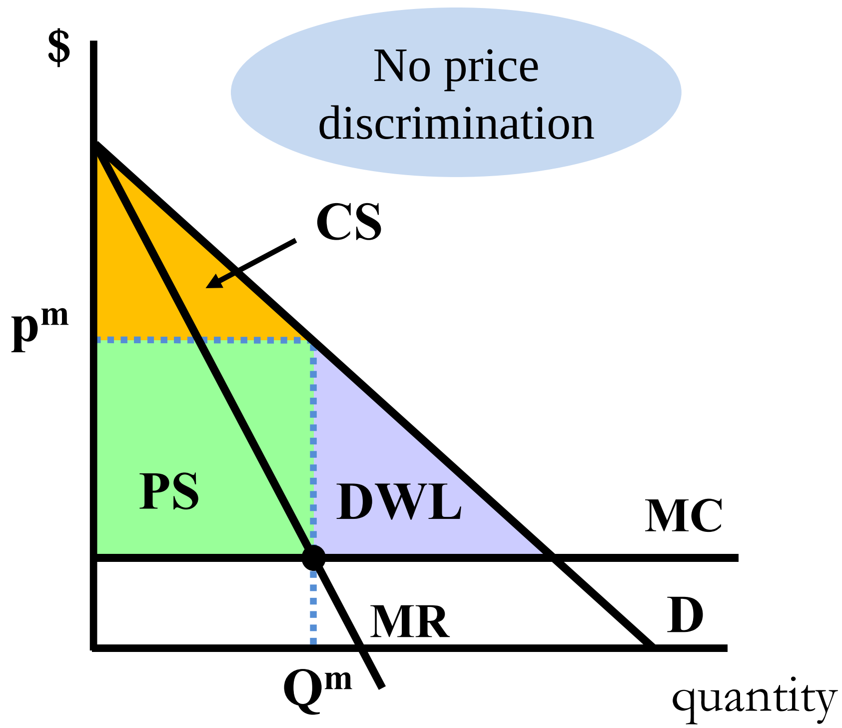
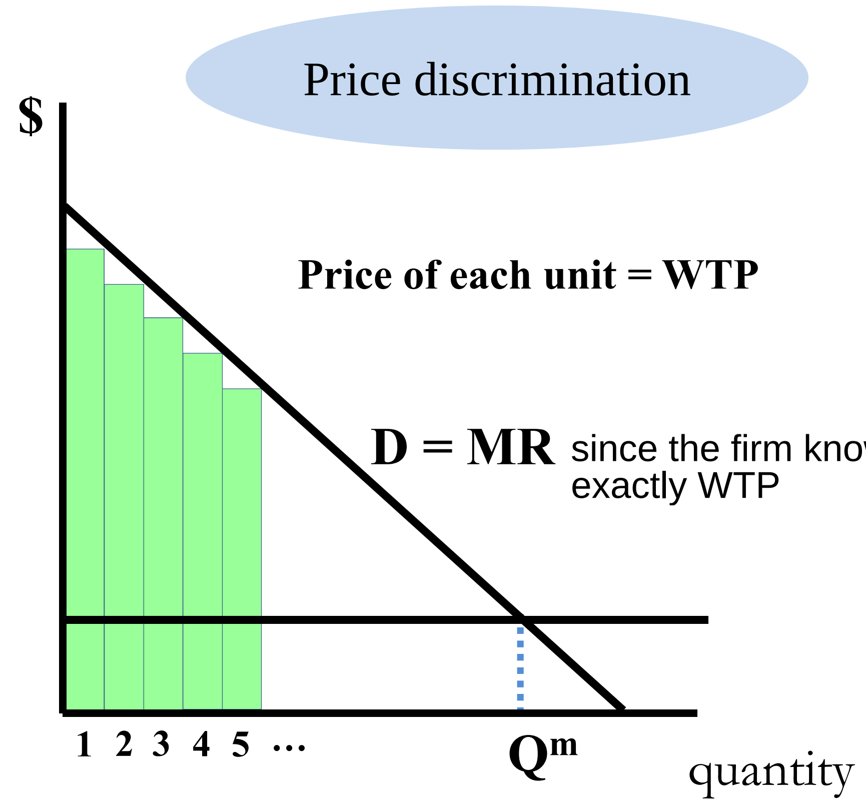
# First-degree Price Discrimination

- Suppose a monopolist can charge the maximum price that each consumer is willing to pay (personalized pricing) ➔ extracts **all consumer surplus**
- **Profit = total surplus under PC ➔** first-degree price discrimination is efficient




since the firm know exactly WTP

MR changes to the same extent as the WTP

DWL=0, in terms of efficiency it is a good outcome

will stop selling when MR=MC
consumer surplus= 0 also so not that good for consumers

# First-degree Price Discrimination

- There are other pricing strategies that lead to the same results
  - **Two-part pricing scheme (two-part tariff)**
  - **Block pricing** don't pay per unit but pay by block
- We'll start with two-part pricing
- **Two-part pricing scheme**:
  - a fee that entitles the consumer to buy the good
  - a price for each unit the consumer actually buys
  - Often referred to as "Disneyland pricing"

# Two-part pricing

- Suppose a club serves **two identifiable types of consumers**: teenagers (t) and young professionals (y)
- $\mathbf{Q_t}$ and $\mathbf{Q_y}$ are the number of drinks consumed by each type of consumer
- Young professionals have demand: $\mathbf{Q_y = V_y - P_y}$
- Teenagers have demand: $\mathbf{Q_t = V_t - P_t}$

