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/Victor

- 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
3. Price discrimination: self-selection
4. Non-linear pricing
5. Should price discrimination be legal?

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1. **Why price discriminate?**
2. Price discrimination: selection by indicators
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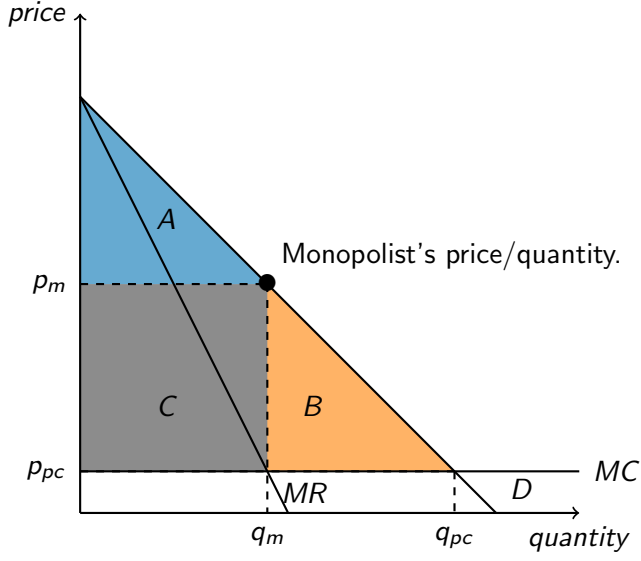
Why price discriminate?

- 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 higher prices 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 lower prices 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 exact willingness to pay of each consumer in the market.
- This is called **perfect 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.

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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

- **Setup**:
- Two markets denoted 1 and 2.
- Demand:
  - market 1: $q_1 = D_1(p_1)$
  - market 2: $q_2 = D_2(p_2)$
- Total cost: $C(Q)$ where the total quantity Q is:

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

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

Price discrimination: selection by indicators

- **Solution**: Idea - **"two monopolists, one in each market"**

- Method 1: 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

- Method 2: 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 lower price in those market segments with more elastic 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 elastic' means higher absolute values so that e.g. a market with $\epsilon = -4$ is more elastic than a market with $\epsilon = -2$

- 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:**
  - 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: $Q = q_1 + q_2 = 12 - 2p_1 + 4 - p_2 = 16 - 3p$
    - Note: The above is true so long as demand in positive in both markets (i.e. here $p \leq 4$). If price is > 4 then the demand in market 2 will be 0 and total demand $Q = 12 - 2p_1$. 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?

  - Market 1:

  - 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?

  - Market 2:

  - 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 ($q_1 = 5, p_1 = 3.5, q_2 = 1.5, p_2 = 2.5$)

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

  - 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.

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3. **Price discrimination: self-selection**
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Price discrimination: self-selection

- In the previous section we studied 'selection by indicators'.
  - To use selection by indicators, the seller needed information about the characteristics of consumers so they could offer different buyers different prices.
  - Often, sellers do not have much information about consumers.
  - e.g. if you're selling airline tickets online, not much information about who the high-value business travellers are.
- We will now discuss three types of **price discrimination by self-selection**.
  - These are used when the seller does not have much information about the characteristics of consumers.
  - Instead, the seller offers different 'deals' which cause buyers to self-select into which group they belong to.

Self-selection: versioning

- **Self-selection by versioning**: offering different 'versions' of a product, each version targeted at a different group of consumers.

- Typical: a 'high-quality' version targeted at high-value consumers, and a 'lower-quality' version targeted at low-value consumers.

- **Examples:**

- Discount airfares with date/destination restrictions

- Iphone pro vs Iphone pro max

- Different models of Amazon Kindle

Self-selection: versioning

- An extreme form of versioning: **damaged goods** - reduce the quality of existing products
- **Example:**

Figure: 2017 Tesla Model S full range: $76 thousand

Figure: Exactly the same car with a few extra lines of code to restrict battery: $70 thousand

- Why would it be profitable for a seller to intentionally make some of its products worse? Price discrimination.

Self-selection: versioning, example (p131)

- **Example:**
- Two versions of product: full and stripped-down. MC = 300 for both versions.
- Two types of consumers: 1 million people of type 1; 0.2 million people of type 2
- Willingness-to-pay of consumers:

	full	stripped-down
type 1 (high-end)	1500	800
type 2 (low-end)	600	500

- **Questions:**
- 1. Find the profit from selling only the full version for 1500.
- 2. Find the profit from charging 1500 for full version; 500 for the stripped-down version.
- 3. Find the profit from charging 1199 for full version; 500 for the stripped-down version.

