Before there was “New” Empirical IO

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Grad IO

Early Stuff

This lecture is a bit different from all of the others

- Focus is primarily on theory rather than empirics
- History of approaches (some of which have fallen out of fashion).
- Should be familiar to most of you
    - Brush up on first few chapters of Tirole (1988) (somewhat dated) but still the best reference for oligopoly theory.
    - Vives (2000) is a more modern (and focused) review of oligopoly theory.
    - I assume familiarity with an undergrad text like Carlton and Perloff (1999), Cabral (2000) or Shy (1996).

History of IO: Part I

Structure-Conduct-Performance (1940-1960) Harvard

- Associated with the work of Joe Bain.
- Structure (number of firms, market shares, etc.). Barriers to entry are key.
- Structure $\rightarrow$ conduct (ie: how firms behave)
- Conduct $\rightarrow$ performance (ie: prices, markups, efficiency)
- Use accounting data to get performance (profits, price-cost margins, etc.)
- OLS regression across industries to see whether profits are higher in more concentrated industries.
- Empirics were somewhat atheoretic.

Complaint: the direction of causality is assumed. (Don't profits determine number of entrants too?).

History of IO: Part II

Chicago School (1960-1980)

- Most associated with the work of George Stigler and later Robert Bork "Antitrust Paradox"
- Monopoly is more often alleged than confirmed
- Even when monopoly does exist -often only temporary (did MSFT take over the world?)
- Entry and threat of entry is crucial.
- Emphasis on price theory (markets work) and better econometrics
- Still quite persuasive for practice of anti-trust (judges and lawyers).

History of IO: Part III

Game Theory (1980-1990s)

- For most of the 1980s, IO was dominated by game theorists.
- Strategic decision making, Nash Equilibrium
- Lots of intuitive (and sometimes counter-intuitive) clean theoretical models
- Hard to know which model is the right model for the industry we are looking at.

History of IO: Part IV

The not so “new” anymore empirical IO (NEIO) (1989-)

- Back to one industry at a time.
- Careful game-theoretical model of industry behavior
- Joined with modern econometrics, data, and computation.

The Monopoly Problem

Start with a quantity-setting monopolist facing a known inverse demand curve $P(Q)$ and costs $C(Q)$.

$$\pi(Q) = P(Q) \cdot Q - C(Q) - F$$

Take the FOC:

$$\begin{aligned}
\pi'(Q) &= 0 \\
\underbrace{\overbrace{P'(Q) \cdot Q}^{\text{monopoly distortion}} + P(Q)}_{MR} &= \underbrace{C'(Q)}_{MC} \\
\frac{P(Q) - C'(Q)}{P(Q)} &= -\frac{P'(Q) \cdot Q}{P(Q)} = \frac{1}{|\epsilon_d|}
\end{aligned}$$

The Monopoly Problem

We could have rewritten it as

$$P\left(1 + \frac{1}{\epsilon_d}\right) = MC$$

- This is helpful because it shows us the important result that the monopolist never produces in the inelastic portion of the demand curve. $\epsilon_d \in (-1, 0]$.
- Why? MR is negative! Reduce Quantity!
- Often data report: $\frac{P-MC}{MC} = \frac{1}{\epsilon_d - 1}$. But we usually work with the Lerner formula in IO.
- For the monopolist firm level elasticity ϵ_d is the same as ϵ_D the market elasticity.

Cournot Model (1838) / Nash in Quantities

- I am going to assume constant marginal cost $c_i = c$ and n equal sized firms to make life easy.
- We let $Q = \sum_{i=1}^{N} q_i$ the total output of the industry.

