Using Frontier Analysis to Indicate Banking Productivity

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Frontier Efficiency Analysis 1

Is used to estimate relative cost, profit, or revenue differences among banks within or across countries. It measures relative efficiency.

Studies suggest that:

Bank costs could be 20% lower or
Bank profits could be 40% to 50% higher

if the average bank had the same cost or profit as those on the frontier.

Stochastic and linear programming models yield generally similar results. The sources of cost or profit inefficiencies are not specified or identified.

Frontier Efficiency Analysis 2

Differences in efficiency are presumed to reflect hard to measure productivity differences. They are not balance sheet differences.

Frontier analysis was originally developed to estimate cost efficiency in non-profit organizations (which may not minimize costs).

Once obvious (stochastic) cost function influences are specified,

Output level (for scale effect)
Factor and material input prices (for cost shifts)

the remaining residual unexplained cost difference among organizations is attributed to unknown productivity differences.

Frontier Efficiency Analysis 3

The firm with the lowest unexplained cost residual is presumed to have the lowest cost inefficiency. This firm is deemed to be the "most efficient" and defines the cost frontier. Other firms are measured relative to this benchmark.

	Firm 1	Firm 2	Firm 3
Total Cost:	100	98	95
Explained Cost:	93	92	90
Unexplained Residual:	7	6	5

Firm 3 defines the cost frontier. Unexplained cost at Firm 3 (5) is 71% of the unexplained cost at Firm 1 and 83% at Firm 2, so average efficiency is 77%.

Firm 1 efficiency: 5/7 = .71 Average efficiency: (.71 + .83)/2 = .77
Firm 2 efficiency: 5/6 = .83 Average inefficiency: (1 - .77)/.77 = .30

Alternatively, average inefficiency is [(7 - 5)/5 + (6 - 5)/5]/2 = .30 or 30%.

Problems with Frontier Efficiency Analysis 1

Academic Issue:

No agreement on best way to determine the inefficiency residual in a composed error model (but both give similar average efficiency results).

> Distribution Free Approach: assume each firm's average residual has random error = zero so the average residual ≈ firm's average inefficiency;
>
> Stochastic Frontier Approach: assumes random error = 0 and inefficiency has a half-normal distribution (so most firms are very close to the frontier).

No agreement on whether parametric models (above) or linear programming is best.

> Data Envelopment Analysis: uses same cost "variables" to form linear constraints and assumes all error (random or otherwise) is zero.

Problems with Frontier Efficiency Analysis 2

Practical Issue:

If the source(s) of inefficiency can be identified, then measured inefficiency is not informative. The unexplained residual is small relative to total cost.

	Firm 1	Firm 2	Firm 3
Total Cost:	100	98	95
Explained Cost:	99.3	97.4	94.5
Unexplained Residual:	.7	.6	.5

Firm 3 defines the cost frontier. Unexplained cost at Firm 3 (.5) is 71% of the unexplained cost at Firm 1 and 83% at Firm 2, so average efficiency is 77%.

Firm 1 efficiency: .5/.7 = .71
Firm 2 efficiency: .5/.6 = .83

Average efficiency: (.71 + .83)/2 = .77
Average inefficiency: (1 - .77)/.77 = .30

High R^2 but economically insignificant unexplained cost (only 0.5% to 0.7%).

Frontier Efficiency and Productivity 1

Need to identify at least 3 sources for bank cost differences:

Cost influences largely outside of management control:

1. Business environment influences on operating cost (regional or cross-country):
   - Current asset size
   - Prevailing average wage in region/country
   - Prevailing property prices in region/country
   - Indicator of business conditions (affects staffing levels, ATM use)
   - Indicator of possible market competition (market share)

2. Standard cost function influences:
   - Output types and levels (different types of loans, securities)
   - Input types and their prices

Note: Need to explain only operating cost; interest cost has very small unexplained residual. Off-balance-sheet activities generate ≈ 0 costs but have large revenues.

Frontier Efficiency and Productivity 2

Need to identify at least 3 sources for bank cost differences:

Cost influences largely subject to management control:

3. Productivity influences on operating cost:

    Substitution of ATMs for branch offices (ATM/branch ratio)
    Output/labor ratio (deposit/labor ratio)
    Output/capital ratio (deposit/branch ratio)
    Share of electronic transactions (electronic/total non-cash transactions)
    Loan/total asset ratio (loans are more costly than securities)
    Etc.

Similar measures are used in the banking industry for peer group comparisons.

Frontier Efficiency and Productivity 3

Standard approach to measuring banking productivity:

Select one or multiple productivity indicators common in an industry.
May have no way to weight multiple indicators into an overall productivity index.
Don't know when have the "complete" set of productivity indicators.

