How Efficient is Your Bank?
A Stochastic Frontier Approach

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Background

For half a century commercial banks in the United States were operating in an environment largely shaped by the experience of the Great Depression. Compared to other developed countries, federal and state regulations resulted to a disproportionally large number of banking institutions. Between 1934 and 1985 the total number of commercial banks fluctuated between (approx.) 13,000 and 14,000 institutions. The landscape dramatically changes in the mid-eighties as regulations are relaxed and/or removed and financial innovation changes the traditional nature of banking business. From 1984 to 2005 the total number of commercial banks decreased by forty eight percent (Figure 1) and by the 1988 failures peaked at 206 institutions (Figure 2)

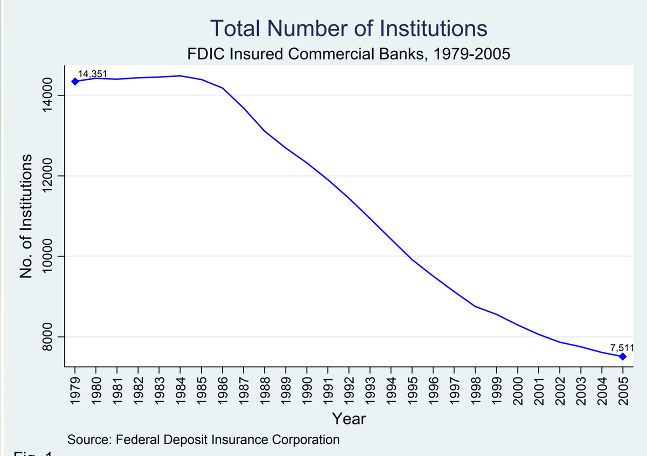

Fig. 1

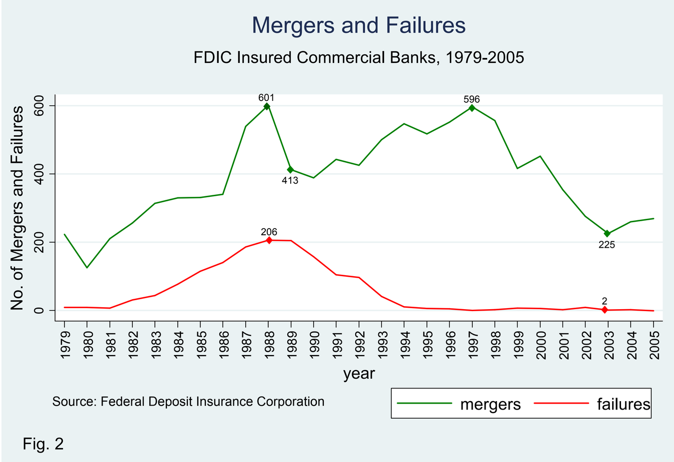

Fig. 2

These developments renewed the interest in the study of production technology of the banking industry with a focus on evaluating resource utilization and measuring relative efficiency of commercial banks. In this study we use a stochastic frontier approach to measure commercial bank efficiency from 1996-2000, as a first step in our exploration of the role that managerial inefficiency plays in the changing structure of this critical sector.

Definition and Measures of Efficiency

The concept inefficiency (and efficiency) is well rooted in the history of economic thought. It is generally defined as deviations of actual from optimum behavior. Frontier models, by identifying "best practices" from observed performance, provide a way of establishing an "optimum benchmark" against which deviations are measured.

