Oligopoly
Chapter 27

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What is Oligopoly?

- Oligopoly is a kind of market structure, like monopoly or perfect competition
- An oligopolistic industry is an industry consisting of a few firms (duopoly $=$ two firms)
- Example industries: auto, operating systems, mp3/music players, airlines

Questions

How can we analyze an oligopolistic industry?

- How are the market prices and quantities determined?
- How does this impact welfare?
- How do we think about competition among oligopolists?
- Why might firms want to collude (form a cartel)?
- How can a cartel be sustained?

We use Game Theory to Study Oligopoly

- With PC and monopoly market structures, we analyze a firm making an individual decision
- PC: very many firms, one firm's actions do not impact others
- Monopoly: only one firm, no one else to impact
- However, oligopoly: each firm's p, q decisions affect competitor's profits
- Strategic interaction/interdependence $\Longrightarrow$ apply game theory

Oligopoly models

Considerations:

- Do firms compete on price or quantity?
- Do firms act sequentially (leader/followers) or simultaneously (equilibrium)
- Stackelberg models: quantity leadership
- Cournot equilibrium models: simultaneous choice quantity competition
- Bertrand equilibrium models: simultaneous choice price competition

Oligopoly

Today:

- Cournot model
- Compare to PC, monopoly
- Next time:
  - Stackelberg model
  - Bertrand model
  - Cartels

Example: comparing market structures

- The basics:
  - Inverse demand: $p = a - Q$ (where Q is *total* quantity)
  - Marginal cost: c (no fixed cost)
- First establish baseline predictions about outcomes + welfare
  - Perfect Competition (P = MC)
  - Monopoly (MR = MC)
- Then examine Cournot model
  - Duopoly (two firms)
  - More general oligopoly (N firms)

Example: comparing market structures

Baseline predictions:

- Baseline: Perfect competition ($p = MC$)
  - $p = c,\ Q = a - c$ (individual $q_i \approx 0$)
  - $\Pi = 0,\ CS = \frac{1}{2}(a-c)^2,\ W = \frac{1}{2}(a-c)^2$
- Baseline: Monopoly ($MR = MC$)
  - $p = \frac{a+c}{2},\ q = Q = \frac{a-c}{2}$
  - $\Pi = \frac{1}{4}(a-c)^2,\ CS = \frac{1}{8}(a-c)^2,\ W = \frac{3}{8}(a-c)^2$

Cournot Model of Duopoly

- Two firms compete in the same market
  - Simultaneously choose q_i
  - This determines total $Q\ldots$
  - $\ldots$which determines price
- Each would love to be monopolist, but can't control behavior of other
- Each firm's choice affects competitor
  - Given competitor's quantity, q_j, firm i would choose q_i to max profits.
  - But given q_i, firm j might choose different q_j' to maximize profits (so q_i would change

Cournot Model of Duopoly

Q: How do we make predictions about behavior?

A: Use notion of (Nash) equilibrium

- If firms keep adjusting their quantities in response to one another, where will they end up?
- At a point where each firm is maximizing profits given the behavior of the other
- q_i is the best response to q_j *and* q_j is the best response to q_i
- At this point, neither firm has any incentive to change its quantity
- System is in equilibrium

Nash Equilibrium: taking the behavior of others as given, each party is choosing an optimal response.

Finding Nash Equilibrium in the Cournot Model

- Suppose firm j chooses q_j. What should firm i do?
- Choose q_i that maximizes profits
- Write down i's profits, as a function of q_i, q_j:

$$\Pi_i(q_i, q_j) = pq_i - cq_i = (a - q_i - q_j - c)q_i$$

- First-order condition:

$$\frac{\partial \Pi_i}{\partial q_i} = a - 2q_i - q_j - c = 0$$

- Solve for firm i's *reaction function* (gives best response for each value of q_j:

$$q_i^*(q_j) = \frac{a - q_j - c}{2}$$

Finding Nash Equilibrium in the Cournot Model

- *reaction function*:

$$q_i^*(q_j) = \frac{a - q_j - c}{2}$$

- Because of symmetry, firm j's reaction function is:

$$q_j^*(q_i) = \frac{a - q_i - c}{2}$$

- How to find equilibrium?
- Both firms must be best responding to each other so

$$q_j = q_j^*(q_i) \text{ and } q_i = q_i^*(q_j)$$

- Also, by symmetry, $q_i^* = q_j^*$

$$q_i^* = q_j^* = \frac{a - q_i^* - c}{2}$$

- Solve:

$$q_i^* = \frac{a - c}{3} = q_j^*$$

Finding Nash Equilibrium in the Cournot Model

- Optimal quantities:

$$q_i^* = \frac{a-c}{3} = q_j^*$$

- So $Q = q_i + q_j = \frac{2}{3}(a-c)$
- and $p = a - Q = \frac{a+2c}{3}$
- Calculate welfare
  - $CS = \frac{1}{2}[a - \frac{a+2c}{3}][\frac{2}{3}(a-c)] = \frac{2}{9}(a-c)^2$
  - $\pi_i = (p-c)q_i = [\frac{a+2c}{3} - c]\frac{a-c}{3} = \frac{(a-c)^2}{9}$
  - $W = CS + \Pi = \frac{2}{9}(a-c)^2 + 2 * \frac{(a-c)^2}{9} = \frac{4}{9}(a-c)^2$

Behavior and welfare lie between PC and monopoly

Generalizing to N-firm Oligopoly

Now suppose that there are N Cournot competitors

- Write down i's profits, as a function of $q_1, \ldots, q_N$:

$$\Pi_i(q_1, \ldots, q_N) = (p - c)q_i = (a - (q_i - Q_{-1} - c)q_i,$$

  where Q_{-i} is the sum of all the $N - 1$ competitors quantities

- First-order condition:

$$\frac{\partial \Pi_i}{\partial q_i} = a - 2q_i - Q_{-i} - c = 0$$

- Firm i's *reaction function*:

$$q_i^*(Q_{-i}) = \frac{a - Q_{-i} - c}{2}$$

- Because of symmetry, every firm has same reaction function and behavior, so $q_1^* = q_2^* = \cdots = q_i^* = \cdots = q_N^*$
- This means $Q_{-i} = (N - 1)q_i^*$, so $q_i^* = \frac{a-(N-1)q_i^*-c}{2}$
- Solve: $q_i^* = \frac{a-c}{N+1}$ and $Q^* = \frac{N}{N+1}(a - c)$