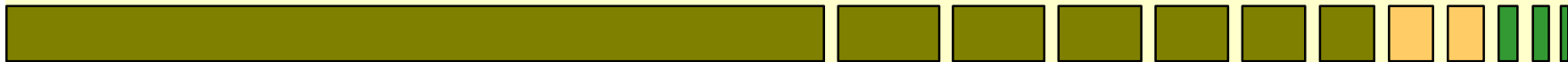


# Today's Agenda-Banking Markets Study




- Banking Undergoing Substantial Change:
  - Markets and Competition Now Matter, But Regulation Isn't Going Away Anytime Soon.
- Empirical Literature Finds Strong Inefficiencies, But Does Not Tell Us WHY.
- Develop *Structural* Model to Explain The Observed Inefficiencies.
  - Have We Identified the Explanations?
  - Have We Captured Everything?
  - Does Structural Econometric Work “Work”?

# Study Objectives



- Determine Effects on Bank Profitability of
  - Risk (of All Kinds)
  - Effective Capacity Planning
    - » Scale and Scope Economies/Diseconomies
  - Customer Satisfaction/Value
  - Unidentified Profit Drivers: Have We Found “Causes” for All the Effects?
- Statistical Analysis Using an Economic Model of Banking Markets to *Simultaneously* Estimate These Effects

# Why Does This Matter?


- 
- Berger, October 1994: “The Research Challenge Is To Find Out What’s Responsible for These Inefficiencies.”
  - What Can Banks Do To Improve Profitability?
  - In the Face of Rapid Industry and Regulatory Change, What Are Appropriate *Public Policy* Directions For This Industry?
  - New Research Method: Structural vs. Reduced Form Estimation.

# A Modeling Approach



- Explicit Structural Model of Bank Choices, Information, and Market Interactions.
  - Six Products, Long- and Short-Run Cost Functions.
  - Aggregate and Product Risk.
  - Capacity Planning Under Uncertainty.
  - Customer Satisfaction/Quality: Choice or Type?.
  - Cournot-Nash Asymmetric Multi-Market Equilibrium.
- Estimate Parameters from Profit Equation Derived From Cournot First-Order Conditions.

# The Data


- 
- Operating Results Data: *Call Report* (FDIC) *Accounting Data.*
  - Stock Market Data: CRSP Data (Univ. of Chicago) *Capital Market Data.*
    - Merge  $\Rightarrow$  1984-1992 (quarterly) 219 publicly traded banks > \$1 B assets  $\Rightarrow$  6190 observations
  - Customer Satisfaction Data: Greenwich Associates (Newly Compiled) *Survey Data.*
    - Uses Selected Survey Questions from Bank Customers
    - Merge  $\Rightarrow$  112 banks (annual)  $\Rightarrow$  476 observations.

# Call Report Data



- Detailed Income Statement and Balance Sheet Information, by Bank (state); Mandated Quarterly Reporting by Fed & FDIC.
- Revenues and Quantities on Six Bank Products:
  - Demand Deposits
  - Time Deposits
  - C&I Loans
  - Consumer Loans
  - Real Estate Loans
  - Off-Balance-Sheet Items (Counterparty Guarantees)

# Stock Market Data

- 
- Daily Stock Prices, for Each Bank Holding Company; Center for Research in Stock Prices (CRSP) Dataset.
  - Estimated Stock Market  $b$  for Each Quarter and Each Bank, Using Stock Data for Past Year.
  - Holding Company  $b$  Imputed to Constituent Banks.

# Customer Satisfaction Data




- Scalar Measure, Based on Greenwich's Customer Survey Results, 1985-1992.
- Average (in each Market Segment) of 8 Questions:
  - How Do You Rate This Bank in:
    - » willingness to lend
    - » competitive loan pricing
    - » cash management capabilities
    - » international service capabilities
  - How Do You Rate This Bank's Account Officers in:
    - » convincing bank to meet credit needs
    - » prompt follow-up
    - » knowledge of cash management services
    - » advice on corporate finance

# Customer Satisfaction Data (Cont'd)



- Computation of Quality Measure:
  - In Each Market Segment, Average of Percent Respondents Giving Bank “Above Average” Is Computed, then Z-score Normalized.
  - Z-scores Weighted by Respondent Size and Added Together.
  - Scale Shifted to Lie in  $[1,100]$ , with Mean = 50.
  
- Sample Size: 112 Banks, 476 Observations.

# The Economic Model

- 
- The Model Is Based on Banks, In Each Quarter,
    - Choosing Capacity Based On Demand Estimates.
    - Choosing a Risk Level.
    - Delivering Their Quality (*Not* a Short-Run Choice, But a Property).
  - Banks Then Interact in Six Imperfectly Competitive Product Markets by Choosing Quantity of Each Product to Supply.
  - Bank Choices, Along with Technical Parameters, Are *Inferred* Econometrically From Their Actions.

