LECTURE 9—IO PART 2

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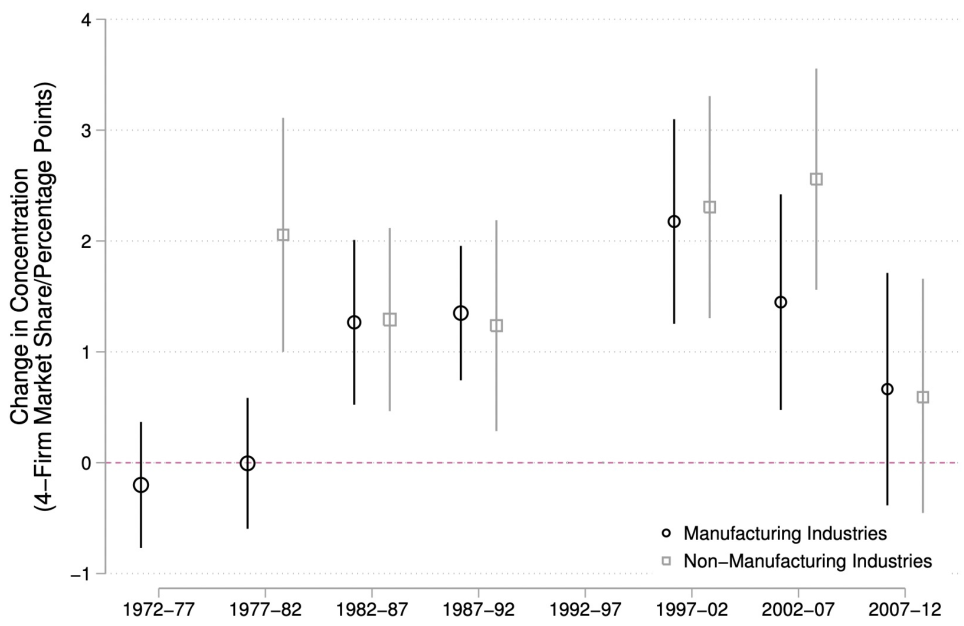
FOR TODAY:

I. Why study Oligopolies?
II. Environment
III. Cournot Competition
IV. Characterization
V. When Cournot gives rise to Monopolies

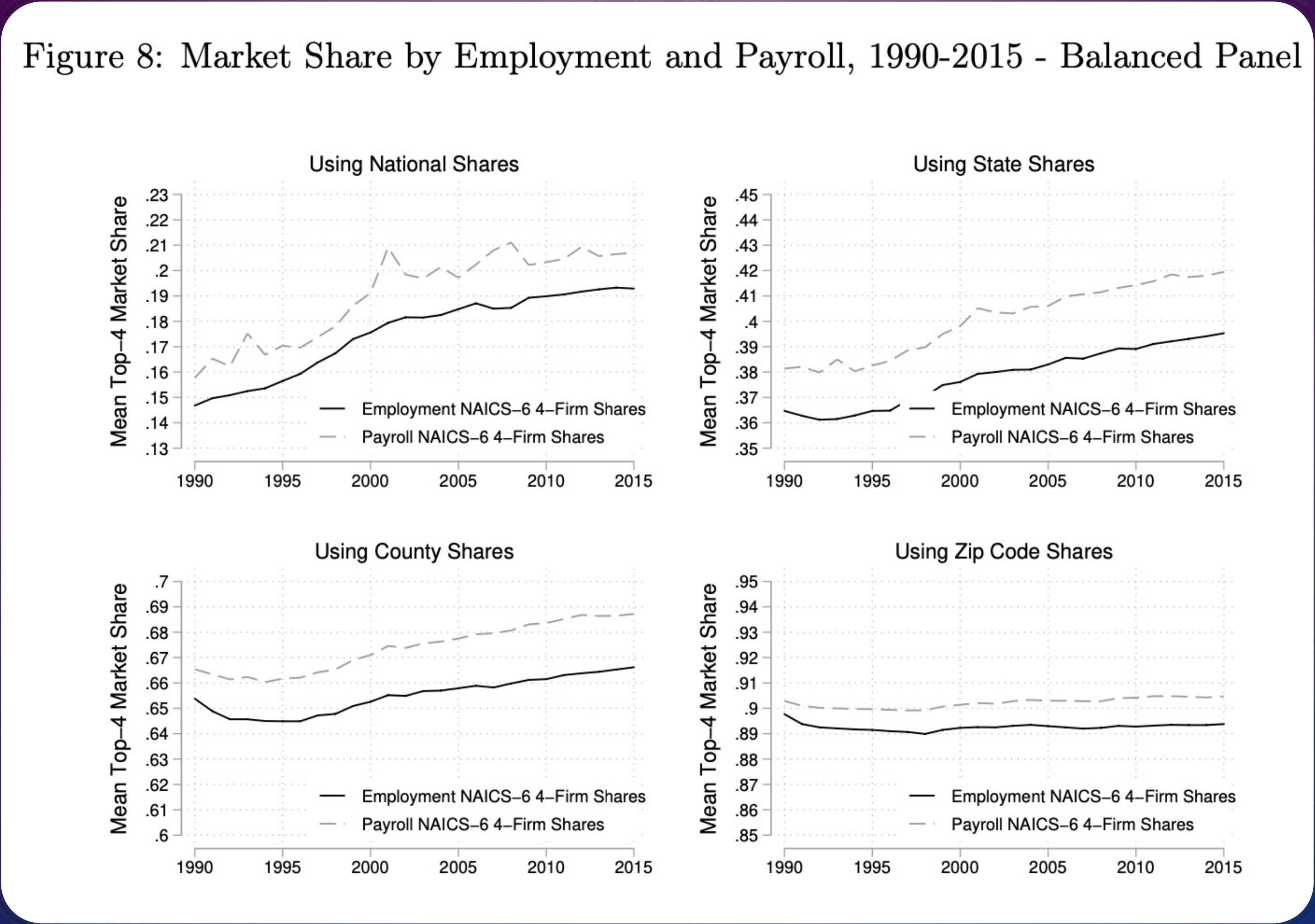
WHY SHOULD ONE STUDY OLIGOPOLIES?