Self-selection: versioning, example

- **Solution:**

- Idea: each type of consumer will self-select into the version with the highest consumer surplus (consumer surplus=willingness-to-pay - price). E.g. the consumers buy the full version if:

$$\text{consumer 1: } 1500 - p_{full} > 800 - p_{stripped-down}$$
$$\text{consumer 2: } 600 - p_{full} > 500 - p_{stripped-down}$$

- 1. Find the profit from selling only the full version for 1500.
  - Consumer type 1 buys the full version (receiving CS=0)
  - Consumer type 2 does not buy anything (since their CS would be 800-1500=-700 from buying the full version).
  - Then, $Profit = (1500 - 300) \times 1 \text{ million} = \$1.2 \text{ billion}$

Self-selection: versioning, example

- **Solution:**

- 2. Find the profit from charging 1500 for full version; 500 for the stripped-down version.

  - (Why are we considering this pricing? This is the pricing the seller would choose if it could practice perfect price discrimination. That is, pricing the full version at the type-1 willingness-to-pay and the stripped-down version at the type-2 willingness-to-pay.)

  - Consumer type 1: buys stripped down version (CS=0 from full version but CS=800-500=300 from the stripped-down version).

  - Consumer type 2: buys stripped down version (CS=600-1500=-900 from full version but CS=500-500=0 from the stripped-down version).

  - Then, $Profit = (500 - 300) \times 1 \text{ million} + (500 - 300) \times 0.2 \text{ million} = \$240 \text{ million}$

  - Profit is actually less than in part 1 when we only offered the full version. Why? Consumer type 1 now chooses the stripped-down version.

Self-selection: versioning, example

- **Solution:**
- 3. Find the profit from charging 1199 for full version; 500 for the stripped-down version.
  - Consumer type 1: buys full version (CS=1500-1199=301 from full version but CS=800-500=300 from the stripped-down version).
  - Consumer type 2: buys stripped down version (CS=600-1199=-599 from full version but CS=500-500=0 from the stripped-down version).
  - Then, $Profit = (1200 - 300) \times 1 \text{ million} + (500 - 300) \times 0.2 \text{ million} = \$1.3 \text{ billion}$
  - So, compared to Part 1, the seller is better off by \$100 million.

Self-selection: versioning

- Why are profits in Part 3 of the previous example higher than in Part 2?
- The reason is that the prices in Part 3 ensured that the **high-end consumer had no incentive to go for the deal that was intended for the low-end consumer.**
  - Put another way, the prices in Part 3 of the example ensured that high-end consumers self-selected into buying the high-quality version, and low-end consumers self-selected into buying the low-quality version.
- We will now study another form of price discrimination by self-selection: bundling.

Self-selection: bundling

- **Bundling**: combining products and selling them together.

- **Examples**:
- Software is bundled as a 'suite' e.g. microsoft office
- Cable tv channels
- Phone and internet plans
- Movie distribution

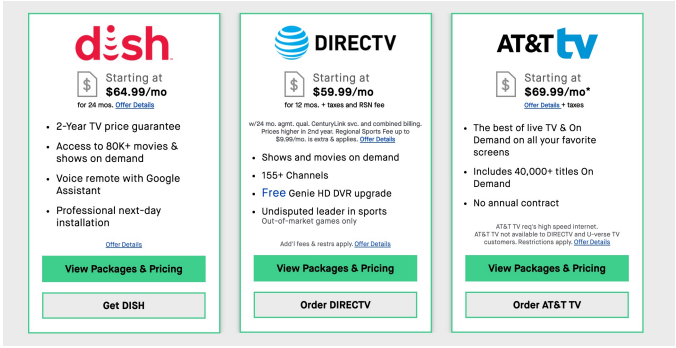

Figure: Centurylink internet bundles

Self-selection: bundling, example p133

- **Example**: Three user types: writer, number cruncher, generalist. Two products: word processor, spreadsheet. Assume $TC = 0$.

User type	**Number of users**	**Willingness to pay**	
		Word processor	Spreadsheet
Writer	40	50	0
Number cruncher	40	0	50
Generalist	20	30	30

- **Questions**:

- 1. What is the profit if each product is sold separately?