# Cost of Operational Activities Model

- Each Bank Can Offer  $n$  Services
- Bank Chooses Its *Short-Run* Cost Function

$$C(\mathbf{q}; F, \mathbf{c}) = F + \sum_{i=1}^n c_i q_i^{2a_{ii}} + \sum_{i=1}^{n-1} \sum_{j=i+1}^n n_{ij} (q_i q_j)^{a_{ij}}$$

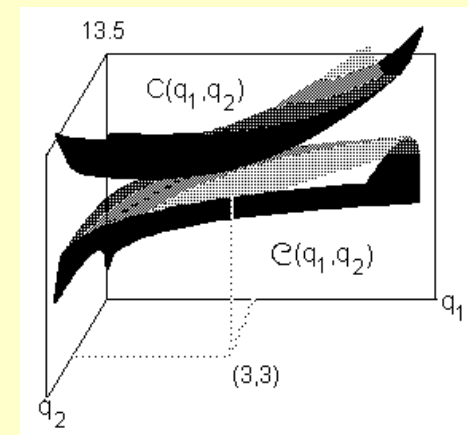
by Choosing Parameters  $(F, \mathbf{c})$  from the set defined by

- The *Long-Run* Cost Function

$$C(\mathbf{q}) = \sum_{i=1}^n \sum_{j=i}^n l_{ij} (q_i q_j)^{g_{ij}}$$

which lies below and is tangent to all short-run cost functions; for all  $\tilde{\mathbf{q}}$  :

$$C(\tilde{\mathbf{q}}; F, \mathbf{c}) = C(\tilde{\mathbf{q}}) \quad \nabla C(\tilde{\mathbf{q}}; F, \mathbf{c}) = \nabla C(\tilde{\mathbf{q}})$$



# Cost of Risk Model

- Measuring Aggregate Risk Cost: Stock Market  $\beta$
- Cost of Risk = Additional Earnings Demanded by Investors to Compensate for  $\beta > 0$

– Bank Mkt Value =  $V$  on uncertain earnings stream  $\Pi_t$ ; define *uniform expected earnings*  $\bar{p}$  and *risk-free earnings*  $\tilde{p}$ :

$$V = E \left[ \sum_{t=1}^{\infty} \frac{\Pi_t}{(1+s)^t} \right] = \sum_{t=1}^{\infty} \frac{\bar{p}}{(1+s)^t} = \sum_{t=1}^{\infty} \frac{\tilde{p}}{(1+r_f)^t}$$

where  $s = r_f + \mathbf{b}(r_m - r_f)$ ,  $r_f$  = risk - free rate,  $r_m$  = market rate

$$\mathbf{R} = \bar{p} - \tilde{p} = \bar{p} \cdot \left( \frac{\mathbf{b}(r_m - r_f)}{r_f + \beta(r_m - r_f)} \right) = \text{Cost of Risk}$$

# Demand Model

- Demand System Allows Product Interdependence

$$p_i = A_i \prod_{j=1}^n Q_j^{h_{ij}}, \quad \text{for } i = 1, \dots, n.$$

- Self- and cross-*flexibilities* (inverse of elasticities) are constant:

$$\frac{Q_j}{p_i} \frac{\partial p_i}{\partial Q_j} = h_{ji}$$

# Customer Satisfaction/Quality Model



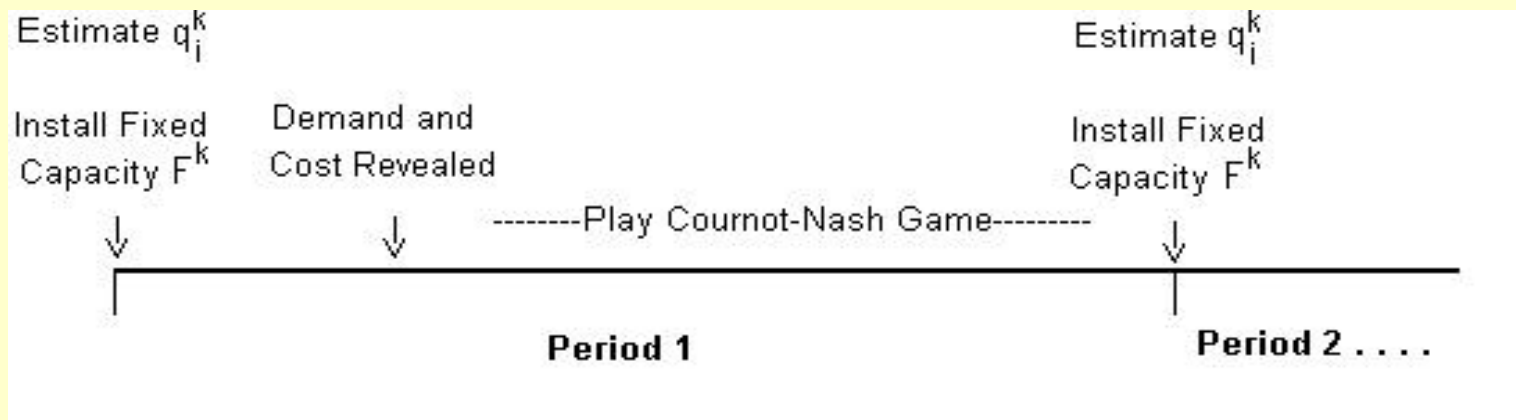
- Quality Assumed to be a *Property* of Each Bank (in Each Period), Not a *Choice Variable*.
- Measured Quality Applies Only to Commercial Customers, So Will Be Focused on C&I Loans
- Cost and Demand Models Modified: Let  $X=Quality$ ;

LR Cost: 
$$C(\mathbf{q}) = \sum_{i \neq 3} \sum_{\substack{j \geq i \\ j \neq 3}} I_{ij} (q_i q_j)^{g_{ij}} + X^d \sum_{j=1}^6 I_{3j} (q_3 q_j)^{g_{3j}}$$

Demand: 
$$p_3 = X^v P_3 \prod_{j=1}^6 Q_j^{h_{3j}}$$

# Information and Timing

- Prior to Each Period, Firms *Estimate* Demand  $\tilde{q}^k$  and Choose a SR Technology  $(F^k, c^k)$ .
- Demand Is Then Revealed; Firms Play an Asymmetric Multi-Market Cournot-Nash Quantity Game.