- Most industries have few, but more than 1 producer
- There is often an even smaller subset of producers controlling the entire supply
- Figures from Ganapati (2018)

Figure 1: Average Change in Market Share of 4-Largest Firms over 5-year intervals

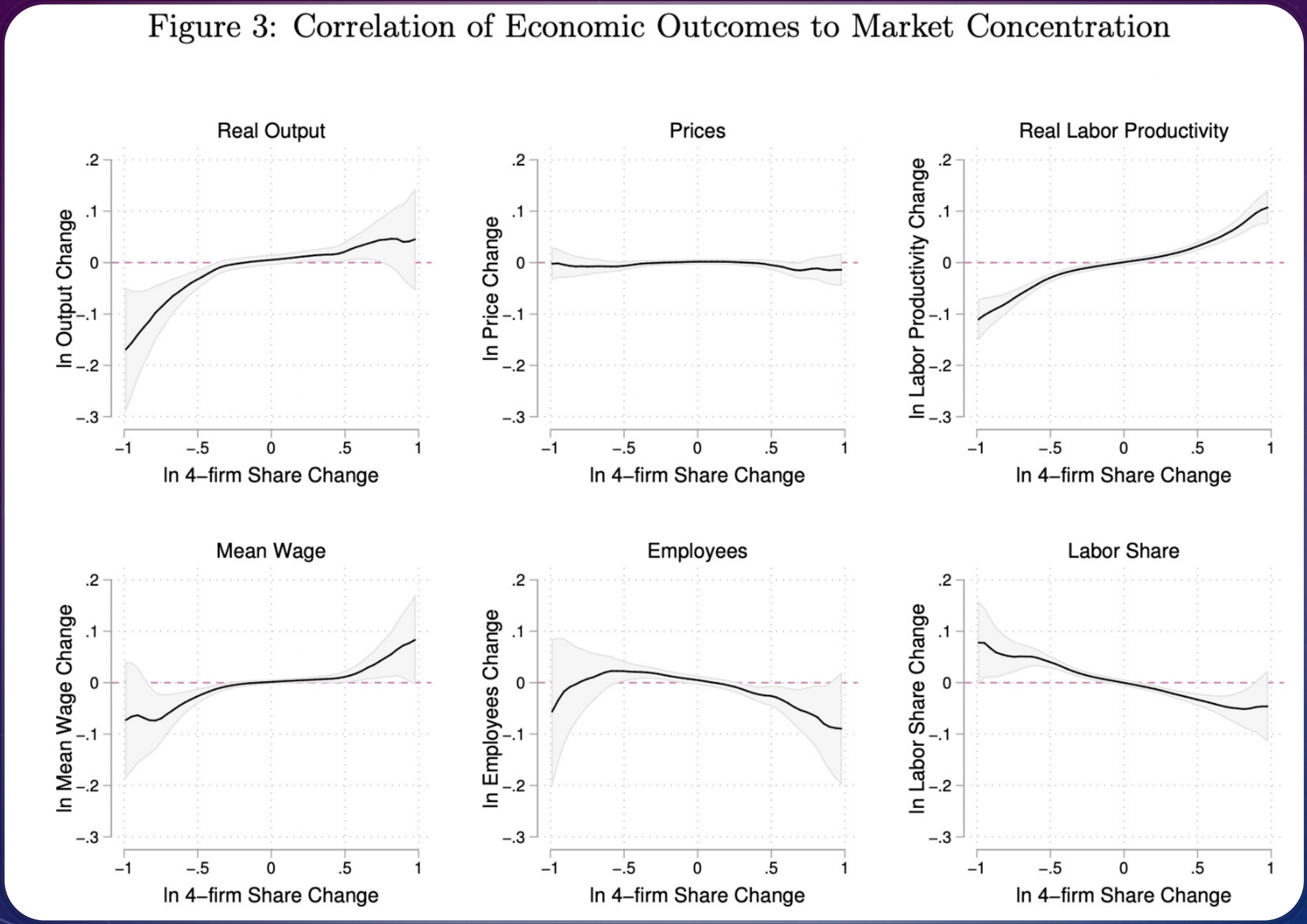


MARKET CONCENTRATION IS GROWING.



- Share of workers in an industry employed by the top 4 firms has been growing for the last 25 years.
- Antitrust laws, however, prevent monopolies to fully overtake industries.

EFFECTS OF MORE CONCENTRATION



I. More production
II. More productive use of labor
III. Less employment (and more outsourcing)
IV. Smaller share of revenues paid in wages

OUR FOCUS WHEN STUDYING OLIGOPOLIES

- Having few, large producers is the norm and it's becoming more so
- Thus, we should understand how these market operate since they clearly impact economic outcomes beyond their industry.
- But ***HOW*** these firms compete usually matters…
- Today, we focus on competition with regards to market share (i.e. how much of the output each firm produces)

ENVIRONMENT: UNDIFFERENTIATED MARKET