different type of consumer have different demand curve

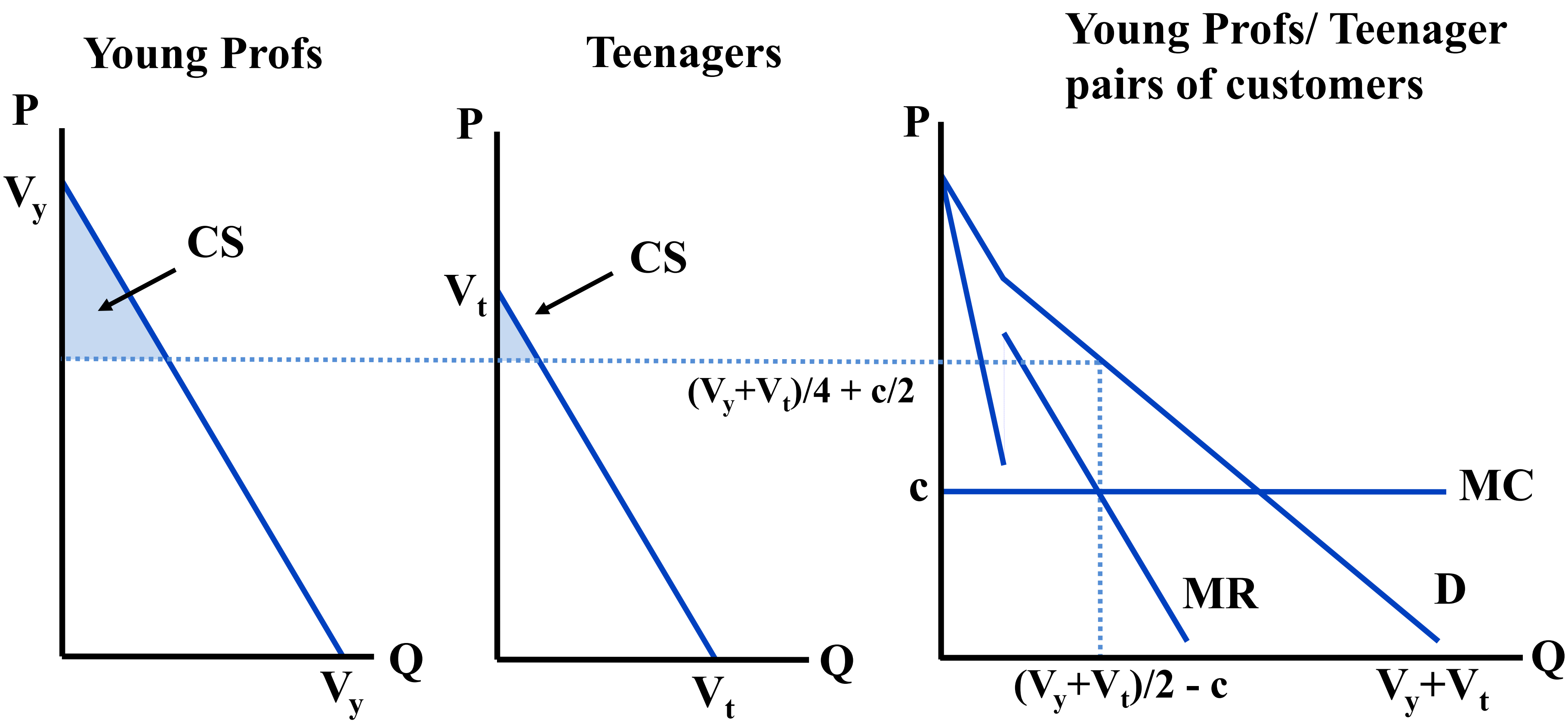
- There are an equal number of each type
- Assume that $\mathbf{V_y > V_t}$ ➔ young professionals are willing to pay more for a given number of drinks
- The cost of providing drinks is $\mathbf{C(Q) = cQ}$

# Two-part pricing

- Suppose that the club owner applies traditional linear pricing: free entry and a set price for drinks
- The aggregate demand is: $\mathbf{Q_u = Q_y + Q_t = V_y + V_t - 2P_u}$
- The inverse demand curve is: $\mathbf{P_u = (V_y + V_t)/2 - Q_u / 2}$
- Marginal revenue: $\mathbf{MR = (V_y + V_t)/2 - Q_u}$
- $\mathbf{MR = MC \Rightarrow Q_u = (V_y + V_t)/2 - c}$
- Substitute into aggregate demand to find price: $\mathbf{P_u = (V_y + V_t)/4 + c/2}$
- Each professional buys: $\mathbf{Q_y = (3V_y - V_t)/4 - c/2}$
- Each teenager buys: $\mathbf{Q_t = (3V_t - V_y)/4 - c/2}$
- Profit from each pair of customers is: $\boldsymbol{\pi_u = (V_y + V_t - 2c)^2/8}$

sum of one YF and T

# Two-part pricing




No price discrimination leaves each type of consumer with CS that the monopolist would like to convert into profit

# Two-part pricing

- Suppose there are **N** customers of each type. Total profits are then:

$$\Pi_u = N\pi_u = N(p_u - c)Q_u = \frac{N}{8}\left(V_y + V_t - 2c\right)^2$$

- Let $\mathbf{V_y = \$16}$, $\mathbf{V_t = \$12}$, $\mathbf{c = \$4}$, and $\mathbf{N = 100}$ then

$$P_U = \frac{\left(V_y + V_t\right)}{4} + \frac{c}{2} = 9 \qquad Q_U = \frac{\left(V_y + V_t\right)}{2} - c = 10$$

buying more units at 10 dollars

$$Q_y = \frac{\left(3V_y - V_t\right)}{4} - \frac{c}{2} = 7 \qquad Q_t = \frac{\left(3V_t - V_y\right)}{4} - \frac{c}{2} = 3$$

$$\pi_U = \frac{1}{8}\left(V_y + V_t - 2c\right)^2 = 50 \qquad \Pi_U = N\pi_U = 5000$$

# Two-part pricing

- **Consumer surplus** under the uniform price is

$$CS_y = \frac{1}{2}(V_y - P_u)Q_y = \frac{1}{2}Q_y^2 = \frac{1}{2}\left(\frac{3V_y - V_t}{4} - \frac{c}{2}\right)^2 = \$24.5$$ in benefits

$$CS_t = \frac{1}{2}(V_t - P_u)Q_t = \frac{1}{2}Q_t^2 = \frac{1}{2}\left(\frac{3V_t - V_y}{4} - \frac{c}{2}\right)^2 = \$4.5$$ teenagers not as much

- This consumer surplus represents the **surplus that the firm fails to extract**
- The firm can do better by using a two-part tariff

# Two-part pricing

- Charge the young professionals an entry free $\mathbf{E_y}$ equal to $\mathbf{CS_y}$ and charge teenagers an entry fee $\mathbf{E_t}$ equal to $\mathbf{CS_t}$ while continuing to charge a uniform price $\mathbf{P_u}$ per drink

- Profits increase by the amount of the entry fee per person while consumer surplus decreases to 0

- Profit per type:

capture the entire CS

$$\pi_y = E_y + (P_u - c)Q_y = 24.5 + (9-4)7 = \$59.5$$

$$\pi_t = E_t + (P_u - c)Q_t = 4.5 + (9-4)3 = \$19.5$$

- Total profit:

