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 0

Early 20th century Agricultural Economics

- How can we estimate supply and demand from data?
- Mostly homogenous agricultural products.
- Early discussion of simultaneity/endogeneity econometrics

Complaint: everything still perfectly competitive.

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 → conduct (ie: how firms behave)
- Conduct → 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 antitrust (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 and derive the Lerner Index:

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

- This is known as the *Lerner (1934) Index* or economic markup.

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: $\frac{P}{MC}=\mu$. 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

- 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).

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

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: $HHI \geqslant 2500$.
    - Moderately Concentrated: $HHI \in [1500, 2500]$. $\Delta HHI \geqslant 250$ merits scrutiny.
    - Un-Concentrated: $HHI \leqslant 1500$.

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:

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

HHI and Welfare

Under Cournot (and only Cournot) with constant MC, we can relate HHI to particular measures of welfare:

- Cowling Waterson (1976) relate HHI to producer share of revenue:

$$HHI = \epsilon_d \cdot \frac{PS}{R}$$

- Spiegel (2020) relates HHI to producer share of surplus:

$$HHI = \frac{1}{\epsilon_d \left(Q*\right)} \cdot \frac{PS}{CS}$$

$$\frac{CS}{TS} = \frac{1}{1 + \epsilon_d \left(Q*\right) \cdot HHI}$$

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 relates to 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).

Also, how do we define markets in the first place?