ECN 453: Pricing and Price Discrimination 1

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Price Discrimination

- Price discrimination: **setting different prices for the same good**.

- Examples: airline tickets, software, pharmaceuticals

Figure: Photo: Flickr

- We will look at different ways that firms price discriminate and the implications for policy.

Plan

1. Why price discriminate?

2. Price discrimination: selection by indicators

Plan

1. **Why price discriminate?**

2. Price discrimination: selection by indicators

Why price discriminate?

- Previously, we studied a monopolist who could only set **one price**.

- In the following diagram, I argue that a monopolist could increase profit if it could set **different prices for different consumers**.

Why price discriminate?: Monopoly diagram
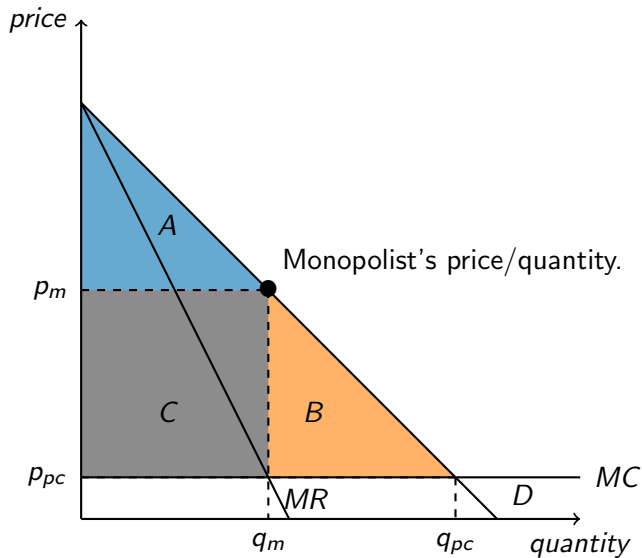
Why price discriminate?: Monopoly diagram

- On the previous slide there are three areas:

1. **Area A**: consumers who are willing to pay a price higher than p_m.
   - This was consumer surplus (when monopolist can only set one price)

   - Monopolist could increase profits if it set <u>higher prices</u> for these consumers.

2. **Area B**: consumers who are willing to pay a price lower than p_m, but higher than MC.
   - This was dead-weight-loss (when the monopolist can only set one price)

   - The monopolist could increase profits if it set <u>lower prices</u> for these consumers and sold to them.

3. **Area C**: this is the current profit of the monopolist.

Why price discriminate?: Monopoly diagram

- In order to fully extract all of area *A* and *B* in the previous diagram, the monopolist would have to know the <u>exact willingness to pay</u> of each consumer in the market.

- This is called **perfect price discrimination**.
  - Specifically, the monopolist charges each consumer a price equal to their exact willingness to pay.

  - It is also known as 'first-degree price discrimination'.

- Perfect price discrimination is a useful - but unrealistic - benchmark

- In practice, firms only have limited information about each consumer's willingness to pay.
  - We will now see some alternative forms of price discrimination when firms have more limited information about consumers.

Plan

1. Why price discriminate?

2. **Price discrimination: selection by indicators**

Price discrimination: selection by indicators

- **Selection by indicators** is when the seller divides buyers into groups, setting a different price for each group.

- **Example:** Car sales

Model	Italy	UK
Fiat Uno	21.7	8.7
Nissan Micra	36.1	12.5
Mercedes 190	15.6	12.3

Figure: Car margins across countries

Price discrimination: selection by indicators

- Selection by indicators requires the buyer to have information about which groups consumers belong to.

- Other examples:

    - Movie tickets (students vs non-students)

    - Other forms of geographical price discrimination (pharmaceuticals in developing vs non-developing countries)

    - Different prices due to differences in browsing history/cookies on the internet

- Selection by indicators is also known as 'third-degree price discrimination'.

Price discrimination: selection by indicators

- **Setup**:

- Two markets denoted 1 and 2.

- <u>Demand</u>:
    - market 1: $q_1 = D_1(p_1)$

    - market 2: $q_2 = D_2(p_2)$

- <u>Total cost</u>: $C(Q)$ where the total quantity Q is:

$$Q = q_1 + q_2 = D_1(p_1) + D_2(p_2)$$

- **Aim:** Find the optimal price (the profit maximizing price) in each market.