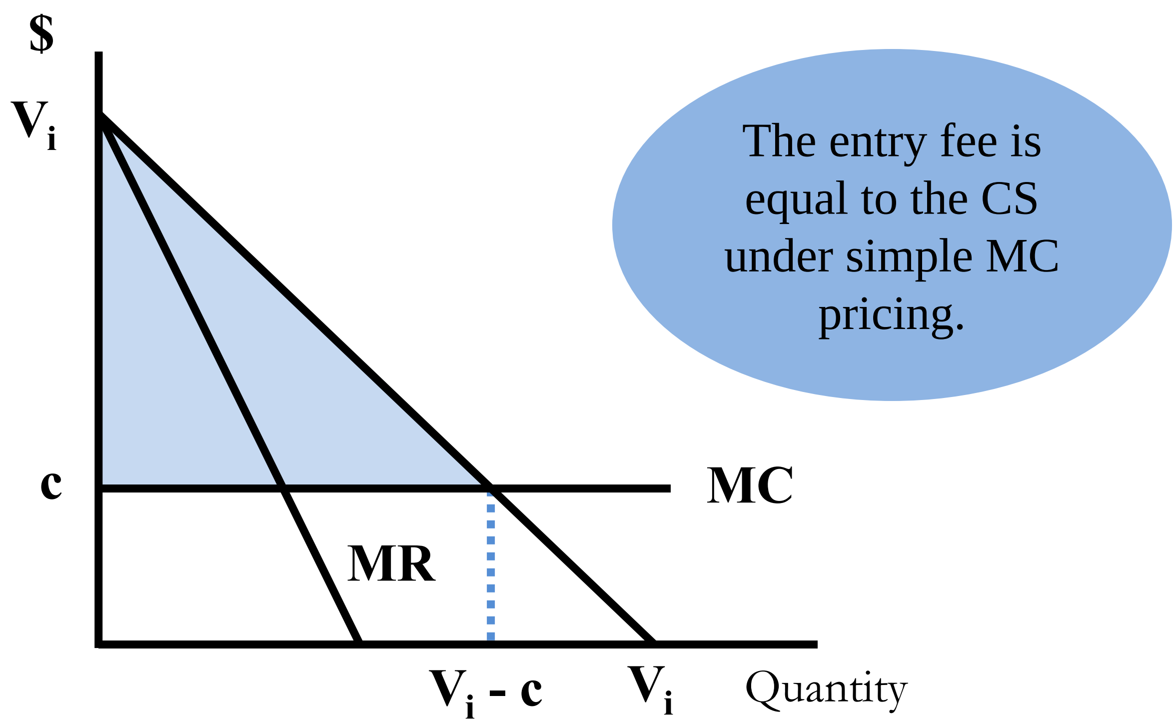
$$\Pi = N(\pi_y + \pi_t) = 100(59.5 + 19.5) = \$7{,}900$$

profit increases by the fixed fee

increases

# Two-part pricing

- The firm can still do better by reducing the price and extracting the extra surplus created by increasing the entry fee
- The profit-maximizing two-part pricing scheme is
  - Set price equal to marginal cost
  - Set the entry fee equal to each person’s consumer surplus



# Two-part pricing

- Thus, **P = 4** and the entry fees are **equal to consumer surplus**:

$$\pi_y = E_y = CS_y = \frac{1}{2}\left(V_y - c\right)Q_y = \frac{1}{2}\left(V_y - c\right)^2 = \frac{1}{2}\left(16-4\right)^2 = \$72$$

$$\pi_t = E_t = CS_t = \frac{1}{2}\left(V_t - c\right)Q_t = \frac{1}{2}\left(V_t - c\right)^2 = \frac{1}{2}\left(12-4\right)^2 = \$32$$

- Total profit is:

$$\Pi = N\left(\pi_y + \pi_t\right) = 100\left(72+32\right) = \$10{,}400$$

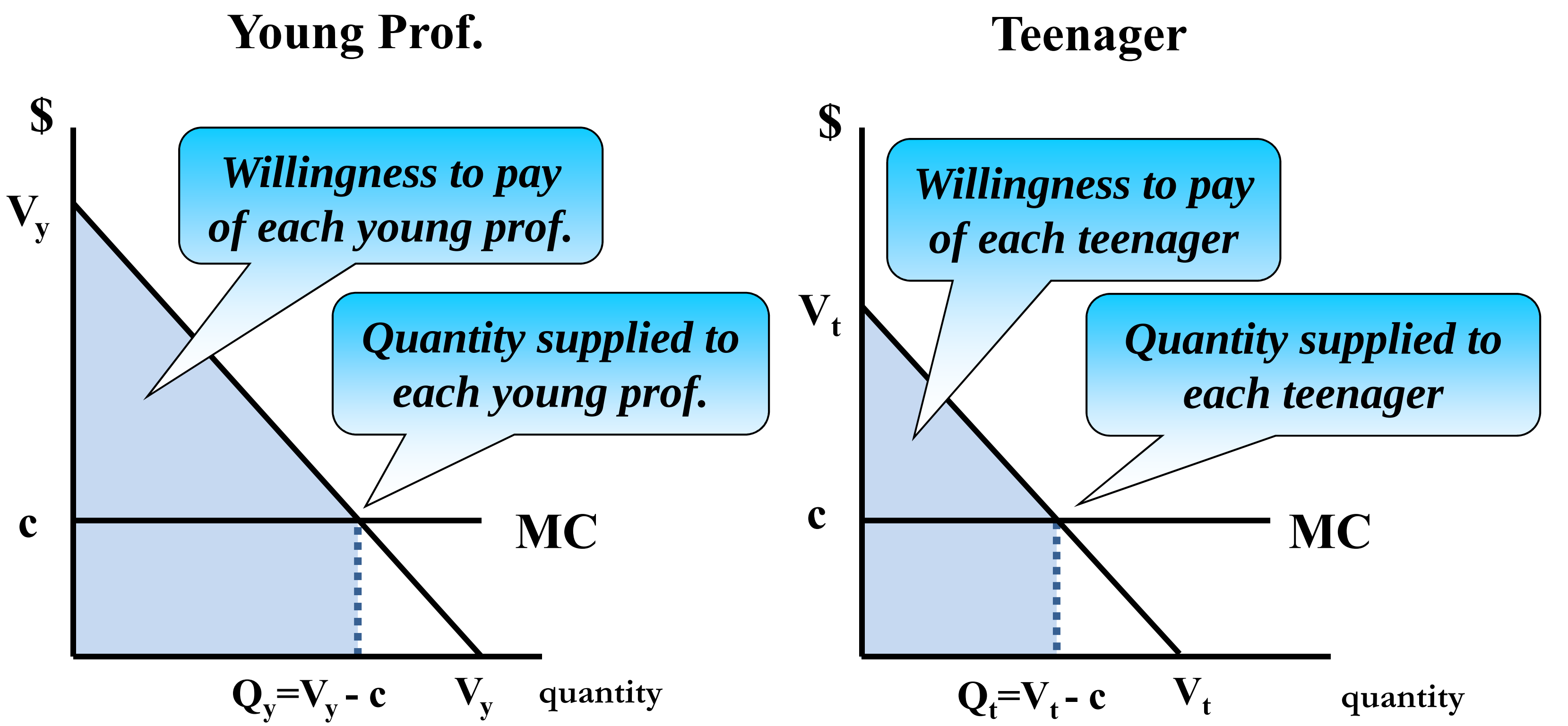
- The ability to price discriminate induces the monopolist to sell the efficient outcome
- Consumers receive zero surplus while the monopolist earns the total surplus

