitoring the bank does to keep the loan performing, and their riskiness. Unless these characteristics are controlled for, one might conclude a bank was producing in a very efficient manner if it were spending far less to produce a given output level, but its output might be highly risky and of a lower quality than that of another bank. It would be wrong to say a bank was efficient if it were scrimping on the credit evaluation needed to produce sound loans. Although previous efficiency studies have failed to compare the costs of producing outputs of equal quality and risk, the study of Third District banks described below does so.

Scale and Scope Efficiency Studies. Most of the studies interested in measuring scale and scope efficiency for a particular sample of banks have estimated an *average practice cost function,* which relates a bank's cost to its output levels and input prices. The technique implicitly assumes that all banks in the sample are using their inputs efficiently, that is, there is no X-inefficiency, and they are using the same production technology. Of course, it recognizes that data are typically measured with error and that there might have been unpredicted factors

[9] A slight variation on the intermediation approach, which has been used in some studies, is to distinguish between transactions deposits, which are treated as an output, since they can serve as a measure of the amount of transactions services the bank produces, and purchased or borrowed funds (like federal funds or large CDs purchased from another bank), which are treated as inputs, since the bank does not produce services in obtaining these funds. The strict intermediation approach would consider the transactions services produced by the bank as an intermediate output, something that must be produced along the way toward the bank's final output of earning assets. Hughes and Mester (1993) empirically tested whether deposits should be treated as an input or output and found that they should be treated as an input in their study.

Another approach that has been taken less often is the "value-added" approach, which considers all liabilities and assets of the bank to have at least some of the characteristics of an output. See Berger and Humphrey (1992a) for further discussion.

Still another approach, taken in Mester (1992), is to consider the bank's output to be its loan origination and loan monitoring services.

See Humphrey (1985) and Berger and Humphrey (1992a) for further discussion of the different approaches to measuring bank output.

that affected a bank's cost over the period when the data were collected, like an unusually large amount of computer down time or up time (bad and good luck) or extraordinary sick leave. Thus, no bank is expected to lie precisely on the estimated cost function; instead the function indicates what, on average, it costs a bank facing a particular set of input prices to produce a particular bundle of outputs. Some banks will produce the given output at a slightly higher cost and others at a slightly lower cost than is indicated by the estimated cost function.

Most studies have focused on smaller banks, with assets less than $1 billion. These studies, others that included banks of all sizes, and another study that included all banks with assets greater than $100 million found that the average cost curve is relatively flat, with scale economies exhausted somewhere between $75 million and $300 million in assets.[10] This is a relatively small size when you consider the size distribution of U.S. banks. While in 1992 about 90 percent of the 11,461 FDIC-insured commercial banks in the United States had less than $300 million in assets, these banks held only 20 percent of total bank assets. Fifty-one banks had assets over $10 billion, and the largest, Citibank, had over $150 billion. Thus, the studies of scale economies suggest that only small banks are operating with unexploited economies of scale and could become more efficient producers by expanding their output size. Moreover, the measured scale economies for these small banks are usually fairly small: a 1 percent increase in all output levels typically leads to about a 0.95 percent increase in total cost, which means a 0.05 percent decrease in the average cost of producing the bundle of outputs. A handful of studies have focused solely on large banks with assets over $1 billion. Some found scale economies at very large banks—the minimum of the average cost curve usually was found to lie between $2 billion and $10 billion in assets. But here again, measured economies were not very large. On the whole, these studies concluded that there wasn't much in the way of cost gains to be made by changing the scale of operations at the typical bank.[11] Similarly, although there are exceptions, most studies have found little evidence of economies or diseconomies of scope between the products banks currently produce. Hence, there is little evidence that changing the typical bank's product mix would significantly influence its cost of production.[12]

X-Efficiency Studies. More recent studies have focused on measuring not only scale and scope economies but also the degree of X-inefficiency in banking. As with scale and scope efficiency, we start with a set of banks that are using the same production technology for creating output. The technique is to estimate a *best practice cost function*—that is, the predicted cost function of banks that are X-efficient—and then measure the degree of inefficiency relative to this best practice technology. Two common methodologies are *data envelopment analysis* (DEA) and *stochastic econometric cost frontier analysis*.[13]

[10] Berger and Humphrey (1992b), Evanoff and Israilevich (1991), Clark (1988), and Mester (1987) summarize the results of the studies.