- Players: unit mass continuum of buyers and $n \geq 2$ sellers
- Actions:

i. Buyers purchase 0 or 1 unit

ii. (Cournot): each seller $j \in \{1,2,\cdots,n\}$ picks a mass of goods to produce $q_j \in [0,1]$

- Payoffs:

i. A buyer purchasing $x \in \{0,1\}$ units receives a payoff of $x\,\{\theta - p\}$ for $\theta \in [0,1], F(\theta) = \theta$ and valuations and drawn iid

ii. When sellers produce $q = \left(q_j\right)_{j=1}^{n} \in [0,1]^n, \sum_{j=1}^{n} q_j \leq 1$, each seller j nets a payoff of $\pi_j(q) = \left[p(\sum_{i=1}^{n} q_i) - c_j\right]q_j$

- Assume that for each seller j, $c_j \in [0,1]$ and for each pair $i, j, i < j$, then $c_i \leq c_j$.

TIMING

I. Nature draws valuations and privately informs each buyer of their own valuation
II. Sellers, simultaneously, choose how much to supply q_j
III. Buyers, simultaneously, make a purchase decision
IV. Game ends

STRATEGY

- Sellers do not receive any information BEFORE making a choice, a seller j strategy is quantity $q_j \in [0,1]$
- A buyer strategy remains as a function b: $[0,1]^{n+1} \to \{0,1\}$ with the same interpretation from before
- Note that we will define market clearing.