# Block pricing

- There is another pricing method by which the owner can achieve the same level of profit**:**
  - Set the quantity offered to each consumer type equal to the amount that type would buy at a price equal to the marginal cost (12 drinks and 8 drinks in our example)
  - Set the total payment for each type to the total willingness to pay for the relevant quantity
- How to implement the pricing scheme?
  - Give customers the appropriate number of tokens (by type) that can be exchanged for drinks at no additional charge

# Block pricing

more preferred for second degree price discrimination




$$WTP_y = (V_y - c)^2 / 2 + (V_y - c)c = (V_y^2 - c^2)/2 = (16^2 - 4^2)/2 = \$120$$

$$WTP_t = (V_t - c)^2 / 2 + (V_t - c)c = (V_t^2 - c^2)/2 = (12^2 - 4^2)/2 = \$64$$

# Block pricing

- Profit from each type of consumer is equal to the WTP minus the cost of the drinks

$$\pi_y = WTP_y - (V_y - c)c = 120 - (16 - 4)4 = \$72$$

$$\pi_t = WTP_t - (V_t - c)c = 64 - (12 - 4)4 = \$32$$

- Profits are exactly the same as those obtained under the two-part pricing scheme

# Second-degree Price Discrimination

- If the firm knows that buyers differ but cannot identify each buyer's type, then price discrimination based on personalized pricing or group pricing is impossible
- Instead, the firm can provide a menu of packages from which consumers choose (menu pricing)
  - Ex. 12-pack of soda vs one can

will have to give up a bit of surplus

- By the buyer's self-selection the firm is able to discriminate profitably between the types
- Since the discrimination can only be partial, the firm does not earn as much profit as in the previous, full-information cases
  - The firm will not be able to extract as much CS as when it could identify each customer's WTP

# Second-degree Price Discrimination

- We’ll continue with the previous example
- Suppose now buyer type depends on income which is hard to verify
- A high income buyer has a high WTP (formerly young professional) and a low income buyer a low WTP (formerly teenager)
- Under the previous two-part pricing scheme, the high WTP types receive zero CS under the package designed for them but would receive positive CS if they could buy the package designed for the low WTP types
  - A high income buyer can pretend to be of low income to get the price intended for low WTP buyers ➔ pays a \$32 entry fee instead of a \$72 entry fee
- Same with block pricing

have to desiign in a way that the high demand do not take the low demand chocies

  - Also won’t work as designed because high WTP buyers will pretend to be low WTP buyers and receive positive CS

# Second-degree Price Discrimination

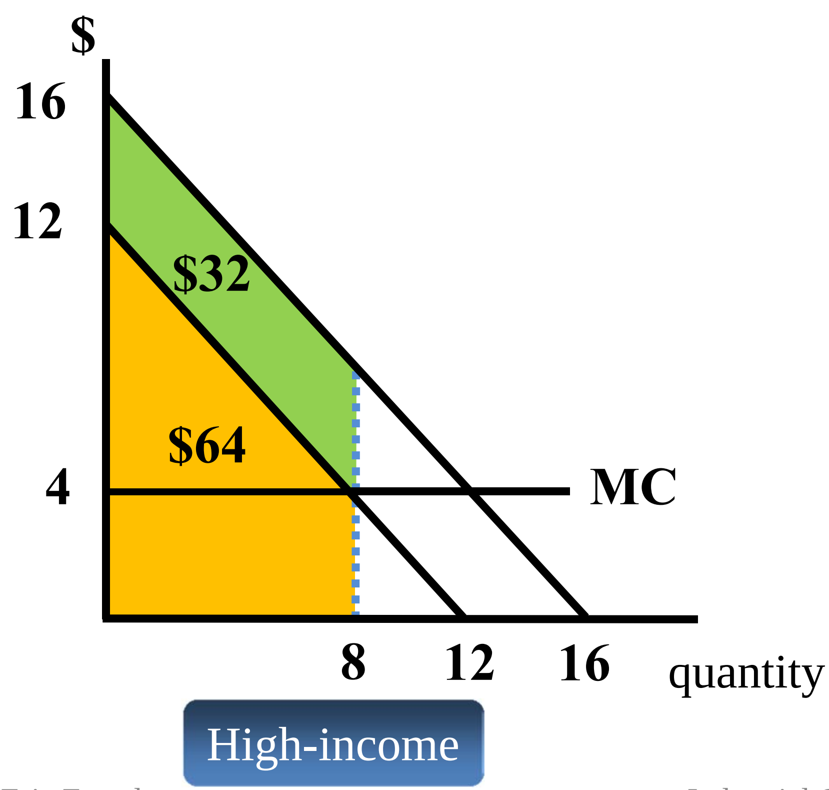
- For **menu pricing** to work the customers must self-select the package designed for their type
- In other words, the menu must be **incentive compatible**:
  - any offer designed for high WTP buyers must provide them as much CS as they would get from an offer designed for low WTP buyers
  - (low WTP buyers never buy the package for high WTP buyers)
- If the menu is incentive compatible, the high WTP buyers will never choose the package for low WTP customers
  - the seller can price discriminate even without being able to identify each customer’s type