- Game Is Repeated Next Period.

# Market Equilibrium

- Banks Maximize Profits Over Output Bundles, Given Their Technology (Suppressing Quality Parameters):

$$\max_{q_i^k} p^k = \sum_{i=1}^n p_i(\mathbf{Q}) q_i^k - F^k - \sum_{i=1}^n c_i^k (q_i^k)^{2a_{ii}} - \sum_{i=1}^{n-1} \sum_{j=i+1}^n n_{ij} (q_i^k q_j^k)^{a_{ij}} - \sum_{i=1}^n \Delta r_i^k q_i^k$$

- First-Order Conditions  $\frac{\mathbb{J} p^k}{\mathbb{J} q_i^k} = MR_i^k - MC_i^k = p_i (1 + \sum_{j=1}^n s_{ji} f_{ji} q_j^k) - MC_i^k = 0$

$$\text{or } \frac{p_i - MC_i^k}{p_i} = \sum_{j=1}^n s_{ji} h_{ji} q_j^k \quad \text{where } s_{ji} = \frac{p_j Q_j}{p_i Q_i}, \quad h_{ji} = \frac{Q_i}{p_j} \frac{\mathbb{J} p_j}{\mathbb{J} Q_i}, \quad q_j^k = \frac{q_j^k}{Q_j}$$

- Bank  $k$ 's marginal cost:

$$MC_i^k = 2a_{ii} c_i^k (q_i^k)^{2a_{ii}-1} + \sum_{j>i}^n a_{ij} n_{ij} (q_i^k)^{a_{ij}-1} (q_i^k)^{a_{ij}} - \Delta r_i^k$$

# Market Equilibrium (cont'd)

- Solve FOC for coefficients  $c_i^k$ :

$$c_i^k = \frac{p_i \left(1 + \sum_{j=1}^n s_{ji} h_{ji} q_j^k\right) - \sum_{j>i}^n a_{ij} n_{ij} (q_i^k)^{a_{ij}-1} (q_j^k)^{a_{ij}} - \Delta r_i^k}{2 a_{ii} (q_i^k)^{2a_{ii}-1}}$$

which we denote  $\mathbf{c}^k(\mathbf{p}, \mathbf{q}^k; \mathbf{a}, \mathbf{n}, \mathbf{h})$ . This tells us *what c must have been* for bank  $k$ , based on observations and parameters. We can use previous equations to solve for  $F^k = F(\mathbf{c}^k; \mathbf{a}, \mathbf{g}, \mathbf{l}, \mathbf{n})$

- Economic Profit Function for Bank  $k$ :

$$p^k = \mathbf{p} \cdot \mathbf{q}^k - \sum_{i=1}^n c_i^k(\mathbf{p}, \mathbf{q}^k; \mathbf{a}, \mathbf{n}, \mathbf{h}) (q_i^k)^{2a_{ii}} - \sum_{i=1}^n \sum_{j=i}^n n_{ij} (q_i^k q_j^k)^{a_{ij}} - F(\mathbf{c}^k; \mathbf{a}, \mathbf{b}, \mathbf{l}, \mathbf{n}) - \sum_{i=1}^k \Delta r_i^k q_i^k$$

# Estimating Equations

- We Observe Aggregate Risk  $R^k$  and Accounting Profits

$\bar{p}^k = p^k + R^k$ . We can therefore estimate:

$$R^k = \bar{p}^k \left( \frac{\mathbf{b}^k (r_m - r_f)}{r_f + \mathbf{b}^k (r_m - r_f) - g^k} \right) = \sum_{i=1}^n \Delta r_i^k q_i^k$$

$$\bar{p}^k = \mathbf{p} \cdot \mathbf{q}^k - \sum_{i=1}^n c_i^k (\mathbf{p}, \mathbf{q}^k; \mathbf{a}, \mathbf{n}, \mathbf{h}) (q_i^k)^{2a_{ii}} - \sum_{i=1}^n \sum_{j=i}^n \mathbf{n}_{ij} (q_i^k q_j^k)^{a_{ij}} - F(\mathbf{c}^k; \mathbf{a}, \mathbf{b}, \mathbf{l}, \mathbf{n})$$


- Parameters to be estimated:  $\Delta \hat{r}_i^k, \hat{\mathbf{a}}, \hat{\mathbf{g}}, \hat{\mathbf{h}}, \hat{\mathbf{l}}, \hat{\mathbf{n}}$
- In addition, we estimate firm and year fixed effects.

# What Is a Bank's Output?



- Most Consistent with “User Cost” Model
- What and How Are Customers Paying?
  - Borrowers (C&I, Real Estate, Retail):
    - » output is use of funds over time (\$-yr)
    - » price is interest (\$/\$-yr) and opportunity cost for mandatory deposits.
  - Depositors (Demand, Time):
    - » output is “deposit services,” including liquidity, transaction services, safety, etc.
    - » price is opportunity cost of foregone interest (\$/\$-yr) plus fees⇒  
OUTPUT=DEPOSIT-YRS (\$-yr)
  - Off-balance sheet items:
    - » output is “counterparty guarantees”.
    - » price is “other fee income” divided by output.