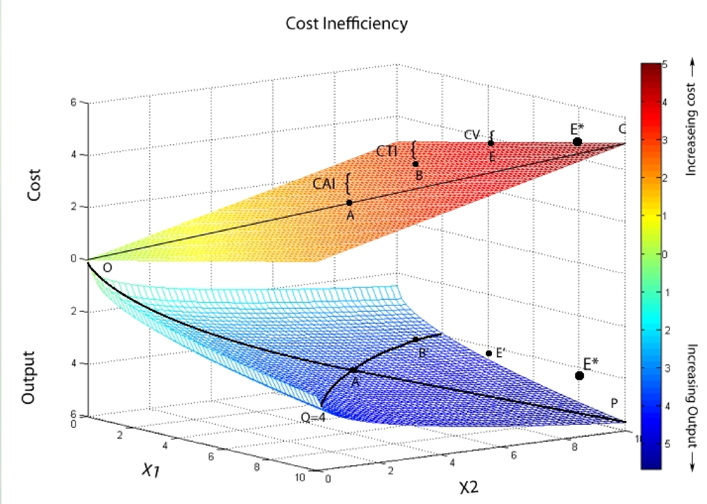

Fig 3A

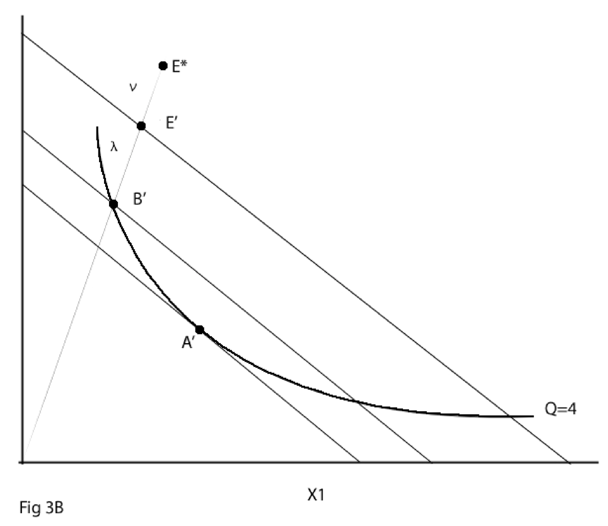

Fig 3B

To illustrate figures 3a and 3b summarize the two input one output case. A firm is observed at point E* producing at an output level Q=4. The stochastic frontier approach (SFA) allows us to identify the optimal input bundle for this level of output at point A. The difference between optimal input-output combination (A) and actual (E*) is the result of "chance" (statistical noise) as well as managerial inefficiency (technical and allocative inefficiency). For the firm in our illustration the stochastic nature of the data account for part of the higher than optimal costs (E* to E') but the rest is due to managerial inefficiency with E'B' representing pure technical inefficiency.

We should note that compared to other frontier estimation techniques (non-stochastic, non-parametric) the SFA has the advantage of explicitly considering the stochastic nature of the data. Random factors increase or decrease production and hence distort measurement of efficiency. By incorporating a random component in the error term the SFA accounts for the deleterious effect of chance on efficiency measurements. Here, the frontier shift from one production unit to the next being random than exact. This flexibility, however, comes with a price: implementation requires a) strong distributional assumptions and b) the adoption of a parametric functional form.

Model

We adopt the intermediation approach that views the banking firm as an intermediary in the credit creation process. It operates in competitive markets and transforms inputs (capital, labor deposits and purchased funds) into outputs (different types of loans). To measure managerial efficiency we specify and estimate a translog multiple input-output cost function with a composite error term (e) that can be written as follows:

$$\ln C = a_0 + \sum_{i=1}^{m} a_i \ln q_i + \sum_{j=1}^{n} b_j \ln p_j + (1/2)\sum_{i=1}^{m}\sum_{r=1}^{m} p_{ir} \ln q_i \ln q_r$$

$$+(1/2)\sum_{j=1}^{n}\sum_{k=1}^{n} d_{jk} \ln p_j \ln p_k + \sum_{i=1}^{m}\sum_{j=1}^{n} q_{ij} \ln q_i \ln p_j + f_0 \ln z$$

$$+\sum_{i=1}^{m} f_i \ln q_i \ln z + \sum_{j=1}^{n} \Phi_j \ln p_j \ln z + (1/2)m(\ln z)^2 + e$$

Where

lnC = the natural logarithm of the variable cost;

$\ln q_i$ = the natural logarithm of the ith output (i=1,….,m);

lnpj = the natural logarithm of the jth input price (j=1,…,n)

$e = v + u$ with $v \sim N(0, s_v^2)$ and $u \sim$ truncated normal

Two sets of restrictions are imposed on the translog cost function. Young's theorem requires that $p_{ir} = p_{ri}$ for all i and r, and $d_{jk} = d_{kj}$ for all j and k. Linear homogeneity in input prices implies that:

$$\sum_{j=1}^{n} b_j = 1\ ;\quad \sum_{j=1}^{n} d_{jk} = 0,\ \text{for all } k\ ;\quad \sum_{j=1}^{n} q_{ij} = 0\ ,\ \text{for all } i\ ;\quad \text{and} \quad \sum_{j=1}^{n} \Phi_j = 0$$

Data

We use the Call Report information for banks with total assets above $100 million for the period 1996-2000. The number of banks in our sample ranges from 3,183 to 3,680 for each year in the study period. Our model includes four outputs, four variable inputs, and one quasi-fixed input as delineated below.

Dependent Variable :

The dependent variable is variable cost (C), which includes : total interest expense; salaries and employee benefits; expenses of premises and fixed assets; and other non-interest expense.

Outputs:

Loans to individuals for household, family, and other personal expenses (q_1); loans secured by real estate (q_2); commercial and industrial loans (q_3); federal funds sold, total securities and assets held in trading accounts (q_4).

Variable Inputs:

The inputs are interest-bearing deposits except certificates of deposit above $100,000 (deposits, x_1); sum of certificates of deposit above $100,000, fed funds purchased, demand notes and other borrowed money (funds, x_2) ; number of employees (labor, x_3); and premises and fixed assets (capital, x_4).