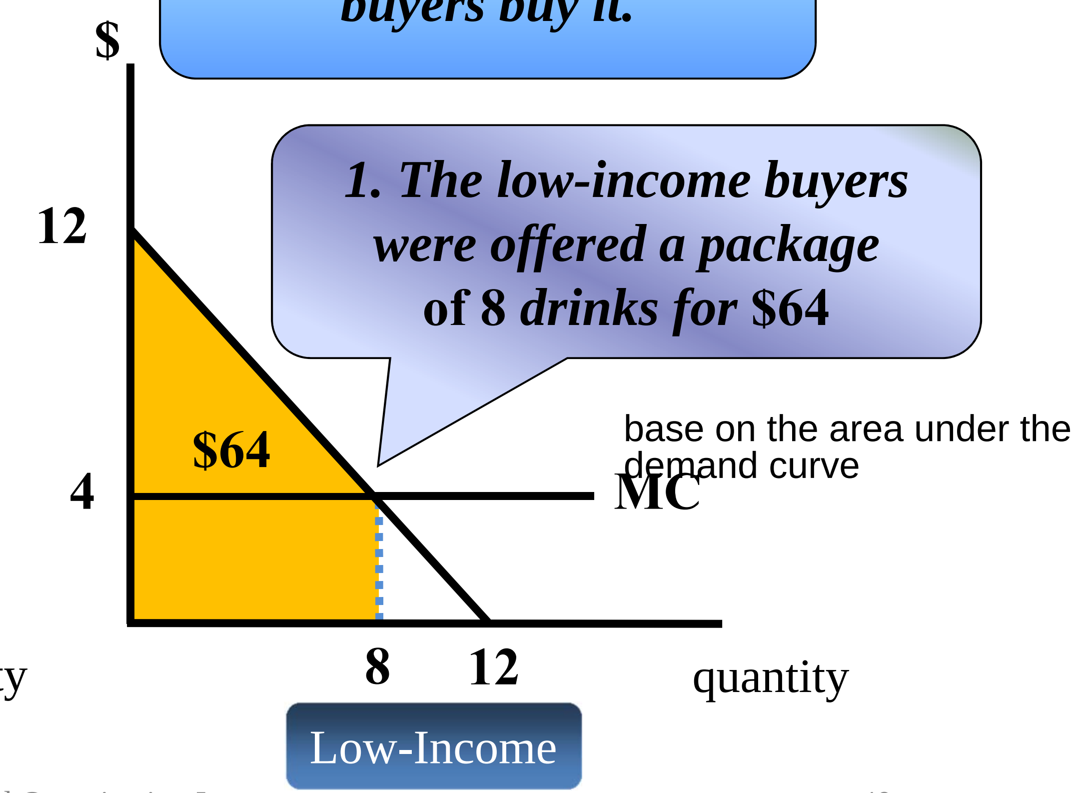
5. *Profit per buyer is $32*

4. *So any package designed for high-income buyers must provide at least $32 in consumer surplus ➔ this is the incentive capability constraint*

3. *But so do the high-income buyers because the ($64, 8) package gives them $32 in CS*

2. *And the low-income buyers buy it.*



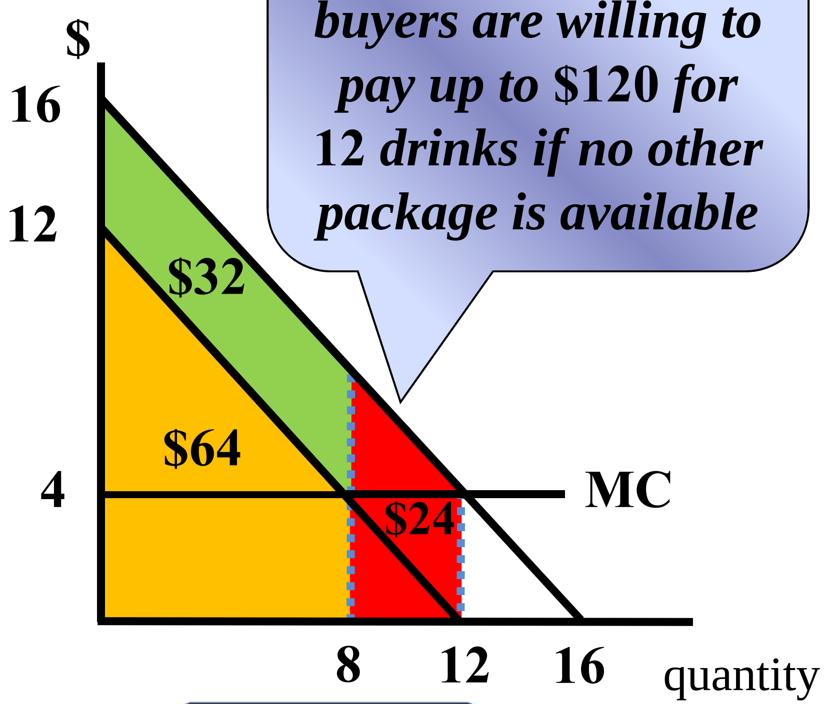
profit increases

***4. Profit from each high-income buyer is $88 - $4 x 12 = $40***

***2. So they would buy a package of ($88, 12) (since $120 - 32 = 88)***

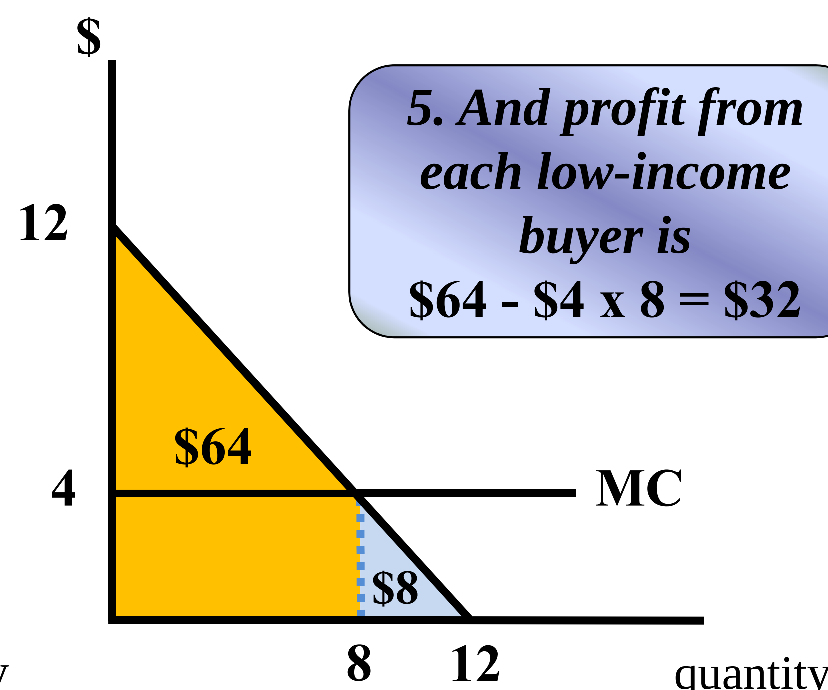
***3. Low income buyers will not buy the ($88, 12) package since they are only willing to pay $72 for 12 drinks***

***1. High income buyers are willing to pay up to $120 for 12 drinks if no other package is available***




High-income

***5. And profit from each low-income buyer is $64 - $4 x 8 = $32***




Low-Income

*1. Can the club owner do even better?*

*2. Yes! Reduce the number of drinks offered to the low-income buyers.*

*3. Suppose each low-income buyer is offered 7 drinks. They are willing to pay $59.50.*