# Frontier Methods

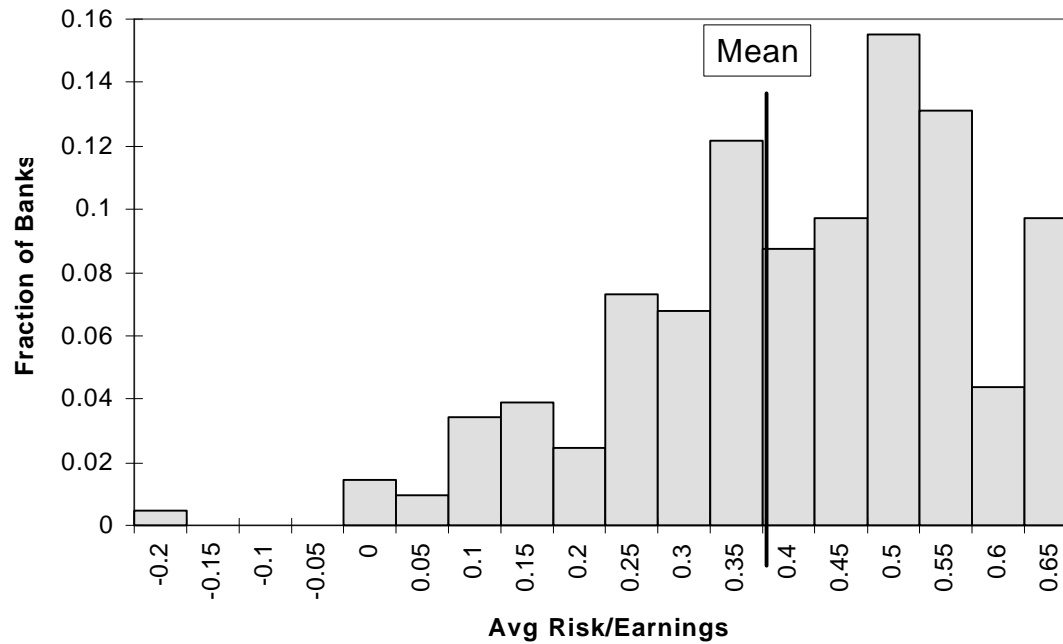
- 
- Preferred Mode: Specify the Hypothesized Inefficiency, Explicitly Model It , and Then Estimate It.
  - Last Resort: Fixed Effects/Frontier Methods.
    - OK if hypothesized inefficiency is inherently unobservable, such as a unique human resource; good for identifying if further modeling required.
  - Choice of Method
    - ☒ DEA: “throws the baby out with the bathwater”
    - ☒ Thick Frontier: theoretical foundations weak
    - ☒ Stochastic frontier: same as Fixed Effects, but with special distributional assumptions (see Berger,*J. Prod Analysis*,1993)
    - ☑ Fixed Effects: gets the job done with solid foundations.
  - ***IF WE’VE DONE OUR MODELING WELL, FIXED EFFECTS SHOULD BE INSIGNIFICANT!***