- 2. What is the profit if each product is sold separately for \$50 and a bundle of the two products is offered for \$60?

Self-selection: bundling, example p133

- Main idea: each consumer will choose (i.e. self-select into) the product/bundle with the highest consumer surplus (= willingness-to-pay - price). We need to first find the optimal price and then find the profit.

- 1. What is the profit if each product is sold separately?

- **Solution:**

- The optimal price is to charge \$50 for the word processor and \$50 for the spreadsheet.
  - Here, writers choose the word processor (and generate profit $= 50 \times 40 =$ \$2000), and number crunchers choose the spreadsheet (generating \$2000), for total profit of \$4000.

- An alternative price is to charge \$30 for both products. But, this is not optimal.
  - Both writers and generalists will choose the word processor (generating $40 \times 30 + 20 \times 30 =$ \$1800 from word processors). Similarly, \$1800 profit is made from selling the spreadsheet for a total profit of \$3600.

- (If it's not obvious, convince yourself that intermediate prices e.g. \$40 for both products, are not optimal.)

Self-selection: bundling, example p133

- 2. What is the profit if each product is sold separately for \$50 and a bundle of the two products is offered for \$60?

- **Solution:**

- Writers: choose the word processor (they could choose the bundle but they would be paying \$10 more for something they do not value). Profit from writers $= 40 \times 50 = 2000$.

- Number cruncher: choose the spreadsheet (they could choose the bundle but they would be paying \$10 more for something they do not value). Profit from number crunchers $= 40 \times 50 = 2000$.

- Generalists: choose the bundle (value the bundle at \$60, but would not want to buy a word processor or spreadsheet individually for \$50 since they only value each of these at \$30). Profit from generalists = \$1800.

- So, make \$5800 profit in total, and \$1800 more profit, from selling the bundle.

Self-selection: bundling, example p133

- Why did bundling increase profits in the previous example?
- By offering a bundle of the two products, the seller was able to:
  - get the generalist group to self-select into buying the bundle...
  - ...while still getting the writers and number crunchers to purchase products separately.
- This self-selection revealed to the seller the type of user.
  - The seller could then price-discriminate and charge a price equal to the willingness-to-pay in each group.

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Non-linear pricing

- Consumers often decide not just *whether* to buy a produce but also *how much*.
- **Examples**
  - How many scoops of ice-cream?
  - How much electricity/water/gas to use?
- **Non-linear pricing**: when the price changes with the total quantity purchased.
  - e.g. first ice-cream scoop costs \$5, second costs \$2, third \$1,...

Figure: Getty Images

Non-linear pricing

- We will look at a particular form of non-linear pricing: **two-part tariffs**
  - We will study the case with homogeneous consumers (i.e. identical consumers who all have the same demand curve). Technically, this is not an example of price discrimination but rather more general pricing strategies - it is in this section to be consistent with the textbook.

- A two-part tariff is in the form:

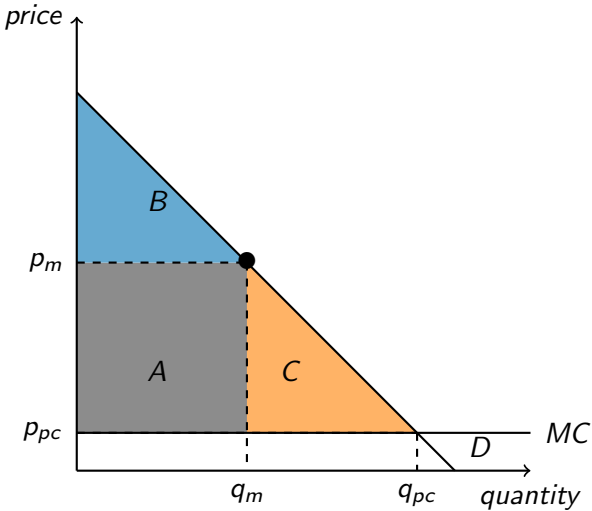
$$\text{two-part tariff} = f + pq$$

  - f: fixed part (e.g. golf club membership)
  - p: variable part (e.g. greens fee you pay every time you play golf)
  - q: quantity

- The **price per unit** (i.e. average price) is $p + f/q$ and decreases as quantity q increases.