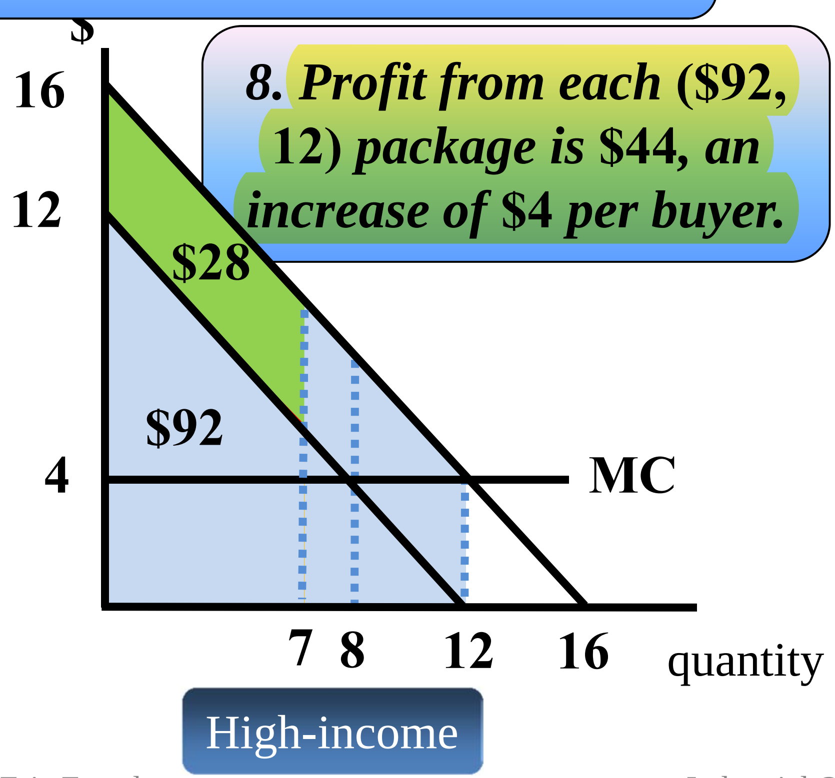
*4. Profit from each ($59.50, 7) package is $31.50, a reduction of $0.50 per buyer.*

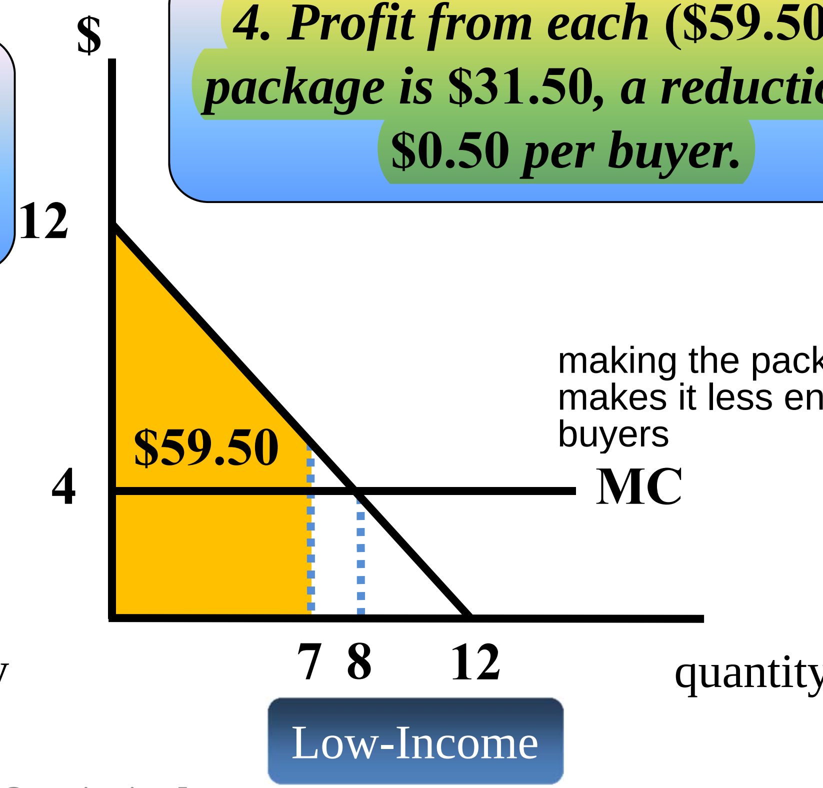
*5. A high-income buyer will pay $87.50 for 7 drinks.*

*6. Buying the ($59.50, 7) package gives him $87.50-$59.50=$28 in CS.*

*7. So 12 drinks can be sold for $92 ($120 - 28 = $92).*

*8. Profit from each ($92, 12) package is $44, an increase of $4 per buyer.*




making the package smaller makes it less enticing for big buyers



profit increase for high income buyers cover the reduction in profit from low income buyers