We consider profits and FOC's:

$$\begin{aligned} \pi_i(q_i) &= (P(Q) - C_i'(q_i)) \cdot q_i \\ \frac{\partial \pi_i(q_i)}{\partial q_i} &= (P(Q) - C_i'(q_i)) + q_i \cdot P'(Q) \cdot \frac{\partial Q}{\partial q_i} = 0 \end{aligned}$$

Cournot competition implies that $\frac{\partial Q}{\partial q_i} = 1$ and $\frac{\partial q_j}{\partial q_i} = 0$ for $i \neq j$ (this is because it is a simultaneous move game).

$$P(Q) + P'(Q) \cdot q_i = P(Q) + \overbrace{P'(Q) \cdot \frac{Q}{n}}^{\text{Cournot Distortion}} = mc$$

Cournot Model (1838) / Nash in Quantities

Rearrange to form the Lerner Index:

$$\frac{P - mc}{P} = -\frac{1}{n}\frac{Q}{P}P'(Q) = -\frac{1}{n \cdot \epsilon_D}$$

Some notes

- In general market demand is much less elastic than firm level demand.
- When things are symmetric then we can relate aggregate to firm level elasticity: $\epsilon_d = n \cdot \epsilon_D$.
- For beer market demand $\epsilon_D \approx -0.8$. If $n = 5$ then a typical firm faces an elasticity of -4.0.
- We can back out implied markups pretty easily: $P = \frac{MC}{1-(1/\epsilon_d)} = \frac{4}{3}MC$.
- Market demand can be at inelastic part of curve – but firm level demand cannot.

Betrand Paradox (1883)/ Nash in Prices

Briefly contrast with Bertrand

- Two firms with symmetric marginal costs $c_i = c$.
- Nash in prices means that $p = c$.
- This is not very interesting or helpful. Also firms make profits!
- Solutions
  - Add capacity constraints (starts to behave like Cournot again (Kreps Scheinkman)).
  - Add other frictions (search costs?)
  - Add product differentiation (mostly we focus on this).

Asymmetric Cournot and HHI

- Symmetry doesn't seem like a particularly realistic assumption.
- We can extend this to the asymmetric case pretty easily by modifying the Cournot distortion: $q_i \cdot P'(Q) \cdot \frac{\partial Q}{\partial q_i}$.
- Instead we have that $\frac{q_i}{Q} \cdot \frac{\partial Q}{\partial q_i} = \frac{q_i}{\sum_{j=1}^{n} q_j} \equiv s_i$ or market share.
- Obviously this nests symmetric case where $q_i = \frac{Q}{n}$ or $s_i = \frac{1}{n}$.
- The Cournot markup / Lerner Index is just

$$\frac{P - mc_i}{P} = \frac{s_i}{|\epsilon_D|}$$

- Cournot: markups are proportional to market-share.
- Nests perfect competition $n \to \infty$ or $s_i \to 0$.
- Semi-joke: IO economists say something is intuitive if it follows Cournot predictions.

Asymmetric Cournot and HHI

Now consider the market share weighted Lerner index:

$$HHI = \sum_{i=1}^{N} \frac{P - mc_i}{P} s_i = \sum_{i=1}^{n} \frac{s_i^2}{\epsilon_D}$$

- For $\epsilon_D = 1$, this is known as the Hirschman-Herfindal Index.
- This gives us a measure of market concentration that varies from 0 to 10,000 (units of s_i are in percentages).
- DOJ/FTC describe markets as:
  - Highly Concentrated: $HHI \geq 2500$.
  - Moderately Concentrated: $HHI \in [1500, 2500]$. $\Delta HHI \geq 250$ merits scrutiny.
  - Un-Concentrated: $HHI \leq 1500$.

Asymmetric Cournot and HHI

- Can also work backwards form HHI to get effective "number of firms".
- Here HHI is in units of $[0,1]$ instead of $[0,10000]$.

$$HHI = \sum_{i=1}^{N} s_i^2 = \frac{1}{n^*} \rightarrow n^* = \frac{1}{HHI}.$$

- ex. Four firms with shares $40\%, 30\%, 15\%, 15\%$. So the $HHI = .295$. Thus $n^* = 1/.295 = 3.39$ and $\epsilon_d = \epsilon_D \cdot 3.39$.
- Alternatively (under Cournot only!) can write:

$$\frac{P - MC}{P} = \frac{HHI}{\epsilon_D}$$

Alternatives to HHI

- Another alternative is the k firm concentration ratio $CR_k = \sum_{i=1}^{N} s_i$.
- This can be useful as an additional descriptive statistic.
- It shows up in some older work
- 4 firms is a popular measure.