[11] This isn't to say that banks operating at a significant distance from optimal scale couldn't become more efficient by changing their operating scale. See Evanoff and Israilevich (1991) for more discussion on this point.

[12] This is not to say that deregulation that permits banks to expand the types of products they can offer (e.g., equities underwriting) could not enable banks to take advantage of potential scope economies.

[13] There are other techniques for deriving efficiency measures, including so-called "thick frontier" analysis and "shadow price" models. Evanoff and Israilevich (1991) describe these techniques.

A simpler method to compare the efficiency of banks is to use peer-group analysis. Certain cost ratios are com-

DEA uses the data on costs, outputs, and input prices for a sample of banks and determines, for each output bundle and set of input prices, the bank in the sample that spends the least to produce the output bundle at the given input prices—this is the "best practice" (that is, most efficient) bank for that output/input price combination. (If no bank in the sample produces a particular combination, then a "best practice" bank for the combination is approximated based on "best practice" banks producing similar combinations that do show up in the sample.) A bank's relative inefficiency is then measured by the ratio of its own cost compared with the cost of the "best practice" bank that faces the same input prices and produces the same output bundle. The technique is called data *envelopment* analysis because the data on best practice banks "envelop" the data from the rest of the banks in the sample. One benefit of DEA is that it doesn't posit a particular functional form for the best practice banks' cost function—it is more flexible. But a serious drawback of the technique is that it does not allow for any error in the data—banks that have been lucky or whose costs have been undermeasured will be labeled as most efficient and other banks will look relatively less efficient in comparison. Similarly any unfavorable influence beyond the bank's control will be attributed to inefficiency.

Cost frontier analysis does not have to assume data are measured without error. Instead, a bank is labeled as inefficient if: (1) its costs are higher than the costs predicted for an efficient bank producing the same outputs and facing the same input prices *and* (2) the difference cannot be explained by statistical noise, e.g., measurement error or luck.[14] To obtain the *cost frontier*, that is, the relationship between costs, outputs, and input prices for the *efficient* banks, statistical techniques (that is, regression analysis) are used to obtain the best fitting curve through the data, just as they are used to obtain the average practice cost function usually employed in the scale and scope economies studies. The difference is that the cost frontier indicates what, on average, it costs an efficient bank facing a particular set of input prices to produce a particular bundle of outputs, while the average practice function applies to all banks. A particular bank's cost will deviate from that predicted by the cost frontier for two reasons: first, there will be statistical noise, or unpredicted factors, that affected the bank's costs—either positively or negatively—compared with an efficient bank's costs; second, the bank may not be X-efficient—hence its costs will be higher than those of efficient banks. The statistical technique used to obtain the cost frontier also provides information on these two types of deviations in the sample. The second deviation is always positive, since inefficient banks' costs are always higher than efficient banks' costs. This "one-sided" deviation can be used to obtain measures of any particular bank's inefficiency or the average level of inefficiency in the sample of banks. (As with the average practice cost function, no efficient bank is expected to lie precisely on the estimated cost frontier. Hence, the point estimate of inefficiency for these banks will be small but not

pared for banks that are considered to be similar in the types of customers they serve and products they produce. These ratios might include operating expenses per dollar volume of assets, number of employees per dollar volume of loans, or expenses attributed to commercial loans per volume of commercial loans. The Functional Cost Analysis (FCA) data collected by the Federal Reserve System permit such an analysis. The drawback of the cost ratio approach is that it cannot control for differences in banks' product mix or in the input prices banks face, which influence bank costs, and it cannot give an overall measure of efficiency. Also, the FCA program is voluntary and the sample is skewed toward smaller banks. And a bank's allocation of cost into various lines of business may require some arbitrary division of fixed or shared costs.

