

Before there was “New” Empirical IO

C. Conlon

Fall 2024

Grad IO

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).

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?).

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.

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**:

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

- 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.

Bertrand 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 $n \rightarrow \infty$ or $s_i \rightarrow 0$.
- ▶ 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 from 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:

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

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:

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

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?