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”? 

October 10, 1995 Slide 1 Seminar Presentation
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

  - 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 ⇒ 1984-1992 (quarterly) 219 publicly traded banks > $1 B assets ⇒ 6190 observations

- Customer Satisfaction Data: Greenwich Associates (NewlyCompiled) *Survey Data*.
  - Uses Selected Survey Questions from Bank Customers
  - Merge ⇒ 112 banks (annual) ⇒ 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 Beta for Each Quarter and Each Bank, Using Stock Data for Past Year.
- Holding Company Beta Imputed to Constituent Banks.
Customer Satisfaction Data


- 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

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

by Choosing Parameters $(F,c)$ from the set defined by

The *Long-Run* Cost Function

$$C(q) = \sum_{i=1}^{n} \sum_{j=i}^{n} \lambda_{ij} (q_i q_j)^{\gamma_{ij}}$$

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

$$C(q;F,c) = C(q) \quad \nabla C(q;F,c) = \nabla C(q)$$
Cost of Risk Model

- Measuring Aggregate Risk Cost: Stock Market

- 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* $\bar{\pi}$ and *risk-free earnings* $\tilde{\pi}$:

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

  where $s = r_f + \beta(r_m - r_f)$, $r_f$ = risk-free rate, $r_m$ = market rate

  \[
  R = \bar{\pi} - \tilde{\pi} = \bar{\pi} \cdot \left(\frac{\beta(r_m - r_f)}{r_f + \beta(r_m - r_f)}\right) = \text{Cost of Risk}
  \]
Demand Model

- Demand System Allows Product Interdependence

\[ p_i = A_i \prod_{j=1}^{n} Q_j^{n_{ij}}, \quad \text{for } i = 1,\ldots,n. \]

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

\[ \frac{Q_j}{p_i} \frac{\partial p_i}{\partial Q_j} = \eta_{ji} \]
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 $X=\text{Quality}$;

**LR Cost:**

$$C(q) = \sum_{i \neq 3} \sum_{j \geq i}^{j \neq 3} \lambda_{ij} (q_i q_j)^{\gamma_{ij}} + X \delta \sum_{j=1}^{6} \lambda_{3j} (q_3 q_j)^{\gamma_{3j}}$$

**Demand:**

$$p_3 = X \delta p_3 \prod_{j=1}^{6} Q_j^{\eta_{3j}}$$
Information and Timing

■ Prior to Each Period, Firms Estimate Demand $q^k$ 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):

\[
\max_{q_i^k} \pi^k = \sum_{i=1}^{n} p_i (Q_i q_i^k) - F^k - \sum_{i=1}^{n} c_{i}^k (q_i^k)^{2\alpha_{ii}} - \sum_{i=1}^{n} \sum_{j=i+1}^{n} v_{ij} (q_i^k q_j^k)^{\alpha_{ij}} - \sum_{i=1}^{n} \Delta r_i^k q_i^k
\]

- First-Order Conditions

\[
\frac{\partial \pi^k}{\partial q_i^k} = M R_i^k - M C_i^k = p_i (1 + \sum_{j=1}^{n} s_{ji} \phi_{ji} \theta_j^k) - M C_i^k = 0
\]

or

\[
\frac{p_i - M C_i^k}{p_i} = \sum_{j=1}^{n} s_{ji} \eta_{ji} \theta_j^k
\]

where

\[
s_{ji} = \frac{p_j Q_j}{p_i Q_i}, \quad \eta_{ji} = \frac{Q_i}{p_j} \frac{\partial p_j}{\partial Q_i}, \quad \theta_j^k = \frac{q_j^k}{Q_j}
\]

- Bank \(k\)’s marginal cost:

\[
M C_i^k = 2\alpha_{ii} c_{i}^k (q_i^k)^{2\alpha_{ii}-1} + \sum_{j>i}^{n} \alpha_{ij} v_{ij} (q_i^k)^{\alpha_{ij}-1} (q_i^k)^{\alpha_{ij}} - \Delta r_i^k
\]
Market Equilibrium (cont’d)

- Solve FOC for coefficients $c_i^k$:

$$c_i^k = \frac{p_i (1+ \sum_{j=1}^{n} s_{ji} \eta_{ji} \theta_j^k) - \sum_{j>i}^{n} \alpha_{ij} v_{ij} (q_{ij}^k)^{\alpha_{ij}} - \sum_{j>i}^{n} \alpha_{ij} v_{ij} (q_{ij}^k)^{\alpha_{ij}} - \Delta r_i^k}{2\alpha_{ii} (q_{ij}^k)^{2\alpha_{ii} - 1}}$$

which we denote $c^k(p, q^k; \alpha, \nu, \eta)$. This tells us what $c$ must have been for bank $k$, based on observations and parameters. We can use previous equations to solve for $F^k = F(c^k; \alpha, \gamma, \lambda, \nu)$

- Economic Profit Function for Bank $k$:

$$\pi^k = p \cdot q^k - \sum_{i=1}^{n} c_i^k (p, q^k; \alpha, \nu, \eta)(q_{ij}^k)^{2\alpha_{ii}} - \sum_{i=1}^{n} \sum_{j=1}^{n} v_{ij} (q_{ij}^k q_{ij}^k)^{\alpha_{ij}} - F(c^k; \alpha, \beta, \lambda, \nu) - \sum_{i=1}^{k} \Delta r_i^k q_i^k$$
Estimating Equations

We Observe Aggregate Risk $R^k$ and Accounting Profits $\pi^k = \pi^k + R^k$. We can therefore estimate:

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

$$\bar{\pi}^k = p \cdot q^k - \sum_{i=1}^{n} c_i^k (p, q^k; \alpha, \nu, \eta)(q_i^k)^{2\alpha_{ii}} - \sum_{i=1}^{n} \sum_{j=i}^{n} \nu_{ij} (q_i^k q_j^k)^{\alpha_{ij}} - F(c^k; \alpha, \beta, \lambda, \nu)$$

Parameters to be estimated: $\Delta r_i^k, \hat{\alpha}, \hat{\gamma}, \hat{\eta}, \hat{\lambda}, \hat{\nu}$

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 ⇒
      \[ \text{OUTPUT} = \text{DEPOSIT-YRS} \ (\$/yr) \]
  - Off-balance sheet items:
    - output is “counterparty guarantees”.
    - price is “other fee income” divided by output.
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!
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

Fitted Cost-Bias Function

Total Cost/Total Revenues vs. \( m^k \)
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

Distribution of Bias Parameter

Number of Banks

"Planned-for" Demand/Actual Demand

Mean
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 ½%.
- 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.
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

  - 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.
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 (≠x) Pays” Story:
  \[
  \frac{\partial \pi}{\partial x} = \frac{\partial p}{\partial x} Q + \frac{\partial Q}{\partial x} p - \frac{\partial C}{\partial x} > 0
  \]
  \[
  0 + 0 > 0
  \]
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!*