[14] Again, the banks in the sample are assumed to be using the same production technology in producing their outputs.

zero.) Once the cost frontier is estimated, one can also estimate scale and scope economies for banks operating efficiently.[15]

One drawback of cost frontier analysis compared with DEA is that it does require the researcher to make more assumptions about the form of the frontier and the errors; hence, it is less flexible. However, this is a less serious problem than DEA's inability to allow for any noise in the data.[16] Therefore, I use frontier analysis to analyze efficiency of banks in the Third Federal Reserve District. Another potential problem with frontier analysis is that if the researcher misspecifies the cost function to be estimated or omits factors that affect cost, this may be attributed incorrectly to inefficiency. Current research is expanding on the methodology by trying to actually model the inefficiency rather than rely on deviations from the frontier to capture inefficiency. This has great potential, since it would more readily indicate the causes of inefficiency. (See Faulhaber, 1993.)

The handful of frontier studies (including stochastic econometric and thick frontier methodologies), in general, used data from the 1970s and 1980s, and have found X-inefficiency on the average of about 20 to 30 percent in banking (see Evanoff and Israilevich, 1991). That is, elimination of X-inefficiency at the average bank could produce about a 20 to 30 percent cost savings, making this a much more serious source of inefficiency than scale and scope inefficiency. Not surprisingly, since DEA attributes any statistical noise to inefficiency, the estimates of inefficiency are higher from these studies—on the order of 20 to 50 percent. These results suggest that there is substantial room for improvement at the average bank in the United States, and the average bank will have to cut costs considerably or will have to leave the industry via merger or failure as competitive pressures increase. Is the same true of Third District banks?

EFFICIENCY OF THIRD DISTRICT BANKS

I used the cost frontier approach to study the efficiency in 1992 of commercial banks operating in the Third Federal Reserve District, which comprises the eastern two-thirds of Pennsylvania, the southern half of New Jersey, and the entire state of Delaware. Since I wanted to estimate the cost frontier of standard commercial banks that are using the same production technology, some banks were omitted from the sample.[17] The sample of 214 banks included all the Third District banks except the special purpose banks in Delaware (legislated under the Financial Center Development Act and the Consumer Credit Bank Act—thus, we excluded Delaware's credit card banks), de novo banks (that is, banks less than five years old, which have start-up costs that more mature banks do not have), and three very large banks (which very likely use different production techniques than the other banks).[18] The median asset size

[15] A more technical explanation of the frontier methodology is contained in Mester (1994).

[16] Moreover, there are ways of relaxing some of the maintained assumptions of stochastic frontier analysis and achieving more flexibility, depending on the available data. For example, using panel data—that is, data from several periods (years, quarters, etc.) on the same sample of banks—allows some of the assumptions regarding the error structure to be relaxed. See Schmidt and Sickles (1984).

[17] Since efficiency is measured relative to the cost frontier, it is important that all banks in the sample have access to the same frontier; hence they should be using the same technology. (Whether one technology is better than another is a separate issue.) One advantage to restricting the sample to the Third District rather than using a U.S. sample is that banks in the Third District are likely to have more in common with each other, thus making it more likely they are using the same production technology. It should be remembered that the results presented below apply only to the 1992 period. Since branching restrictions have only recently been eliminated in Pennsylvania—branching throughout the state became totally unrestricted only on March 4, 1990—more years of data were not included in the study.

of banks included was $144 million, and the average asset size was $325 million.

The intermediation approach was used to determine bank outputs and inputs. Three outputs were included: real estate loans, commercial and industrial plus other loans, and loans to individuals. Each of these was measured by the average dollar volume that the bank held in 1992. These three outputs account for just about all of a bank's nonsecurities earning assets. The average volume of each of these three outputs at banks in the sample was about $120 million, $52 million, and $31 million, respectively. Thus, about 60 percent of the average bank's loan portfolio is in real estate, about 25 percent is business loans, and the rest is loans to individuals.

