

# Before there was “New” Empirical IO

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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).

## 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**:

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



# 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:  $\frac{P}{MC} = \mu$ . But we usually work with the Lerner formula in IO.
- For the monopolist firm level elasticity  $\epsilon_d$  is the same as  $\epsilon_D$  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:

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

## 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:

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



- Another alternative is the  $k$  firm concentration ratio  $CR_k = \sum_{i=1}^k s_i$ .
- 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?