Complaints about HHI

- HHI only measures market power under the Cournot assumptions
  - Holding competitor's output responses fixed so that $\frac{\partial Q}{\partial q_i} = 1$.
  - Competition is about setting quantity rather than price: strong restrictions on cross-price elasticities.
  - Is quantity (instead of price) the relevant strategic variable? (Sometimes...).
- Assumes that products are homogenous so that all firms/products are equally good competitors.
- More concentrated markets have higher markups, but not always lower welfare (allocating production from low to high cost firms might improve welfare).

Conjectural Variations

- If I change my quantity, why doesn't my rival?
- Biggest complaint about Cournot is that we hold quantities of competitors fixed
- Suppose we did not so that $\frac{\partial Q_i}{\partial q_i} = (1 + \frac{\partial Q_{-i}}{\partial q_i})$.
- FOC becomes:

$$P + P'(Q) \cdot q_i \cdot \underbrace{\left(1 + \frac{\partial Q_{-i}}{\partial q_i}\right)}_{\theta_i}$$

- $\frac{\partial Q_{-i}}{\partial q_i} = -1$ or $\theta_i = 0$ corresponds to competition (aggregate quantity is unchanged). (also Bertrand)
- $\frac{\partial Q_{-i}}{\partial q_i} = 0$ or $\theta_i = 1$ corresponds to the Cournot model.
- $\frac{\partial Q_{-i}}{\partial q_i} = N - 1$ or $\theta_i = N$ corresponds to the joint profit maximization (collusion/monopoly).
- This was great for applied theory, now I can nest all of the key classical models

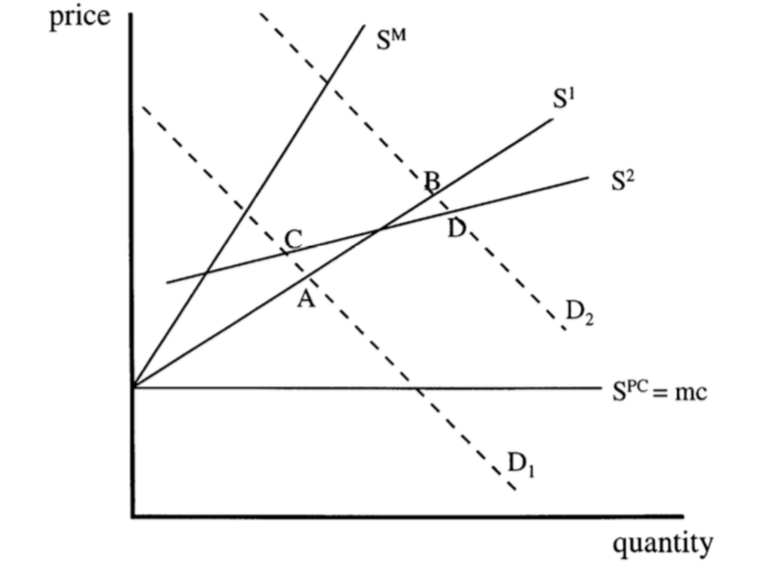
Conjectural Variations: Issues

- On one hand seems like more flexibility was a good thing.
- On the other hand with some θ_i we can justify nearly anything.
- Two questions
  1. Can we expect to recover θ_i from data?
  2. What about consistent conjectures (ie: suppose I require firms to actually want to respond in the way that I believe they will).

Consistent Conjectures

- Bresnahan (1981) posed the consistent conjectures hypothesis (one unique conjecture that satisfied all FOCs simultaneously).
- Large theory literature that followed [see Daughety (1985) or Lind(1992)] show Cournot $\theta_i = 0$ is the only consistent conjecture absent some knife-edge cases.
- This basically meant that CV approaches fell out of favor with game theorists by the late 1980s/early 1990s.
- Things are even more problematic for dynamic models.
- The approach persisted in empirical work until Corts (1999) [more on this later].