Price discrimination: selection by indicators

- **Solution**: Idea - **"optimal pricing rule in each market"**

- <u>Method 1:</u> The optimal price is where:

$$MR_1 = MC \text{ and } MR_2 = MC$$

- In the above equation, MR_1 is marginal revenue in market 1, MR_2 is marginal revenue in market 2

- <u>Method 2:</u> Optimal prices must satisfy the elasticity rule:

$$p_1(1 + \frac{1}{\epsilon_1}) = MC \text{ and } p_2(1 + \frac{1}{\epsilon_2}) = MC$$

- In the above equation, ϵ_1 and ϵ_2 are the price elasticities of demand.

Price discrimination: selection by indicators

- Implication of optimal pricing under discrimination by market segmentation:

  A seller should charge a higher price in those market segments with more inelastic demand.

- **Why?** Dividing the two optimal prices in terms of the elasticity rule:

$$\frac{p_1}{p_2} = \frac{(1 + \frac{1}{\epsilon_2})}{(1 + \frac{1}{\epsilon_1})}$$

- Since demand elasticities are negative, the elasticity in market 1 is more inelastic than market 2 if $\epsilon_1 > \epsilon_2$.

- If $\epsilon_1 > \epsilon_2$, then $1 + \frac{1}{\epsilon_2} > 1 + \frac{1}{\epsilon_1}$ and so $\frac{(1 + \frac{1}{\epsilon_2})}{(1 + \frac{1}{\epsilon_1})} > 1$

- Using the above equation implies that $p_1 > p_2$.

Price discrimination: selection by indicators

- Implication of optimal pricing under discrimination by market segmentation:

  A seller should charge a higher price in those market segments with more inelastic demand.

- Note: this statement can be a little confusing when you come to apply it because demand price elasticity is negative
  - Just remember that 'more inelastic' means lower absolute values so that e.g. a market with $\epsilon = -2$ is more inelastic than a market with $\epsilon = -4$

- We will now see particular example of the above statement.

Price discrimination: selection by indicators - example 1, p126

- **Setup:**

- Demand elasticities for market 1 and market 2: $\epsilon_1 = -4, \epsilon_2 = -2$.

- Marginal cost $= 6$

- **Question:** What are the optimal prices in market 1 and market 2?

- **Solution:**

Price discrimination: selection by indicators - example 1, p126

- **Setup:**

- Demand elasticities for market 1 and market 2: $\epsilon_1 = -4, \epsilon_2 = -2$.

- Marginal cost $= 6$

- **Question:** What are the optimal prices in market 1 and market 2?

- **Solution:**
    - Apply elasticity rule ($p_1(1 + \frac{1}{\epsilon_1}) = MC$ and $p_2(1 + \frac{1}{\epsilon_2}) = MC$):

$$p_1(1 - 1/4) = 6$$
$$p_2(1 - 1/2) = 6$$

    - Solving for p_1 and p_2 implies: $p_1 = \$8, p_2 = \$12$.

    - Note that $p_1 < p_2$ since market 1 is more elastic than market 2.

Price discrimination: selection by indicators - example 2, p127

- **Setup:**

- Market 1 demand: $q_1 = 12 - 2p_1$

- Market 2 demand: $q_2 = 4 - p_2$

- Marginal cost $= 1$

- **Questions:**

- 1. What is the optimal uniform price?

- 2. What are the optimal prices in each market when the monopolist can charge different prices in each market?

- 3. How much does profit increase between 1. a uniform price vs 2. different prices?

Price discrimination: selection by indicators - example 2

- **Solution:**

- 1. What is the optimal uniform price?

    - Idea: combine the two markets to a single market with the same price $p = p_1 = p_2$, and apply the usual monopoly solution.