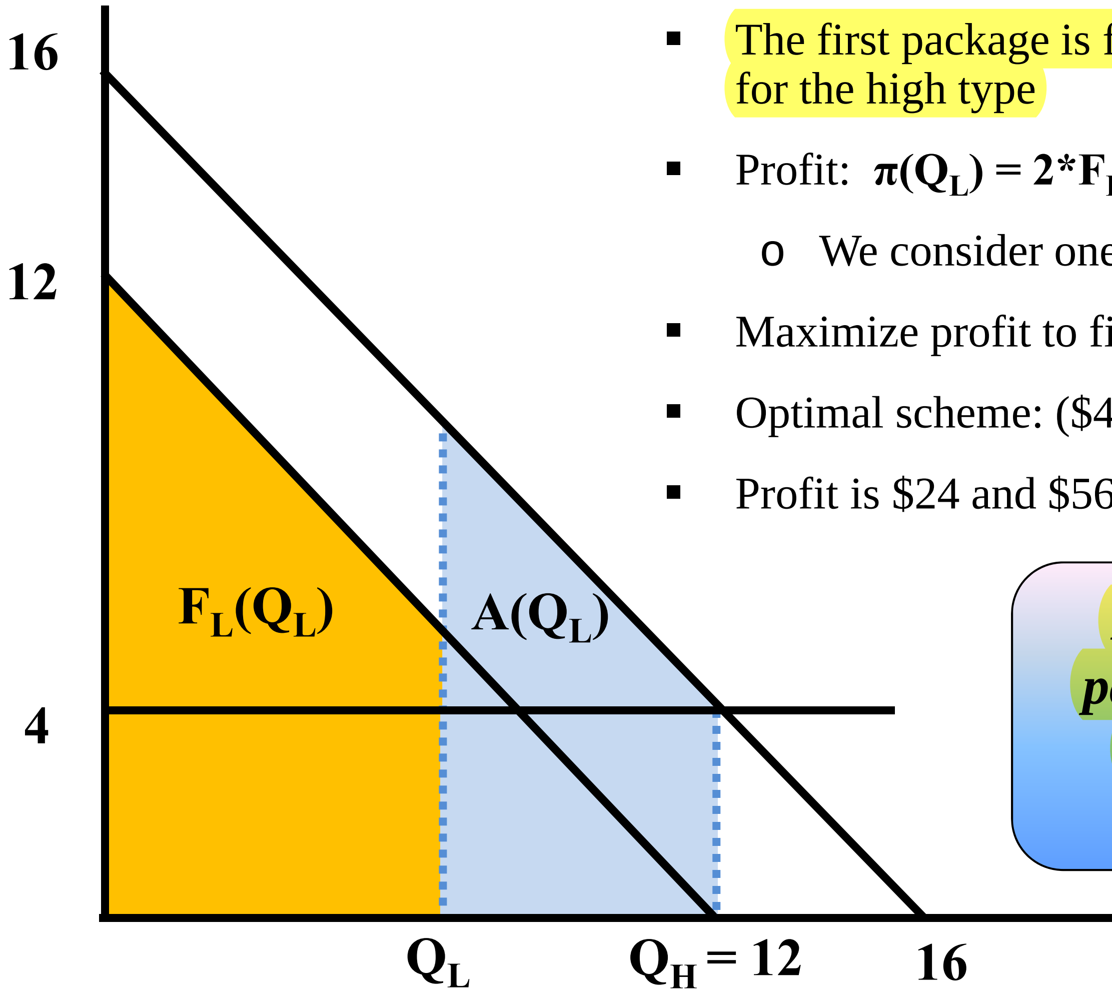
# Second-degree Price Discrimination

- So, ultimately, how does the firm determine the optimal scheme?
- Reducing the quantity of drinks offered to low-income buyers decreases the profit from low-income buyers
- But this allows a smaller fee reduction (from $120) to high-income buyers ➔ this increases the profit from high-income buyers
- Continue this exercise as long as the increase in profit from the high-income buyers is greater than the decrease in profit from the low-income buyers
- Features of the optimal scheme:
  - Low-demand buyers enjoy no CS, high-demand buyers enjoy CS > 0
  - The high-demand buyers get the socially optimal quantity, the low-demand buyers get a suboptimal quantity

P = MC

# Second-degree Price Discrimination

- Offer two packages: $(F_L, Q_L)$ and $(F_L + A, 12)$
- The first package is for the low type, the second package is for the high type
- Profit: revenue minus cost $\pi(Q_L) = 2{*}F_L(Q_L) + A(Q_L) - 4{*}(12+Q_L)$
  - o We consider one customer of each type, can generalize
- Maximize profit to find $Q_L$
- Optimal scheme: ($40,4) and ($104,12)
- Profit is $24 and $56




***Note that the high-quantity package has a lower price per unit than the low-quantity package: $8.67 vs $10***

# Ex. Starhub mobile phone plans

- Optimal menu pricing exhibits quantity discounting: high demand consumers pay less per unit than low demand consumers

PowerValue plans   i2Surf plans   SmartSurf plans   SIM only plans

| ***per minute*** | **$0.254** PowerValue 80 | **$0.257** PowerValue 100 | **$0.16** PowerValue 300 | **$0.12** PowerValue 700 |
|---|---|---|---|---|
| **Monthly Subscription** | $20.33 | $25.68 | $48.15 | $82.93 |
| **Outgoing Local Mins** | 80 mins | 100 mins | 300 mins | 700 mins |
| **SMS/MMS** | | 500 | | |
| | | Unlimited SMS/MMS for Students and NSF | | |

# Empirical Example: Price Discrimination on Broadway

- Leslie (2004) models individual consumer behavior and monopoly price discrimination and estimates the model with data from the Broadway play, “Seven Guitars"
- Data consists of price and quantities of 17 different ticket categories for 199 performances in 1996
- Broadway shows use a variety of methods to price discriminate:
  - Setting different prices for different seat qualities (second-degree)
  - Mailing discount coupons to consumers with a lower willingness to pay (third-degree)
  - Selling on the day-of-performance at a 50% discount at a discount booth (second-degree, damaged goods – the firm makes a lower quality version of its product by deliberately damaging it)
- Differences in prices cannot be explained by costs since the marginal cost of every ticket sold is effectively zero

# Empirical Example: Price Discrimination on Broadway

| | | Mean price ($) | | | Mean price ($) |
|---|---|---|---|---|---|
| **Full price** | Orchestra | 55.08 | **Discount price** | 10% off | 49.40 |
| | Front mezzanine | 55.08 | | Two-fer one | 27.23 |
| | Rear mezzanine | 29.20 | | TKTS | 27.53 |
| | Balcony | 16.93 | | MTC | 22.00 |
| | Boxes | 55.76 | | AENY | 50.36 |
| | Standing room | 22.27 | | Direct mail | 39.51 |
| | | | | Group | 36.26 |
| | | | | Student | 26.21 |
| | | | | TDF | 16.46 |
| | | | | Wheelchair | 26.94 |
| | | | | Complimentary | 0.00 |

- Full price tickets differ by seating area and therefore the quality of the view that is offered
- Discount price tickets differ by how the tickets are purchased (e.g., waiting in line at a discount booth (TKTS))

# Empirical Example: Price Discrimination on Broadway

# Empirical Example: Price Discrimination on Broadway

- Leslie performs several counterfactual experiments
  - That is, he predicts what would happen if some element of the economic environment was different (this is also called a policy change)
  - E.g., how much would the consumption of petrol decrease if a tax on petrol increased?
- Experiment 1: firm is restricted to selling all tickets for all performances at a single, optimal price, \$50.04
  - Attendance drops by 6.3% and revenue increases slightly by 0.6%
  - The higher revenue is due to the elimination of the discount booth category under a uniform pricing policy which prevents consumers from substituting away from buying a full-price ticket to a discounted ticket.