# Distribution of Risk Costs

## *A Big Piece of Earnings*



Distribution of Avg Risk/Earnings



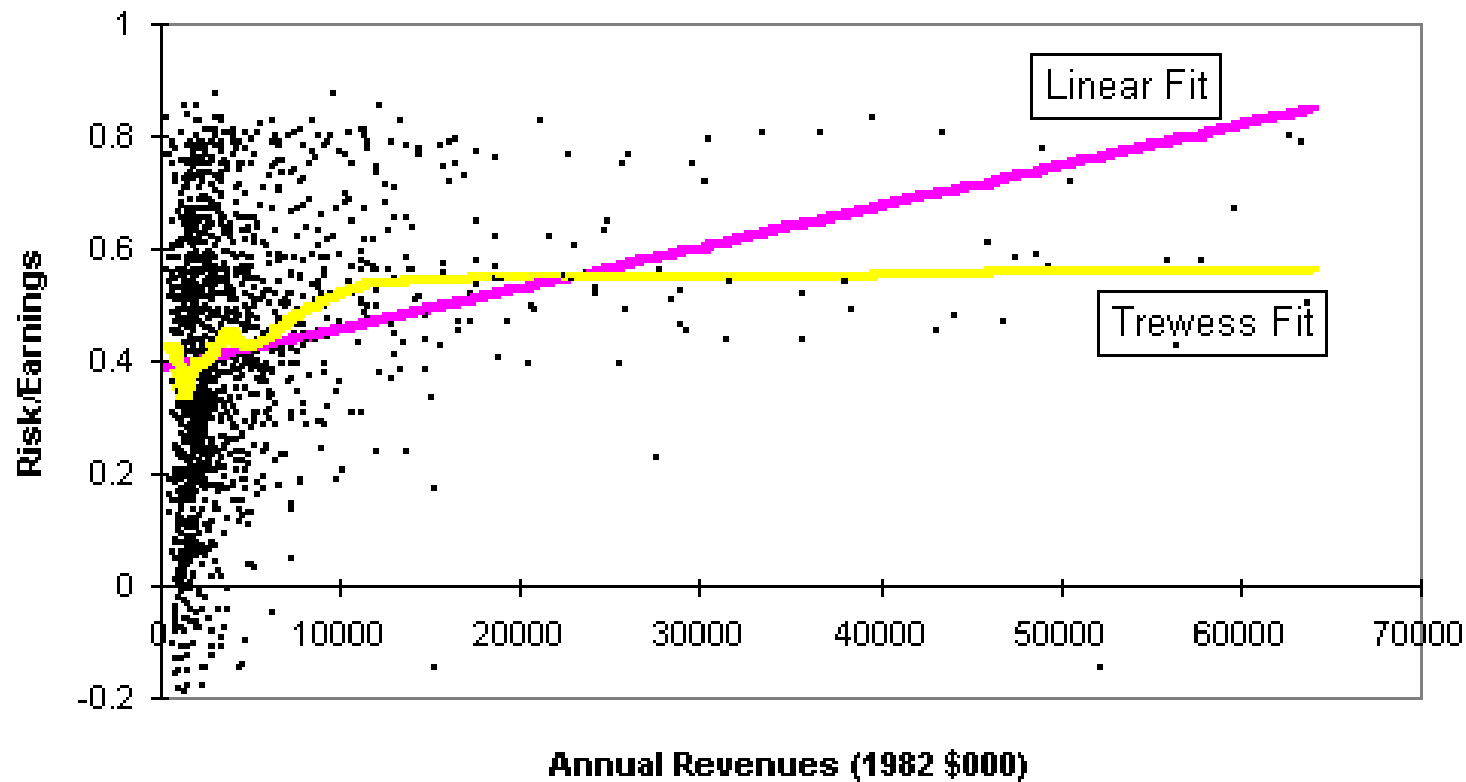
# Risk Results



- Average Risk Cost = 38% of Actual Earnings.
  - This Accounts for About 3% of Bank Cost.
- Significant Variation Across Banks.
  - Over 40% of Banks Have an Average Risk Cost in Excess of 50% of Earnings.
- Some Banks Have Made Risk Management Work for Them.
- Effective Risk Management Is *One* Skill That Differentiates Among Banks.

# Risk vs. Size: *Bigger Isn't Better!*

Risk vs. Size



## Risk vs. Size



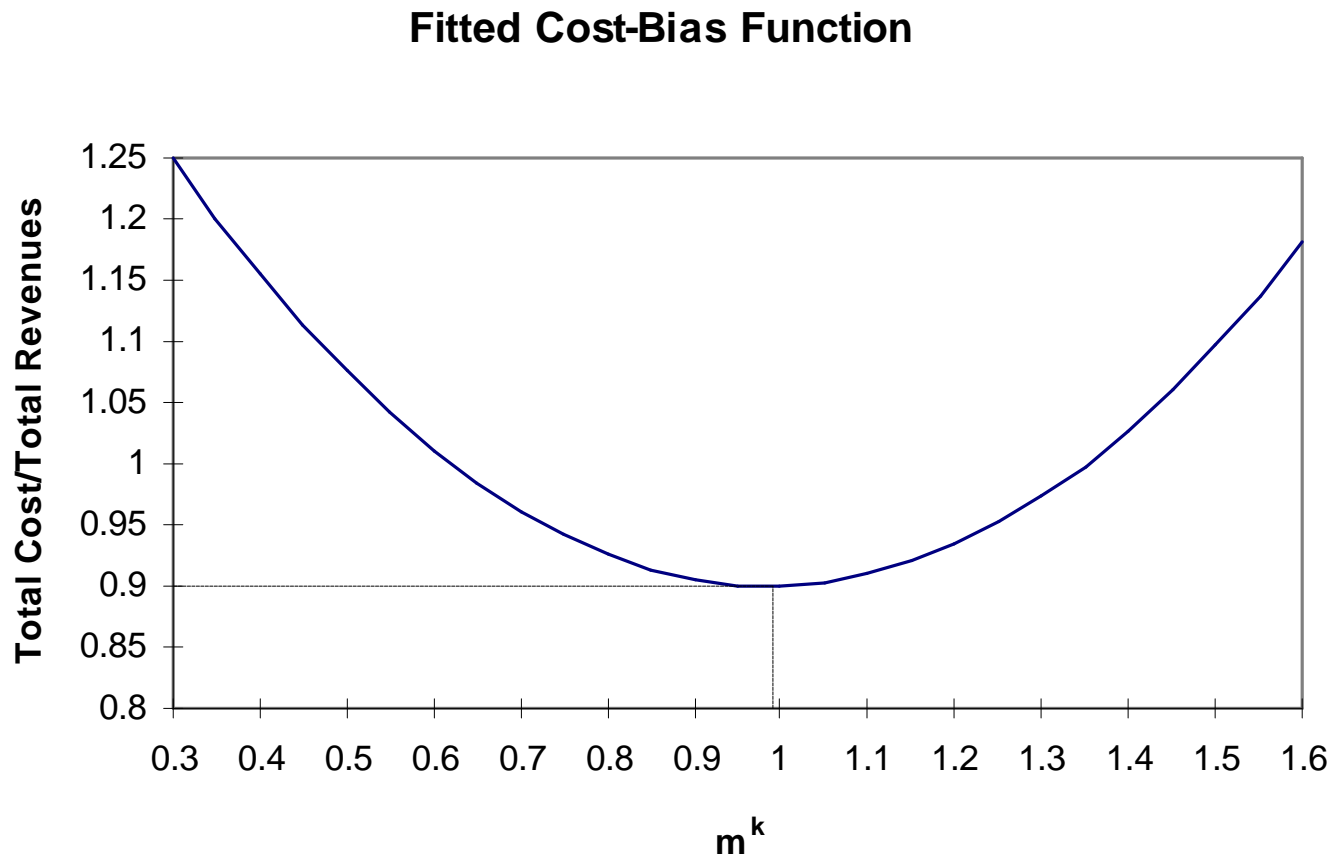
- Larger Banks Have Larger (Relative) Risk.
  - For the Smallest Banks (< \$1M revenues), Bigger Really Is Better.
  - For Larger Banks, the Result Is Unambiguous; Bigger Is *Worse*, But Is Flat for Really Big Banks. **WHY?**
- ☒ Are Risks Harder to Control in a Large Bank?
- ☒ Are Managers of Large Banks Better Able to “Slip the Leash” of Shareowner Control?
- ☒ Do Banks Get Large By Chasing Riskier Assets?
- ☑ Does “Too Big to Fail” Lead to Greater Risk-Taking?

