Oligopoly
Chapter 27
What kind of Price Discrimination does Southwest’s Ding most resemble?

Clicker Vote:

A) Perfect PD
B) Quantity Discounts
C) Multi-market PD
What kind of Price Discrimination

does Southwest’s Ding most resemble?

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What kind of Price Discrimination

...does Southwest’s Ding most resemble?

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So watch out!
Other Kinds of Non-uniform Pricing

- Two-part tariffs: lump-sum fee + constant price per unit

- Tie-in sales: can buy one product only if you buy another one as well
  - Requirement tie-in
  - Bundling (or package tie-in)

- Can think of these as a form of quantity (2nd degree) discrimination, where the average price per unit varies with the number of units purchased
Two-part Tariffs

- Lump-sum fee + per unit price
- E.g. telephone service (connection fee + per minute rate); club cover charges; NFL personal seat license
- Because of fixed fee, average price per unit is higher the fewer units you buy
- Uniform pricing: raise $p$ above $MC \implies$ earn more per unit, but lower CS
- Two-part tariff (ideal): capture each customer’s max potential CS by charging different lump-sum fees, then set $p = MC$
- Like with first degree PD, there is no inefficiency
- But monopolist reaps all gains-from-trade, so equity suffers
Tie-in Sales

- Requirement tie-in:
  - E.g. Printer + ink/toner cartridges, razors + blades
  - Helps firm identify heavy users, i.e. those with high WTP

- Bundling:
  - E.g. Software such as Microsoft Windows + Internet Explorer, internet & cable service, preseason & regular season tickets, service + parts
  - Allows firms that can’t price discriminate to charge different people different prices
  - Profitability depends on tastes (negatively correlated demand for the two goods) and the ability to prevent resale
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 $\implies$ 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 $Q$...
  - ...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
  - \( CS = \frac{1}{2} \left[ a - \frac{a + 2c}{3} \right] \left[ \frac{2}{3}(a - c) \right] = \frac{2}{9}(a - c)^2 \)
  - \( \pi_i = (p - c)q_i = \left[ \frac{a + 2c}{3} - c \right] \frac{a - c}{3} = \frac{(a - c)^2}{9} \)
  - \( W = CS + \Pi = \frac{2}{9}(a - c)^2 + 2 \times \frac{(a - c)^2}{9} = \frac{4}{9}(a - c)^2 \)

Behavior and welfare lie between PC and monopoly
Cournot Equilibrium: Now you try it!

Suppose \( p = 5 - Q \) and \( MC = 2 \). What is the DWL of Cournot Duopoly?

**Clicker vote:**

A) 1/2  
B) 1/18  
C) 0  
D) 1
Cournot Equilibrium: Now you try it!

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Cournot Equilibrium: Now you try it!

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\( a = 5, c = 2 \) so \( a - c = 3 \). Welfare difference between PC and Cournot duopoly:  
\[
DWL = \left[ \frac{1}{2} - \frac{4}{9} \right] (a - c)^2 = \frac{9}{18} = \frac{1}{2}.
\]
Generalizing to \( N \)-firm Oligopoly

Now suppose that there are \( N \) Cournot competitors

- Write down \( i \)'s profits, as a function of \( q_1, \ldots, q_N \):
  \[
  \Pi_i(q_1, \ldots, q_N) = (p - c)q_i = (a - (q_i - Q_{-i} - c))q_i,
  \]
  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 \( Q^* = \frac{N}{N + 1}(a - c) \)
Bertrand Duopoly: price competition

- Firms compete on price
- No clear leader, follower so firms effectively choose $p$ simultaneously
- Take the other firm’s price as given
- Market demand determines equilibrium output
- Both choose same price: divide demand evenly
- One sets lower price: that firm captures entire market
Bertrand Duopoly: price competition

- Suppose two firms have same $MC$
- What price to charge?
Bertrand Duopoly: price competition

- Suppose two firms have same $MC$
- What price to charge?
- Apply Nash equilibrium
  - Each chooses optimal $p_i$ given $p_j$
  - No one has incentive to deviate
- If pricing above marginal cost, each has incentive to undercut competitor ($p_i > p_j > MC$ is not an equilibrium)
Bertrand Duopoly: price competition

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  - No one has incentive to deviate
- If pricing above marginal cost, each has incentive to undercut competitor ($p_i > p_j > MC$ is not an equilibrium)
- $p_i = p_j = MC$ is the only possible equilibrium
- Zero profits for both, but no incentive to deviate:
  - Higher price means no sales
  - Lower price means losses