    - Total demand (add curves *horizontally*):
        - $Q = q_1 + q_2 = 12 - 2p_1 + 4 - p_2 = 16 - 3p$ if $p \leq 4$

        - $Q = 12 - 2p$ if $p > 4$ and $p \leq 6$

    - Marginal revenue (rearranging demand and using the 'twice the slope' trick):
        - $MR = \frac{16}{3} - \frac{2}{3}Q$ if $Q < 4$

        - $MR = 6 - Q$ if $Q > 4$

Price discrimination: selection by indicators - example 2

- **Solution:**

- 1. What is the optimal uniform price?

    - We will assume for now that demand is positive in both markets, and check that the final price $p \leq 4$.

    - Rearrange for price: $p = \frac{16}{3} - \frac{1}{3}Q$

    - Get MR using 'twice the slope trick': $MR = p = \frac{16}{3} - \frac{2}{3}Q$

    - Use MR=MC and solve for optimal Q: $\frac{16}{3} - \frac{2}{3}Q = 1$. So, $Q = 6.5$

    - Solve for optimal price using Q: $p = \frac{16}{3} - \frac{1}{3}\frac{13}{2} = 3.1667$

Price discrimination: selection by indicators - example 2

- **Solution:**

- 2. What are the optimal prices in each market when the monopolist can charge different prices in each market?

- Since marginal cost is constant, we can treat market 1 and market 2 separately.
  - The main idea is that constant marginal cost implies - for example - that the marginal cost in market 1 is not dependent on the quantity produced in market 2.

  - <u>Market 1</u>:

  - Demand: $q_1 = 12 - 2p_1$

  - Rearrange for price: $p_1 = 6 - \frac{1}{2}q_1$

  - Get MR_1 using 'twice the slope trick': $MR_1 = 6 - q_1$

  - Use $MR_1 = MC$ and solve for optimal q_1: $6 - q_1 = 1$, so $q_1 = 5$

  - Plug in $q_1 = 5$ into demand to get price: $p_1 = 6 - \frac{1}{2} \times 5 = 3.5$

Price discrimination: selection by indicators - example 2

- **Solution:**

- 2. What are the optimal prices in each market when the monopolist can charge different prices in each market?

    - <u>Market 2</u>:

    - Demand: $q_2 = 4 - p_2$

    - Rearrange for price: $p_2 = 4 - q_2$

    - Get MR_2 using 'twice the slope trick': $MR_2 = 4 - 2q_2$

    - Use $MR_2 = MC$ and solve for optimal q_2: $4 - 2q_2 = 1$, so $q_2 = 1.5$

    - Plug in $q_2 = 1.5$ into demand to get price: $p_2 = 4 - 1.5 = 2.5$

Price discrimination: selection by indicators - example 2

- **Solution:**

- 3. How much does profit increase between 1. a uniform price vs 2. different prices?

    - Profit with uniform prices ($Q = 6.5, p = 3.1667$):

$$TR - TC = 6.5 \times 3.1667 - 6.5 \times 1 = 14.08$$

    - Profit with different prices ($q_1 = 5, p_1 = 3.5, q_2 = 1.5, p_2 = 2.5$)

$$\text{Market 1:} \quad TR - TC = 5 \times 3.5 - 5 \times 1 = 12.5$$
$$\text{Market 2:} \quad TR - TC = 1.5 \times 2.5 - 1.5 \times 1 = 2.25$$

    - So, total profit with different prices $= 12.5 + 2.25 = 14.75$.

    - Profit increases from 14.08 to 14.75 (i.e. by 0.67) moving from uniform to different prices.

Summary for how to solve these problems (with constant marginal cost)

- Solving for the <u>uniform price</u>:
  - 1. Sum the demand curves horizontally to get the total (combined) demand. The demand curve may have several 'sections' where different markets are operating.

  - 2. Get the marginal revenue for each 'section' of the demand curve.

  - 3. Use MR=MC to solve for the optimal quantity

  - 4. Use the total demand curve to solve for the optimal price.

- Solving for <u>different prices (with constant marginal cost)</u>:
  - Constant marginal cost implies - for example - that the marginal cost in market 1 is not dependent on the quantity produced in market 2.

  - Therefore, we can just solve for the monopoly price and quantity in each market separately.

The limits of selection by indicators

- There are often limits to how finely a monopolist can segment a market by different groups.