# Efficiency in Capacity Planning



- Banks Must Plan in Advance for a Level of Capacity: Computers, Credit Officers, Branches,...
- At the “Planned-for” Demand, Chosen Capacity Minimizes Cost.
  - Too Little Capacity As Bad As Too Much.
- Banks Then Compete Based On Different Fixed Capacity Levels.
  - Higher Capacity Leads to More Business; “Chasing” Demand to “Fill Up the Pipe.”
- We Estimate Average Bias for Each Bank

# Cost vs. Bias: *Too Little As Bad As Too Much*

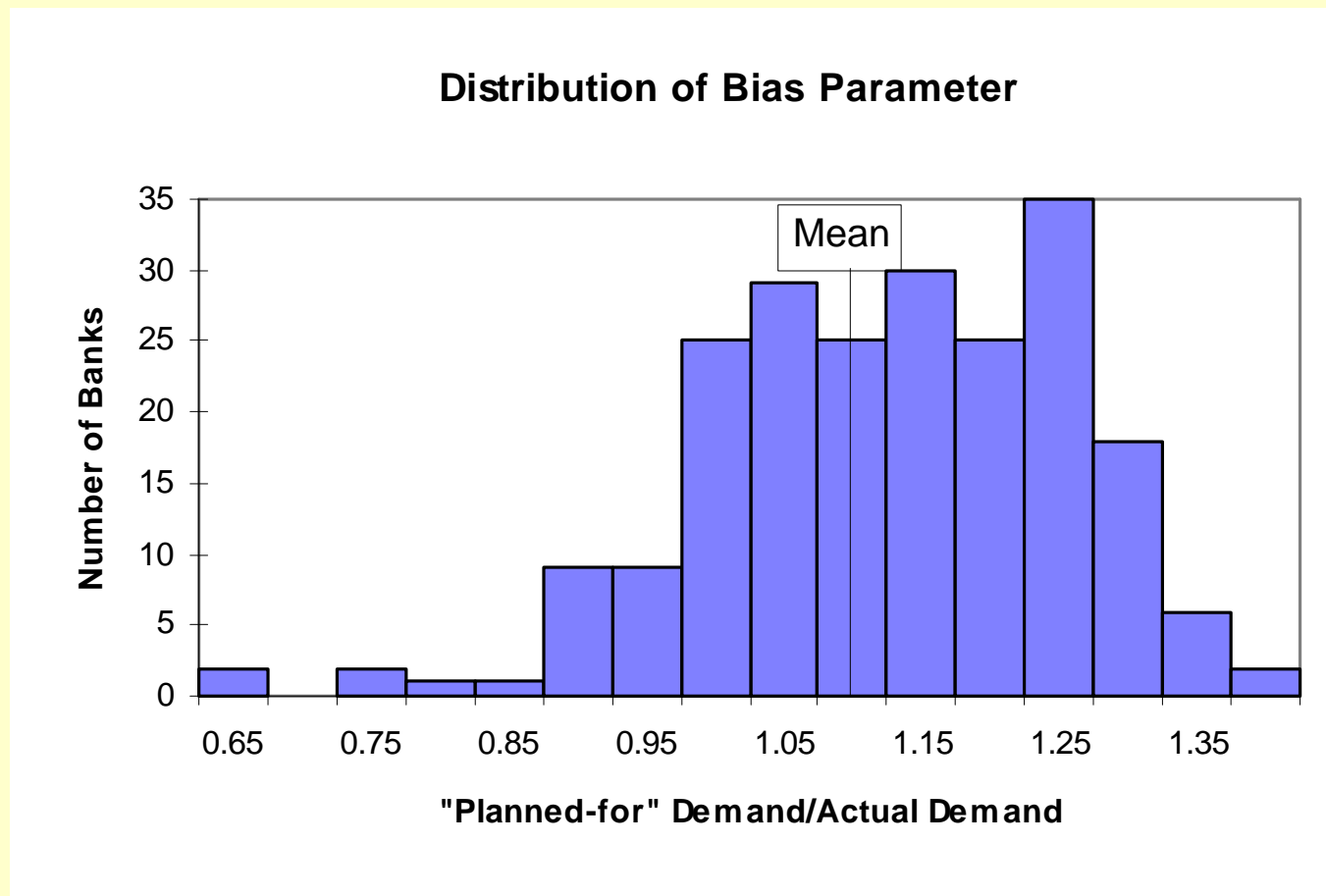


# Efficiency in Capacity Planning




- If Planning Is Efficient, Then Mismatches Should Be Unbiased
  - Some Bias May Be Optimal, With Nonlinear Costs; Evidence Shows This Effect Is Tiny.
- But Actuals Will Differ from Plan, So Some Level of “Inefficiencies” Will Result.
- However, Average Bias Should Be Close to Zero, *If* a Bank Is Doing a Good Job At Capacity Planning.