The inputs (whose prices are used to estimate the cost frontier) are labor, physical capital, and borrowed money (including deposits, federal funds, and other borrowed money) used to fund the outputs. To account for the quality of the banks' outputs and bank risk (and so to avoid labeling as efficient banks that are not monitoring their loans), a bank's volume of nonperforming loans and the volume of its financial capital are included as arguments in the cost function.[19] The volume of nonperforming loans relative to the level of bank output is inversely related to quality: the higher the bank's nonperforming loans for a given volume of loans, the less resources the bank likely spent on monitoring its loan portfolio.[20] The higher the bank's level of financial capital relative to the level of output, the lower the bank's probability of failure and so the bank's interest costs. Financial capital is also included because capital can be used as a funding source for loans.

Scale and Scope Economies at Efficient Third District Banks. The estimated average cost frontier for Third District banks seems to be quite flat. The efficient bank producing the average level of each output and facing the average input prices is producing with constant returns to scale. That is, a 1 percent increase in the level of all outputs would lead to about a 1 percent increase in costs. (See the Table. The first line of the table's top panel, *Average Inefficiency Measures*, shows the average bank's point estimate of the scale economies measure, indicating the percentage increase in cost from a 1 percent increase in all outputs, holding quality and risk constant; it is statistically insignificant from one.) Moreover, over the entire size range of banks operating in the District, efficient banks are operating with constant returns to scale. The first line of the table's middle panel, *Scale and Scope Economies over Different Sized Banks*, shows the scale economies measures for the average efficient bank in each of four size categories. (Although the point estimates suggest decreasing average costs, the scale economies measures are sufficiently close to one that a flat average cost curve cannot be ruled out statistically.) Therefore, there do not seem to be many cost efficiency

[18] If the banks in the District are ordered by asset size, the sizes grow relatively smoothly from about $13 million to about $3.8 billion; then there is a jump to $7.8 billion, then to $9.3 billion, and then to $16 billion. Since there is empirical evidence that very large banks use a different production technology than other banks (e.g., findings of scale economies differ for small and large banks), and large banks also produce different outputs from small banks (e.g., they have more off-balance-sheet business), these three largest banks were not included in the sample.

[19] The translog functional form was assumed for the cost function; the two-sided error representing statistical noise was assumed to have a normal distribution; the one-sided error representing X-inefficiency was assumed to have a half-normal distribution. Interested readers may consult Mester (1994) for further details on the study's setup.

[20] Nonperforming loans are loans that are 30 or more days past due but still accruing interest plus loans that are not accruing interest. While the macroeconomy can affect nonperforming loans, the effect is felt equally across banks. It is the differences in nonperforming loans across banks that capture differences in quality across banks.

TABLE

Average Inefficiency Measures

Scale Economies[a]	0.95%
Scope Economies[b]	0.37%
X-Inefficiency[c]	7.90%

Scale and Scope Economies over Different Sized Banks

	Banks with Assets Under $72 Million (53 banks)	Banks with Assets Between $72 Million and $144 Million (54 banks)	Banks with Assets Between $144 Million and $280 Million (53 banks)	Banks with Assets Over $280 million (54 banks)
Scale Economies[a]	0.89%	0.92%	0.94%	0.99%
Scope Economies[b]	0.006%	0.22%	0.50%	1.10%

Bank-Specific X-Inefficiency Measures[d]

	Range of X-Inefficiency over All Banks in Each Subsample	Average X-Inefficiency over All Banks in Each Subsample[e]
Pennsylvania (182 banks)	2.94% to 19.15%	7.74%
New Jersey (26 banks)	3.71% to 22.97%	9.34%
Delaware (6 banks)	3.69% to 8.58%	6.32%

[a] The scale economies measure is $(\partial ln\ C/\partial ln\ y_1)+(\partial ln\ C/\partial ln\ y_2)+(\partial ln\ C/\partial ln\ y_3)+(\partial ln\ C/\partial ln\ k)+(\partial ln\ C/\partial ln\ q)$ where C is the predicted cost of producing the average output bundle (in the specified bank size category) at the average input prices, y_i is the volume of output i, k is the level of financial capital, and q is the volume of nonperforming loans. The measure indicates the percentage increase in costs from a 1 percent increase in each output level, holding risk and quality constant. Constant returns to scale is indicated if the measure is insignificantly different from one; decreasing returns to scale is indicated if the measure is significantly greater than one; increasing returns to scale is indicated if the measure is significantly less than one.