Benefit of (stochastic) frontier efficiency analysis:

(1) Allows for multiple productivity indicators.

(2) When unexplained residual is small (R^2 is high), know that have identified the "complete" set of relevant productivity indicators.

(3) Regression parameters suggest:
(a) Relative importance of the different indicators; and
(b) Used as weights to form an overall productivity index.

Frontier Efficiency Example 1

Spanish Banking Industry: 1992-2001

Specification for bank interest cost:

Bank Interest Cost = f (External + Technical + Internal influences on cost)

Analysis for bank interest cost:

Using only External + Technical influences we found:

Average efficiency = .922; Average inefficiency = .085
Only 2% of total interest cost remained unexplained.

When added Internal influences and separated commercial from savings banks, efficiency = .99, inefficiency = .001 to .007 with less than 0.2% for unexplained cost.

Frontier Efficiency Example 2

Spanish Banking Industry: 1992-2001

Specification for bank operating cost:

Bank Operating Cost = f (External + Technical + Internal influences on cost)

Analysis for bank operating cost:

Using only External + Technical influences we found:

Average efficiency = .72; Average inefficiency = .41
8.6% of total operating interest cost remained unexplained.

When added Internal influences and separated commercial from savings banks, efficiency = .94 to .96, inefficiency = .04 to .07 with 1.5% to 1.9% unexplained cost.

Obtained efficiency = .98 to .99, inefficiency = .01 to .02 using linear programming model (Data Envelopment Analysis).

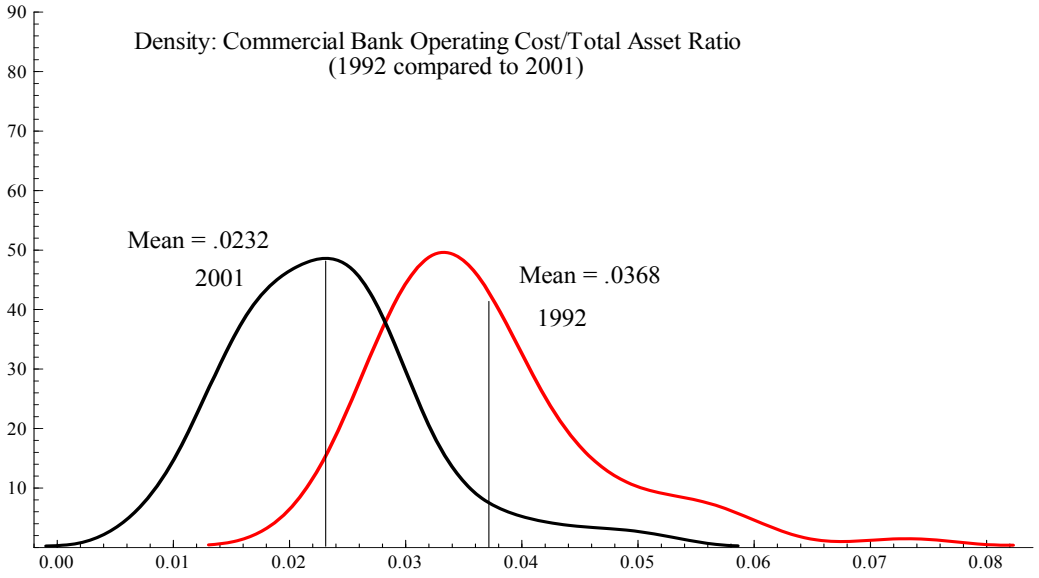
The inability of all banks to accurately forecast branch, ATM, and staffing needs will likely lead to some amount of "irreducible" inefficiency being measured.

Frontier Efficiency Example 3

Spanish Banking Industry: 1992-2001

Frontier analysis focuses on cross-section differences in cost efficiency. These cross-section productivity indicators also explain time-series banking cost changes.

Over 1992-2001, the time-series cost reduction was 5 times the cross-section reduction.



Conclusion

Three benefits of (stochastic) frontier efficiency analysis for productivity measurement.

(1) Can identify multiple productivity indicators for cross-section or time-series productivity measurement.

(2) Estimated regression parameters indicate:
(a) Relative importance of the different productivity indicators; and
(b) Used as weights to form an overall productivity index.

The unique benefit of frontier efficiency analysis is that after accounting for cost influences largely beyond the control of management:

(3) Will know when have identified the "complete" set of productivity indicators.

Summary

Standard approaches to productivity measurement:

- Focuses on one indicator of overall productivity; or
- Estimates/computes TFP; or
- Uses multiple but separate indicators of productivity.

Frontier analysis can:

- Identify factor and other indicators of productivity; and,
- Tells us when we have a “complete” set of efficiency/productivity indicators (controlled largely by management).

Selected Bibliography

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