# Efficiency in Capacity Planning: *Systematic Overcapacity*



# Efficiency in Capacity Planning


- 
- Average Bias = 10% of Actual Demand; WHY?
  - Is Forecasting All That Hard?
    - Average Error Worse Than Simplest Forecasting Rule.
  - But Isn't "Overshooting" a Good Strategy In the Face of Uncertainty and Nonlinear Costs?
    - Evidence Suggests This Is At Most 1/2%.
  - Perhaps Additional Capacity (Such As Extra Branches) Leads to More Convenience and Thus Higher Quality for Customers?
    - Evidence Shows No Correlation between Bias and Quality.

# Efficiency in Capacity Planning



- Result Is Clear: There Is An “Optimism” Bias Among Bank Managers.
- This Bias Costs Banks an Average of 2.2% of Costs, 28% of Earnings.
- Again, There Is Significant Variation Among Banks; Some Control This Well, But Many Err on Either Side.
- Capacity Planning *Another* Skill That Differentiates Among Banks.

# Economies of Scale and Scope

- 
- Previous Extensive Literature Generally Found No Long-Run Scale Economies Above \$1 B in Assets. This Study Confirms That Finding.
  - However, Diseconomies in *Risk-Taking* a Significant New Result.
  - Previous Literature (not so extensive) Found Small Scope Economies. This Study Finds No Significant Product Scope Economies.

# Customer Satisfaction/Quality



- Worked With Greenwich Associates' Extensive Survey Results for 1985-1992.
  - Were Able to Match 112 Banks and 473 Observations.
- Using Statistical Methods, Greenwich Identified Eight Key Questions Across All Market Segments That Their Experience Suggested Captured Quality.
- Questions and Market Segments Were Weighted Into a Scalar Measure of Quality, Focused on Commercial Customers.

# Quality Results



- How Can Quality Affect a Bank's Profits?
  - Costs, Price, Quantity
- Costs Increase With Quality, But Very Little.
- Price Increases With Quality, But Very Little.
  - But Price and Cost Increase the *Same Amount*, So Margins Are Maintained.
- Quantity Increases With Quality, A Lot!
  - After Correcting for Size.
- Earnings Positively Correlated With Quality.
  - After Correcting for Size.

# So Why Isn't Everyone High Quality?



- Since Quality Looks Like a Clear Winner, How Come Everyone Doesn't Do It?
- If the Technology of Producing Quality Were Well-Known, Then Indeed Everyone *Would* Do It, and Profits Would Be Squeezed Out; This Is Not the Case.
- Learning to Provide Quality Seems Difficult, and It Is Diffusing Slowly in Banking. During Gradual Diffusion, Quality Leads to Higher Profits. *But Not Forever!*
- Quality Is Yet *Another* Factor That Differentiates Among Banks.

# Nits and Nats

## ■ Hey, What About *Factor Prices*?

- Cost Function Only Over Outputs.
- If Real Factor Prices Are Relatively Uniform Across Time and Location, Then OK to Omit.
- Tested This Hypothesis By Using Location Dummies for NYC, LA-SF, and Chicago. *NO EFFECT!*

## ■ What About Time Effects? *ZERO*

## ■ So How Do We Know NLS Gives Right Answer?

- We Don't! But Answer Is Robust wrt Starting Values.