None of the scale economies measures is significantly different from one, so there is no evidence of scale economies or diseconomies; that is, there are constant returns to scale.

[b] The scope economies measure is $\{[C(y_1,y_2^m,y_3^m)+C(y_1^m,y_2,y_3^m)+C(y_1^m,y_2^m,y_3)]-C(y_1,y_2,y_3)\}/C(y_1,y_2,y_3)$ where y_i is the volume of output i, y_i^m is the least amount of output i produced by any bank in the sample, and C(•) is the predicted cost of producing an output bundle at the average input prices. The scope measure gives the percentage increase in cost of dividing the bank's products among three banks, each of which is relatively specialized in one of the three outputs. A statistically positive scope measure indicates there are economies of scope between the three outputs; a statistically negative scope measure indicates there are diseconomies of scope between the three products.

None of the scope measures is significantly different from zero, so there is no evidence of scope economies or diseconomies.

[c] The X-inefficiency measure is significantly different from zero (at the 10 percent level). This measure is $E(u_i)$ where u_i is the one-sided component of the composed error term in the frontier regression. See Mester (forthcoming).

[d] The bank-specific inefficiency measure is $E(u_i \mid \varepsilon_i)$ where u_i is the positive component of the composed error term ε_i of the frontier regression. See Mester (forthcoming).

[e] Regression results indicate that while the average point estimates differ across states, once bank characteristics are controlled for there is no statistical difference in inefficiency across states.

gains to be made from Third District banks' changing their sizes, and these results are much like those obtained in studies using U.S. samples.[21]

The scope economies statistics give the percentage increase in cost if the bank's three outputs were divided up and produced in three banks, each of which is relatively specialized in one of the outputs.[22] These measures indicate that there is no evidence of economies or diseconomies of scope at the average efficient bank in the sample nor at banks in different size categories, since the measures are statistically insignificant from zero. (See the Table.) Thus, there do not appear to be many cost efficiency gains to be made by a bank's changing its loan mix (which for the typical bank in the sample is weighted toward real estate loans).

X-Inefficiency at Third District Banks. The cost frontier technique allows one to estimate the average level of X-inefficiency for the entire sample of banks and also bank-specific levels of inefficiency. The bank-specific measures can then be averaged by state to indicate the average level of inefficiency of banks in each of the three states in the District. As shown in the table's top panel, *Average Inefficiency Measures*, and in the bottom panel, *Bank-Specific X-Inefficiency Measures*, X-inefficiency at banks in the Third District runs in the 6 to 9 percent range. In other words, given its particular output level and output mix, if the average bank were to use its inputs as efficiently as possible, it could reduce its production cost by roughly 6 to 9 percent. The average annual cost of output production at banks in the sample was about $12 million, so a 6 percent reduction in cost could potentially add about $720,000 to bank profits, which, given the average bank's size of $325 million in assets, constitutes a potential increase of 0.2 percent in before-tax return on assets, or about 0.15 percent in after-tax ROA. This isn't a trivial amount, as the average bank in the District had an after-tax ROA of 1 percent in 1992. In competitive markets not all of this gain would be retained by the bank—the savings would be passed on to customers in the form of lower loan rates and higher deposit rates. Regardless of who receives the savings—banks or their customers—society gains, since the savings created by increased efficiency can be used for other productive purposes.

Of course, not all banks are the "average" bank. The figure, *Third District Inefficiency Distribution*, indicates the number of banks in the sample that fall into different inefficiency ranges. As you can see, while the distribution is weighted in the 6 to 9 percent range, some banks are quite efficient but others show a good deal of inefficiency (as high as 23 percent). When compared with results of other studies using U.S. samples that found average X-inefficiency on the order of 20 to 30 percent, Third District banks seem to be performing better. It is difficult to determine whether this is a statistically significant difference, however. It might just reflect that the Third District study is based on more recent data, or it might be because banks in the U.S. samples are more diverse, making efficiency measurement more difficult.[23] In any case, as with U.S. banks in general, it appears that many Third District banks have room for improvement.