BUYER PROBLEM

- Given some valuation θ and conjecturing a price p, a buyer solves

$$(1)\ CS\ (\theta) = \max_{x \in \{0,1\}} x(\theta - p)$$

SELLER PROBLEM

- A seller j, conjecturing a pricing function $p(.)$ and quantities $q_{-j} = (q_i)_{i \in \{1,2,\cdots,n\}, i \neq j} \in [0,1]^{n-1}$ solves

$$(2j)\ \pi_j(p, q_{-j}) = \max_{q_j \in [0,1]} \left[p\left(\sum_{i=1}^{n} q_i \right) - c_j \right] q_j$$

EQUILIBRIUM

- An equilibrium is a tuple $\sigma = (q, p, b)$ such that

1. For each $\theta, b(\theta)$ solves buyer problem (1)
2. For each seller j, q_j solves seller problem $(2j)$
3. Beliefs are consistent: $p(\sum_{i=1}^{n} q_i) = p$
4. Markets clear: $E[b(\theta)] = \sum_{i=1}^{n} q_i$

CHARACTERIZATION 1

- We, again, characterize the equilibrium via backwards induction.

1. A buyer buys iff $\theta \geq p$, so the buyer strategy is $\forall\theta \in [0,1], b(\theta) = 1_{\theta \geq p}$
2. This again implies that aggregate demand equals to $\forall p \in [0,1], E\big(b(\theta)\big) = D(p) = 1 - p$
3. We can then plug this functional form into the Market clearing condition stating that

$$(3)\ 1 - p = \sum_{i=1}^{n} q_i$$

CHARACTERIZATION 2

1. Since beliefs are consistent with actions, it holds that

$$(4)\ p = p\left(\sum_{i=1}^{n} q_i\right) = 1 - \sum_{i=1}^{n} q_i$$

CHARACTERIZATION 3

- Given the functional form previously derived, we can re-state a seller j's problem as

$$(5)\ \pi_j^*(q_{-j}) = \max_{q_j \in [0,1]} q_j \left[1 - c_j - \sum_{i=1}^{n} q_j\right]$$

- This problem is characterized by a Lagrange equation of the form

$$(6)\mathcal{L}(q_j, \lambda_1, \lambda_2) = q_j \left[1 - c_j - \sum_{i=1}^{n} q_j\right] + \lambda_1 q_j + \lambda_2 (1 - q_j)$$

CHARACTERIZATION 4

- The complementary slackness conditions imply that $\lambda_1 q_j = \lambda_2(1 - q_j) = 0$
- Meanwhile, the foc states

$$(7)\ 1 - c_j - \sum_{i=1}^{n} q_i - q_j + \lambda_1 - \lambda_2 = 0$$

CHARACTERIZATION 5

- It is easy to see that $q_j < 1$, HOMEWORK if you do not see it, but it is not necessarily true that $q_j > 0$
- Define as P, the set of sellers for whom $q_j > 0$, then the foc for them becomes

$$(8j)\ (1 - c_j) - \sum_{i \in P} q_i = q_j$$

- If one adds up the equations $(8j)$ and re-arrange, it holds that

$$(9)\ \sum_{i \in P} q_i = \sum_{i \in P} \frac{1 - c_j}{1 + \#P} = Q \equiv Total\ Supply$$

CHARACTERIZATION 6

- We can now replace $\sum_{i \in P} q_j$ into equations $(8j)$ and conclude that

$$(10\,j)\ q_j = \left(1 - c_j\right) - \sum_{i \in P} \frac{1 - c_j}{1 + \#P}$$

- Adding up the quantities yields a total supply of

$$(11)\ p = 1 - \sum_{i \in P} \frac{1 - c_j}{1 + \#P}$$

CHARACTERIZATION 7

- The main question at hand is who gets left out.
- We can plug in our expression for $\sum_{i \in P} q_i$, the fact that $\lambda_2 = 0$, and find that $\lambda_1 > 0$ provided that

$$(12) \sum_{i \in P} \frac{1 - c_j}{1 + \#P} > 1 - c_j$$

IMPLICATIONS

- Notice that the unit cost $c_j's$ characterize the productivity of firm: i.e. more productive firms have a lower unit cost of production
- This implies that when firms differ by productivity, there endogenously exists a maximal unit cost which a firm must have in order to justify participating in the market
- It also implies that more productive firms produce a larger share of the output