Can/Should we try and recover θ_i from data?



Testing S-C-P

Can we test for relationship between performance and market structure?

- Positive correlation between HHI and market power.
  - Usually easy to measure concentration (sort of)
  - Measuring Profits is tough:
    - Accounting profits: taxes and depreciation aren't really very close $P - MC$.
    - Tobin's Q
    - The Lerner index: $(P - MC)/P$
  - We don't usually get to observe MC in data.
    - Maybe we see something like total revenue or total variable cost and units sold.
    - Have to use unit values $(P - AVC)/P$ which is okay if $AVC \approx MC$ and our firm sells only a single product at a single P.
    - Trade data sometimes looks a bit like this today...

S-C-P paradigm and empirical work

Bain (1951)

- Census data was across industries but not firm-level data.
- Prices are hard to compare across industries (for obvious reasons)
- Profits/Markups are easier to measure and compare across industries
- Firms make profits was an important stylized fact at the time.

Why do we care?

- The whole basis for modern antitrust and regulation is based on the relationship between concentration and market power.

S-C-P regressions #1

$$y = \beta_0 + \beta_1 \cdot HHI + \gamma X + \varepsilon$$

- Using y as profit measure and each observation a different industry.
- Idea is that $\beta_1 > 0$ meant increased concentration meant higher profits (or prices).
- Lots of different X's (controlling for returns to scale, R&D, etc.): anything that shifts profits that isn't competition.
- We should probably worry that $E[\varepsilon|H, X] = 0$ or that factors might be correlated with both profitability and concentration in unobservable ways.
    - Is Google or Facebook or Apple highly profitable because of concentration?
- Structure, Prices, and Profits are likely simultaneously determined.

S-C-P regressions #2

$$y_{if} = \beta_0 + \beta_1 \cdot HHI_i + \beta_2 s_{if} + \gamma X_i + \varepsilon$$

- One critique (associated with Demsetz (1973) and the Chicago School) was the following
  - With firm level data if we include share of the firm s_{if} the coefficient on that β_2 was positive and significant but any effect on β_1 became insignificant.
  - Even when it looked like concentration led to high prices, it meant that share was correlated with high prices
  - Chicago School took this as vindication of idea that larger firms were more efficient, had lower costs, etc.
  - Of course this is also what would be predicted from a standard Cournot model...

S-C-P: Schmalensee 1989

A huge handbook chapter summarizing the early literature that collected stylized facts.

- Correlations among accounting profit measures are high but correlations between accounting measures and price-cost margins are low and results depend on which type of measure is used.
- Cross industry accounting rates of return are too low to reconcile with standard monopoly models.
- Accounting profitability differences among large firms are highly persistent
- Industry characteristics account for only 10-25% of cross sectional variation in accounting rates of return
- Recent revenue growth is positively correlated with profitability
- Relation between profitability and concentration is weak and effect is usually small. This relationship is not stable over item or industry and disappears with various controls.
- Measures of scale economies or capital requirements are positively correlation with industry-level accounting profits
- R&D is positively related to profits but effect varies with HHI.
- Profitability of largest firms is correlated with industry HHI not true for smaller firms.

S-C-P: What Happened?

- Hundreds of papers written looking at correlations between HHI and π or PCM.
- This literature has been dead for a while.
  - We moved on from descriptive correlations to causes.
  - We generally need more of a theory to ascertain causes.
  - Data on individual industries and firms has gotten much better over time.
- There are still lots of papers that try and infer causality from regressions like

$$\pi_{it} = \alpha + \gamma HHI_{it} + \beta X_{it} + \epsilon_{it}$$

- Mostly they will get rejected from journals if an IO economist sees it.
- Market structure is endogenous and there is no instrument for HHI.
- Supply and demand are determined simultaneously (so real problem is worse).