Characteristics of Inefficient Banks. Ultimately, we'd like to be able to say what banks can do to increase their efficiency. For each bank in the sample, the cost frontier analysis

[21] The average scale measure for the sample indicates that a 1 percent increase in output would yield a 0.95 percent increase in cost, which translates into a trivial potential increase in the average bank's return on assets.

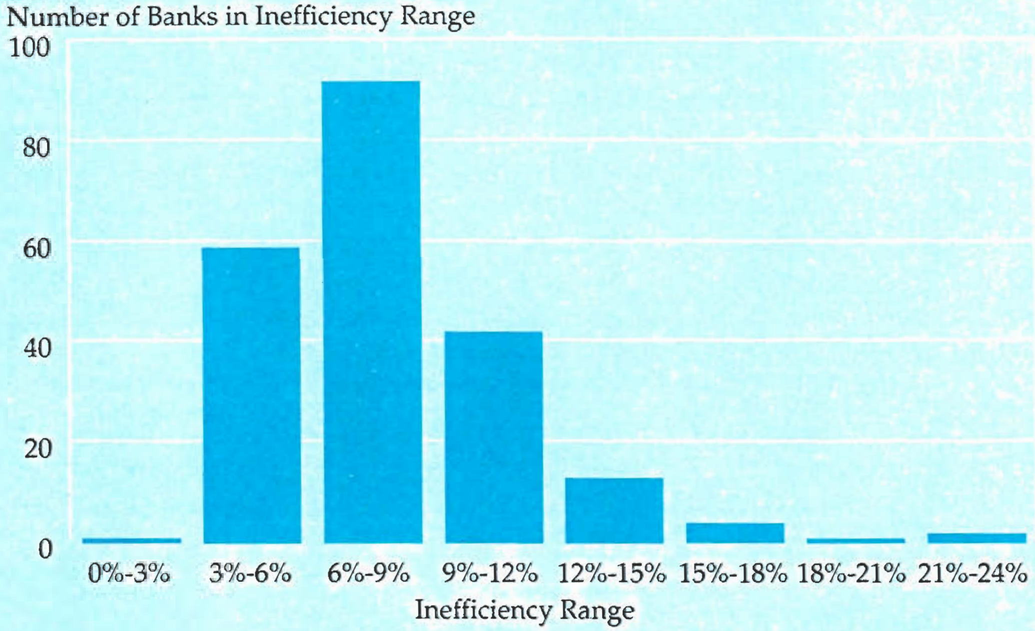
[22] This is the "within-sample degree of scope economies" as defined in Mester (1991).

[23] It might also be because Third District banks use a different production technology than other U.S. banks.

FIGURE

Third District Inefficiency Distribution

(214 Banks in the Sample)



provides a point estimate of its level of X-inefficiency. Perhaps the best way to determine what banks should do to raise efficiency is to go on site to the banks that are identified as most efficient in the study and see what they are doing differently from the banks that are least efficient. A simpler first step is to see if there are any aspects of the banks that seem to be related to their degree of inefficiency. (Of course, a relationship need not imply causality. That is, we are not saying these characteristics cause inefficiency, only that they seem to be more prevalent in inefficient banks.[24]) Simple correlations between the inefficiency measures and characteristics of the banks can be calculated, and the inefficiency measures can be regressed on bank characteristics to get an idea of how the inefficient and efficient banks in the sample differ.[25]

[24] Another reason to interpret the results as providing information on correlation only instead of causality is that there may be some endogeneity, since the characteristics are for the same period as the inefficiency measures. Causality may run from inefficiency to the characteristics instead of the other way around. For example, inefficient firms may choose to invest in real estate rather than investing in real estate leading to inefficiency.