- For example, consider selling cars for different prices in different locations.
    - What happens if you set different prices at the country level? At the city level? At the suburb level? At the car dealer level?

    - As the monopolist more finely segments the market, the price discrimination scheme might be undermined by *consumer arbitrage*.

    - E.g. consider price discrimination at the car dealer level - here, consumers might change where they buy and instead switch to a lower price dealer, making it difficult to segment consumers this finely.

Summary of key points*

- Understand why a monopoly might find it profitable to price discriminate rather than set a uniform price for all consumers.

- Know that 'selection by indicators' is used when a monopolist can observe some characteristics about the consumers.

- Know how to solve for the optimal prices (and the corresponding total profits, consumer surplus, etc) under selection by indicators using:
    - MR=MC

    - Elasticity rule

*To clarify, all the material in the slides, problem sets, etc is assessable unless stated otherwise, but I hope this summary might be a useful place to start when studying the material.

Price discrimination: selection by indicators - more on previous question

- **Setup:**

- Market 1 demand: $q_1 = 12 - 2p_1$

- Market 2 demand: $q_2 = 4 - p_2$

- Marginal cost $= 1$

- Before, we found that the uniform price/quantity is $Q = 6.5$, $p = 3.16667$.

- Before, we found that under price discrimination, $q_1 = 5$, $p_1 = 3.5$ and $q_2 = 1.5$, $p_2 = 2.5$.

- **Questions:**

- 1. How does consumer surplus change from uniform pricing to price discrimination?

- 2. How does the total surplus change from uniform pricing to price discrimination?

- 3. Is there an *equity-efficiency tradeoff*?

Price discrimination: selection by indicators - more on previous question

- **Solution:**

- 1. How does consumer surplus change from uniform pricing to price discrimination?

    - Uniform pricing (Q=6.5, p=3.1667):

    - Market 1: $q_1 = 12 - 2 * 3.1667 = 5.67$
        - So, $CS_1 = 0.5 \times 5.67 \times (6 - 3.1667) = 8.03$

    - Market 2: $q_2 = 4 - 3.1667 = 0.8333$
        - So, $CS_2 = 0.5 \times 0.8333 \times (4 - 3.1667) = 0.347$

    - Total CS $= CS_1 + CS_2 = 8.03 + 0.347 = 8.38$.

Price discrimination: selection by indicators - more on previous question

- **Solution:**

- 1. How does consumer surplus change from uniform pricing to price discrimination?

    - Discriminatory pricing ($q_1 = 5$, $p_1 = 3.5$ and $q_2 = 1.5$, $p_2 = 2.5$):

    - Market 1:
        - So, $CS_1 = 0.5 \times 5 \times (6 - 3.5) = 6.25$

    - Market 2:
        - So, $CS_2 = 0.5 \times 1.5 \times (4 - 2.5) = 1.125$

    - Total CS $= CS_1 + CS_2 = 6.25 + 1.125 = 7.375$.

    - So, consumer surplus <u>falls</u> moving from uniform to discriminatory pricing.

- **Solution:**

- 2. How does the total surplus change from uniform pricing to price discrimination?

    - Uniform pricing
        - We computed PS and CS in previous questions.

        - $TS = CS + PS = 8.38 + 14.08 = 22.46$

    - Discriminatory pricing
        - We computed PS and CS in previous questions.

        - $TS = CS + PS = 7.375 + 14.75 = 22.125$

Price discrimination: selection by indicators - more on previous question

- **Solution:**

- 3. Is there an equity-efficiency tradeoff?

    - More efficient: does total surplus increase?

    - More equitable: does consumer surplus increase? (note: under price discrimination, profits will never decrease)

    - Here, both TS and CS decrease. Therefore, there is no tradeoff, since price discrimination is less efficient (total surplus decreases) but also consumers are worse off.

Price discrimination: book example

- **Setup:**

- Selling a book in Europe and US markets.

- Marginal cost $= 4$

- US demand: $p_u = 36 - 4q_u$

- Europe demand: $p_e = 24 - 4q_e$

- **Questions:**

- 1. What is the optimal uniform price?

- 2. What is the optimal prices under selection by indicators?