Quasi-fixed Input :

We treat non-interest-bearing deposits as a quasi-fixed input. Since banks cannot attract more of these deposits by offering interest, this input can be regarded as exogenously determined.

Input prices:

Average interest cost per dollar of interest-bearing deposits except certificates of deposit above $100,000 (average price of deposits, p_1); the average interest cost per dollar of certificates of deposit above $100,000, fed funds purchased, demand notes and other borrowed money (average price of funds, p_2); the average annual wage per employee (average price of labor, p_3); and the average cost of premises and fixed assets (average price of capital, p_4) . No explicit price exist for the quasi-fixed input, so its quantity rather than its price is included in the cost function.

Inefficiency Index: A Summary

The table 1 and figure 4 provide a summary of the average inefficiencies for all banks and nine subgroups according to asset size for the period 1996-2000.

- Contrary to prior studies, there seem to be no consistent pattern between inefficiency and bank size. While we observe a modest increase (<2.2%) in inefficiency as bank assets increase from $100 million to $1 billion, this pattern breaks down for banks with assets more than $1 billion.

- Compared to previous SFA studies using data from the 1980s our average inefficiency estimates are generally higher. We also observe much higher inefficiency in 1998 following a high merger activity in 1997. This might be explained by consolidation issues and restructuring cost associated with mergers.

Table 1

	Asset Groups (M = million; B=billion)								
	100M-200M	200M-400M	400M-700M	700M-1B	1B-2B	2B-5B	5B-10B	>10B	All(>100M)
	Stochastic Frontier Approach Inefficiencies [MLE (by year)]								
1996	12.2%	13.6%	11.8%	12.1%	12.3%	13.4%	13.1%	16.2%	12.67%
1997	13.1	13.6	13.9	14.8	16.1	18.0	15.4	16.5	13.7
1998	19.5	20.3	21.1	21.2	21.2	20.5	22.0	20.0	20.0
1999	13.0	13.3	14.3	16.0	14.0	15.7	18.6	19.0	13.7
2000	19.2	19.6	19.6	20.3	19.3	18.8	19.3	16.5	19.3

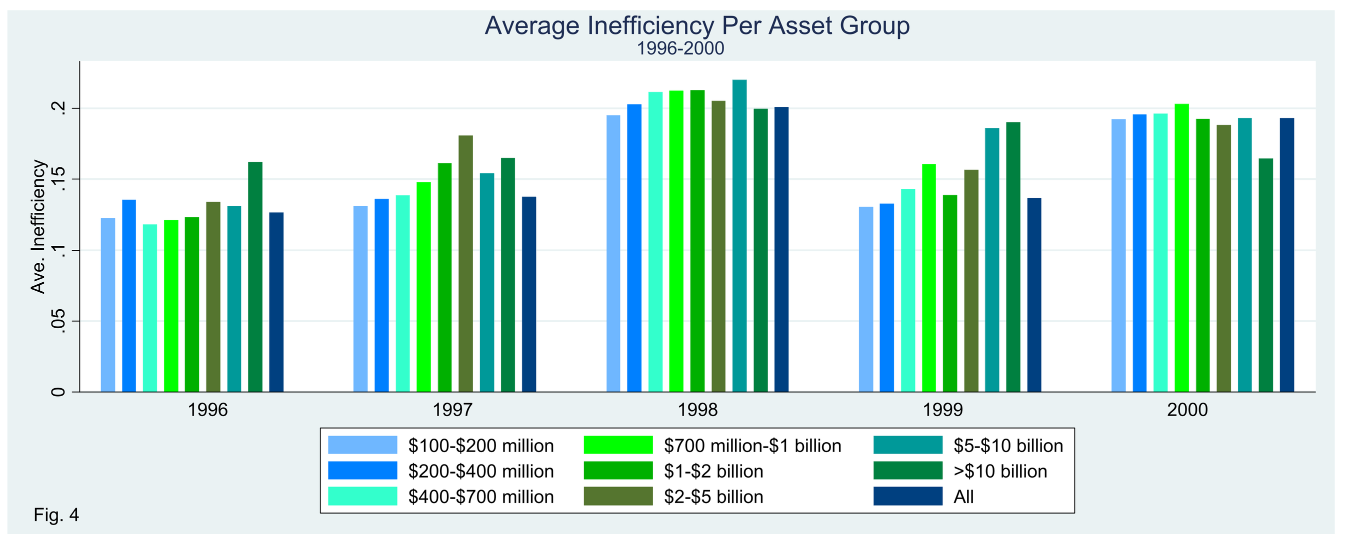

Fig. 4

Direction for further research

The cross section approach we followed thus far does not account for unobserved heterogeneity which may confound inefficiency estimates. In the next stage we will estimate our model using panel data techniques that allow for time varying inefficiency. Our intend is to explore the role that managerial inefficiency plays in bank failures and the mergers and acquisitions process.

References:

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