[25] The regression involved estimating a logistic equation relating the bank-specific inefficiency measure to the following regressors: charter type (federal vs. state), holding company status (member of a holding company or not), member of the Federal Reserve System or not, number of branches, total assets, location in Pennsylvania, location in New Jersey, location in Delaware, total qualifying capital/assets, return on assets, volume of uninsured deposits/total deposits, construction and land development loans/total loans, real estate loans/total loans, loans to individuals/total loans, and year opened. See Mester (1994) for further details.

The simple correlation, which does not hold constant the other characteristics, and the regression results, which do hold constant other characteristics of the bank, indicate that inefficient banks in the District tend to be younger than more efficient banks. This might be evidence that banking involves "learning by doing," or it might indicate that more efficient banks are more likely to survive. (Recall that the de novo banks were not included in the sample, so the result probably doesn't merely reflect younger banks' higher start-up costs, for example, the costs of establishing customer relationships.)

Even though the point estimates show differences in inefficiency among banks in the three states, once other bank characteristics are controlled for, there is no statistically significant difference in inefficiency across the states.[26] Similarly, there is no evidence that larger banks are more or less X-efficient than smaller banks. This result, coupled with our results on scale economies, suggests that banks of all sizes in our District can be equally competitive when it comes to cost efficiency.

Among the statistically significant relationships, one of the more interesting is the negative relationship between inefficiency and the capital-asset ratio.[27] This result should not be interpreted as saying that if a bank increases its capital-asset ratio then its efficiency will increase. But it may be an indication that higher capital ratios may prevent "moral hazard." As is often cited in discussions of the thrift crisis, as an institution's capital level decreases it has an increasing incentive to "bet the bank," since it stands to gain if the risk pays off and tends to lose only the amount of capital it has invested in the bank if the bet loses. Similarly, the managers of banks with lower capital levels might have more of an incentive to engage in perk-taking, and they face less shareholder scrutiny than banks with higher capital ratios. (If the owners' stake, that is, capital, is low, owners have less incentive to make sure the bank is run efficiently.[28]) Therefore, higher bank capital may not only provide a cushion for the deposit insurance fund, it might also provide appropriate incentives to bank managers to avoid waste. The capital-asset ratio might also be significantly related to inefficiency because inefficient banks have lower profits, which might lead to lower capital-asset ratios in the future.[29]

CONCLUSION

Banks in the Third District appear to be operating at cost-efficient output sizes and product mixes, but there appears to be a significant level of X-inefficiency at our banks. Some banks apparently are not using their labor, plant and equipment, and funds in the most efficient way possible, and case studies that focus on the more efficient banks in the District

[26] The simple correlation coefficient indicates that being located in New Jersey is significantly related to being inefficient, but this is because the New Jersey banks in the sample tend to have lower capital ratios than Pennsylvania and Delaware banks in the sample. Once capital ratio is controlled for (as in the regression), being located in New Jersey is not significantly related to inefficiency.

[27] There are a few other statistically significant relationships. For example, inefficient banks tend to have a higher percentage of their loans in construction and land development; national banks appear to be less efficient than state banks that are members of the Federal Reserve System but seem to have the same level of efficiency as state nonmember banks. (Note: all nationally chartered banks are Fed member banks, but their primary regulator is the Office of the Comptroller of the Currency, not the Fed.)

[28] Mester (1990) discusses the incentive effects of bank capital in mitigating bank risk-taking.

[29] But this is probably not the entire reason, since the relationship between capital assets and inefficiency holds even when return-on-assets is held constant, and while return-on-assets and capital assets are correlated, they are not collinear.

might shed light on how greater efficiency can be achieved. Theoretical advances may enable us to better identify the sources of the inefficiencies and verify that measured differences in inefficiency are true differences and do not result just from omitting factors that affect cost or misspecifying the cost function.

In terms of coping with the increased competitive pressures, inefficient banks in the Third District have more to fear from banks that are efficient producers than from banks that are producing a particular output volume or product mix. There is less to be gained in terms of cost savings from changing output size or mix than from using inputs more cost-effectively. Inefficient banks will have to get costs under control or else be prepared to be driven from an increasingly competitive marketplace.

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