## ■ Are Banks the Only Players In the Market? *NO!*

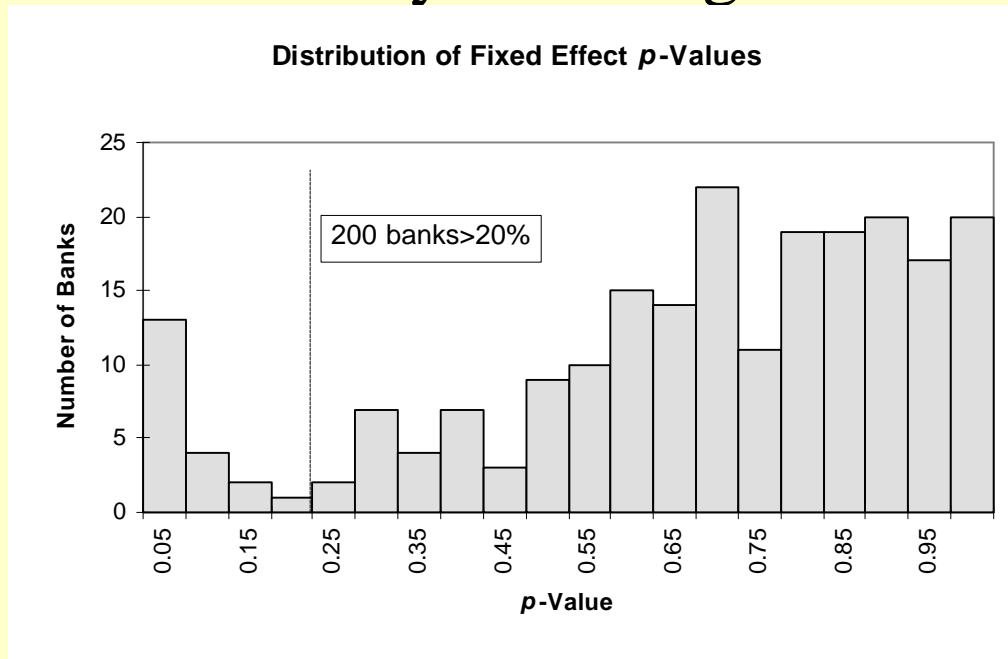
# An Answer to a Big Question



- Previous Research Found Very Large Systematic Differences Among Banks In Profitability and Efficiency.
- Berger, October 1994: “The Research Challenge Is To Find Out What’s Responsible for These Differences.”
- In This Analysis, We Have Hypothesized Drivers of These Inefficiencies: Risk, Overcapacity, Quality.
- *Do These Explain All the Inefficiencies?*

# Bank-Specific Fixed Effects

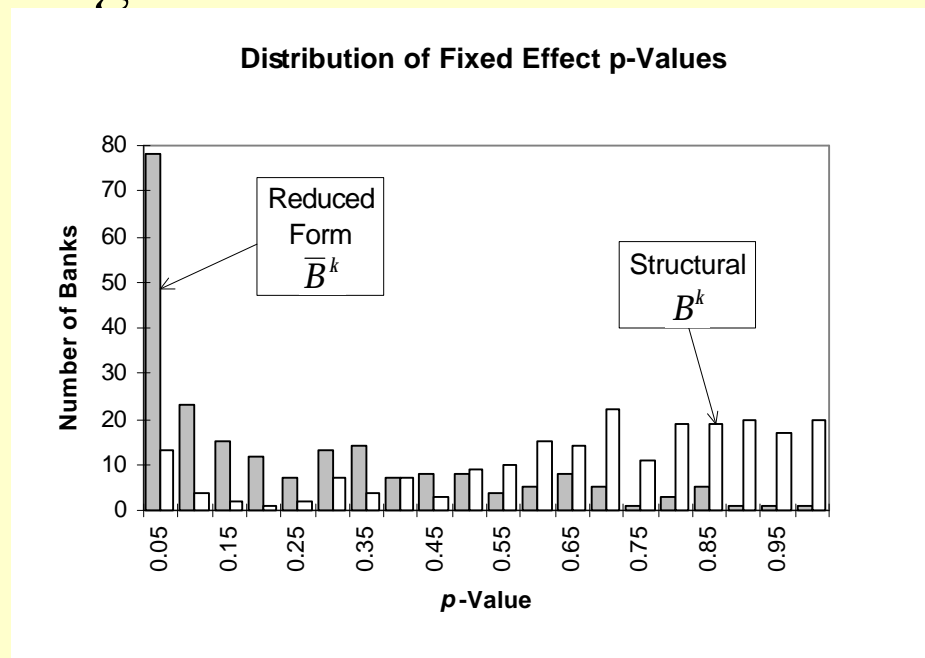
- Fixed Effects: By and Large *NOT SIGNIFICANT!*



- Does Structural Model Explain What Was Previously Attributed to Fixed Effects/Frontier?


# Bank-Specific Fixed Effects (Cont'd)

- Fitting a Reduced Form Model on this Dataset Yields Significant Fixed Effects:




- The Structural Model Captures the Inefficiencies.

# Conclusions

- 
- **Most Significant: The Drivers of Profitability Have Been Identified.**
    - Few Systematic Differences Among Banks Remain to be Explained; We Now Know What's Causing the Inefficiencies.
  - **Risk Costs Significant and Increasing with Size.**
    - Risk Diseconomies of Scale; Is “Too Big to Fail” the Reason? Large Banks More Difficult to Control?
    - Large Variations Among Product Contribution to Risk.
    - Major Differences Among Banks in Ability to Manage Risk.

## Conclusions (Cont'd)

- 
- Capacity Planning Inefficiencies Significant.
    - No Scale, No Scope Economies.
    - Not Explained by Better Quality or Prudence.
    - Major Differences in Ability to Manage Capacity.
  - Quality Differences Significant.
    - Relatively Costless To Do Right.
    - Brings the Customers In the Door.
    - Gives a Substantial Hit to Profits.
    - ...But Relatively Difficult to Learn to Do Right.

# Research and Policy Conclusions

## ■ Structural Models Can Be Done.

- Reduced Form Models Have Dominated Literature.

## ■ Risk Costs Significant and Increasing with Size.

- No Need to Encourage Mergers; “Too Big to Fail” Costly.

## ■ Capacity Planning Inefficiencies Significant.

- Room for Managerial Improvement
- No Scale, No Scope; “Narrow Banking” A Low Cost Option.

## ■ The “Quality ( $\Rightarrow x$ ) Pays”

Story:

$$\frac{\partial p}{\partial x} = \frac{\partial p}{\partial x} Q + \frac{\partial Q}{\partial x} p - \frac{\partial C}{\partial x} > 0$$

0                      +                      0

# Next Steps



## ■ What's Next?

- Update the Model Annually to Provide Banks With a *Benchmark* Against Which They Can Compare Their Performance. The “Annual Wharton Banking Benchmark Model”?
- Survey Field Work: Focus on What the Winners and Losers Are Doing to Turn In Superior/Inferior Performance. *Ask Them!*