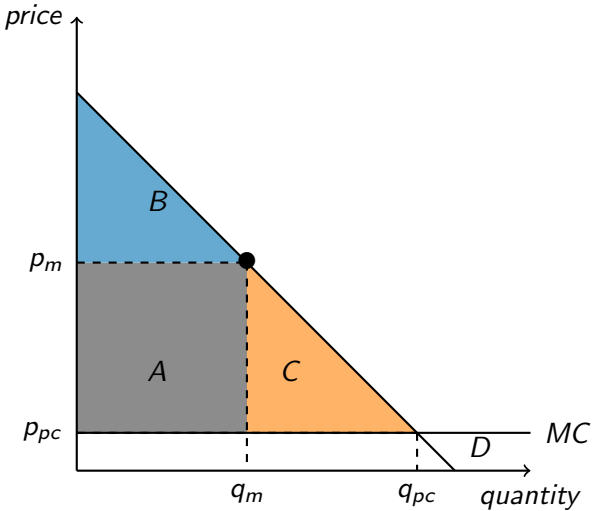
- We will see how a two-part tariff can be more profitable for a seller than a single price.

Non-linear pricing: how should the seller choose f and p?



- First, find optimal f given a particular price p (e.g. $p = p_m$, the monopoly price)
  - Recall that area B is the consumer surplus for a particular price p (denote this $CS(p)$).
  - It is optimal to set $f = CS(p)$.
  - Why? If $f > CS(p)$ then noone will buy.
  - If $f < CS(p)$ then the seller is leaving money on the table.
- Recall that area A is the seller's (variable) profit.
- So, the seller's total profits = A + B.

Non-linear pricing: how should the seller choose f and p?



- We still need to optimally choose the variable part p.
- In the previous slide we saw that optimally choosing the fixed part f results in the total profit = A + B.
- So, let's choose p to make the area A + B as big as possible.
- This happens at $p = p_{pc}$ i.e. the perfect competition price.

Non-linear pricing: how should the seller choose f and p?

- The **optimal two-part tariff** (with identical consumers) is:
- Set $p = p_{pc}$ (the perfect competition price)
- Set $f = CS(p_{pc}) = \text{A} + \text{B} + \text{C}$ (i.e. total surplus under perfect competition)
- Note: areas A, B, C displayed on the previous slide

Non-linear pricing: efficiency and equity

- Who were the winners and losers from moving from uniform pricing (i.e. the monopoly price) to a two-part tariff?
  - **Winner:** the sellers; profits increased from A to $A + B + C$.
  - **Loser:** consumers; consumer surplus decreased from B to 0.
- Overall, the two-part tariff is more **efficient**.
  - Total surplus increases from $A + B$ to $A + B + C$. In fact, it completely eliminated all of the (inefficient) dead-weight-loss of the monopolist (area B).
- However, this came at the cost of **equity**: consumer surplus was reduced to 0.

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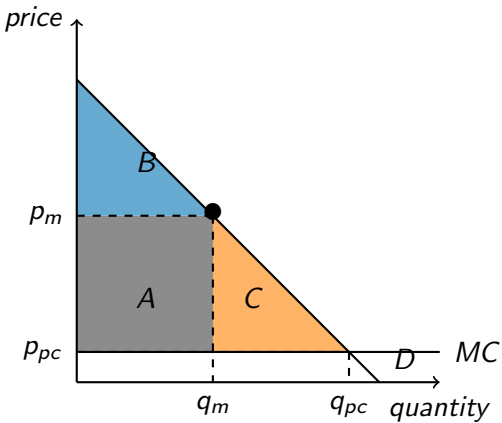
Should price discrimination be legal?



- The non-linear pricing figure from the previous section also depicts the welfare effects of moving from uniform pricing to perfect price discrimination.
- Allowing price discrimination typically:
  - Increases total surplus ($A + B \rightarrow A + B + C$)
  - Reduces consumer surplus ($B \rightarrow 0$)
    - Note: it is possible to construct examples where consumers to be better off under price discrimination, but in most of the cases we will see they are worse off.
  - Results in more consumers being served ($q_m \rightarrow q_{pc}$)

Should price discrimination be legal?

- Whether to allow price discrimination often comes down to an **equity-efficiency tradeoff**.
    - Policymakers may still want to prevent pricing strategies that are efficient for equity reasons.
- While economics makes precise predictions about overall efficiency and the winners/losers from a policy, it usually has less to say about how society should best trade-off these competing objectives.