EXTREME CASES OF INTEREST

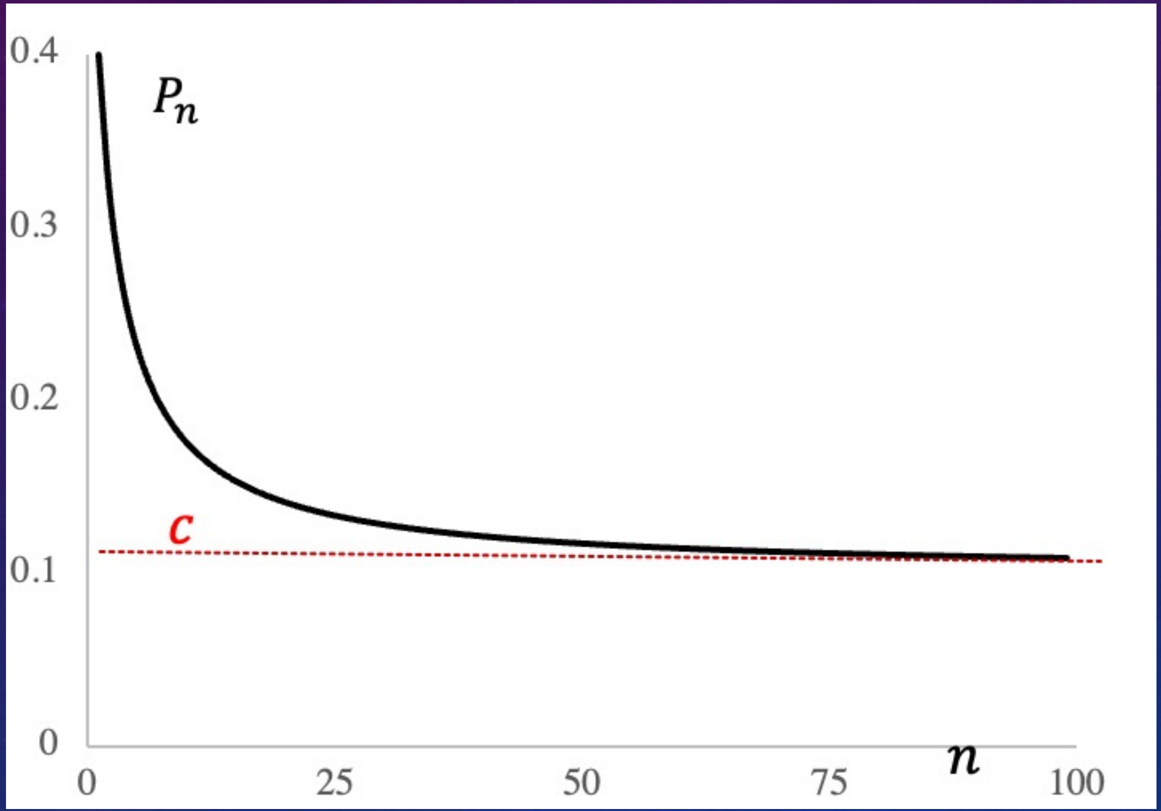
- A useful case to consider is what happens when for each $j, c_j = c > 0$
- Assume that all buyers produce then each producer j produces q

$$(12)\ q = (1-c) - \sum_{i=1}^{n} \frac{1-c}{1+n} = \frac{1-c}{1+n}$$

- Thus, total output and the price equal

$$(13)\ Q_n = (1-c)\left(\frac{n}{1+n}\right), p = 1 - Q_n$$

FIGURE 3: *EQUILIBRIUM PRICE IN AN OLIGOPOLISTIC MARKET WHEN THE NUMBER OF IDENTICAL SELLER INCREASES.*



EXTREME CASE 2: A MONOPOLY

- Suppose that we have 2 sellers
- One has a unit cost of 0 and the other of ½
- Then, the seller with the unit cost of 0 can produce the monopoly quantity of ½
- The other seller, conversely, expects that adding any additional supply would yield an equilibrium price $p \leq \frac{1}{2}$!
- Thus, the second seller does not produce anything.

PUNCHLINES

1. When sellers compete with respect to quantity, in the environment discussed, there exists room for competition so long as they differ in productivity
2. There equilibrium price and profits, in general, lower than in the monopoly case
3. COMPETITION NEED NOT IMPLY LACK OF AN ENDOGENOUS MONOPOLY.