# Empirical Example: Price Discrimination on Broadway

- Experiment 2: firm can price discriminate but the discount booth tickets are eliminated
  - Attendance increases by 1.0% and revenue increases by 5.7%
  - This result along with the result of experiment 1 is evidence that selling tickets at the discount booth is harmful to the firm due to the negative effect it has on the demand for full-price tickets
- Experiment 3: firm isn't restricted to selling discount booth tickets at a 50% discount
  - Leslie finds that the best discount would be 30%
  - Attendance decreases by 1.6% and revenue increases by 7%

# Tie-in Sales

- Tying is a sales practice that allows a customer to use one product (the tying product) only if another product is purchased (the tied product)
- Tying is often used when customers differ by the frequency with which they wish to use a product
  - ex. Polaroid cameras, Hewlett-Packard printers
- And so tying can be used to price discriminate
  - One way is with a two-part tariff for which the lump-sum fee is the cost of the tying product
  - We also will see an example of tying that uses block pricing to price discriminate

trying to link the purchase of first product to the second product as if it is not controlled, the second product will become a competitive one

# Tie-in Sales

- For tying to work, the firm has to have market power over the the tied product, which is often achieved by contract
  - Tying contracts are often disputed as an antitrust violation by the foreclosed firms (firms that are kept out of the tied-product market)
- 1992 Kodak case:
  - Kodak tied the supply of replacement parts for its photocopiers to the supply of service, effectively excluding independent service operators
  - Kodak used tying to price discriminate because high-intensity users require more service than low-intensity users
  - Kodak was found guilty of monopolizing the service market for its photocopiers and the independent service operators were award $23.9 million in damages

# Tie-in Sales

- Consider a particular camera sold by one firm
- The camera users vary by how many pictures they take over a period of time
- Some users will take a lot of pictures and others few
- Suppose:
  - there are 1,000 low-demand consumers with picture demand **Q = 12 - p**
  - and 1,000 high-demand consumers with picture demand **Q = 16 - p**
  - The manufacturer cannot distinguish the two types
  - The manufacturer leases the camera to all 2,000 consumers
- The cost of the camera is a fixed cost
- The marginal cost of producing film is \$2 per photo
- The market for film is competitive ➔ p = \$2

# Tie-in Sales

- The firm can't distinguish types so it cannot lease the cameras at different prices
  - The best it can do is charge a rental fee of \$50, the CS a low-demand consumer receives at p = 2
  - High-demand consumers will take 14 photos
  - Low-demand consumers will take 10 photos
  - Profit will be \$50 x 2,000 = \$100,000 per period

# Tie-in Sales

- How can the firm use tying to increase profit? Suppose that the firm ties the purchase of film at $4 per photo to the leasing of its camera (two-part pricing)
  - Low-demand consumers now take 8 photos and enjoy a CS of $32 ➔ rental fee of $32
  - Profit from the low-demand consumers: ($32 + $2x8) x 1,000 = $48,000
  - High demand consumers take 12 photos per month
    - Low demand consumers pay **$8** per photo
    - High demand consumers pay **$6.67** per photo
  - Profit from high-demand consumers: ($32 + $2x12) x 1,000 = $56,000
  - Total profit: $104,000

monopoly for both the tie and tie in market

# Tie-in Sales

- So far the firm is offering one package. Can it do better?
- Yes, since tying allows the firm to distinguish the high-demand consumers from the low-demand consumers by their film purchases
- Suppose the firm designs two types of cameras with the film integrated into the camera
- One camera includes film for 10 photos and the other film for 14 photos
  - block pricing
- The firm leases the 10-shot camera for $70 and the 14-shot camera for $86
  - Low demand consumers pay **$7** per photo
  - High demand consumers pay **$6.14** per photo
- Profit in this case will be $50 x 1000 + $58 x 1000 = $108,000
- The optimal menu includes a 14-shot camera and a 6-shot camera. Can you find the price of each package and the total profits?

# Bundling

- Bundling occurs when two or more products are packaged together for sale
  - ex. cable tv providers package some channels together rather than allowing customers to subscribe to each channel separately
- Bundling can be used to price discriminate and increase profits when customers have different WTP for different products
- Ex. suppose two customers are on the market for a new computer and monitor. Their WTP:

| | Computer | Monitor |
|---|---|---|
| **Customer 1** | **$1,200** | **$600** |
| **Customer 2** | **$1,500** | **$400** |

- Marginal cost is $1,000 for the computer and $300 for the monitor.

# Bundling

- Suppose the firm does *not* bundle the items
- Computer:
  - $\mathbf{p_c = \$1{,}500 \rightarrow \pi = \$500}$
  - $\mathbf{p_c = \$1{,}200 \rightarrow \pi = \$400}$
- Monitor:
  - $\mathbf{p_m = \$600 \rightarrow \pi = \$300}$
  - $\mathbf{p_m = \$400 \rightarrow \pi = \$200}$

| | Computer | Monitor |
|---|---|---|
| C1 | $1,200 | $600 |
| C2 | $1,500 | $400 |
| MC | $1,000 | $300 |

➢ Set $\mathbf{p_c = \$1{,}500}$ and $\mathbf{p_m = \$600}$ and earn $\mathbf{\pi = \$800}$

- Now suppose the firm bundles the computer and monitor:
  - Customer 1 is willing to pay $1,800 for the bundle and customer 2 is willing to pay $1,900
  - $\mathbf{p_b = \$1{,}900 \rightarrow \pi = \$600}$
  - $\mathbf{p_b = \$1{,}800 \rightarrow \pi = \$1{,}000}$

# Bundling

- Why does bundling increase profit?
- Without bundling, the firm is forced to price to the low valuation customer
- With bundling, the firm in essence is able to price discriminate by lowering the price of the computer to customer 1 and lower the price of the monitor to customer 2 in the bundle *without lowering the price of the monitor to customer 1 or the computer to customer 2*
- Results depend on the customers' WTP being *negatively correlated*
  - customer 2 is willing to pay more for the computer than customer 1
  - customer 1 is willing to pay more for the monitor than customer 2

# Bundling

- What happens if WTP is positively correlated?

| | Computer | Monitor |
|---|---|---|
| **C1** | **$1,200** | **$400** |
| **C2** | **$1,500** | **$600** |
| **MC** | **$1,000** | **$300** |

- In the case of no bundling, optimal pricing does not change: set $\mathbf{p_c = \$1{,}500}$ and $\mathbf{p_m = \$600}$ and earn $\boldsymbol{\pi = \$800}$
- When the firm bundles:
  - Customer 1 is willing to pay $1,600 for the package and customer 2 is willing to pay $2,100
  - $\mathbf{p_b = \$2{,}100 \Rightarrow \pi = \$800}$
  - $\mathbf{p_b = \$1{,}600 \Rightarrow \pi = \$600}$

➢ Bundling does not increase profit

# Mixed bundling

- Mixed bundling is when firms allow customers to buy products separately as well as in a bundle
  - you can buy a computer and monitor as a package from Dell or each item separately
- Suppose marginal costs are the same as before. Customers' WTP:

| | Computer | Monitor |
|---|---|---|
| Customer 1 | $850 | $800 |
| Customer 2 | $1,100 | $600 |
| Customer 3 | $1,300 | $400 |
| Customer 4 | $1,500 | $150 |

# Mixed bundling

- What is the firm's optimal strategy?
- *No bundling*:
  - $\mathbf{p_c = \$1{,}300 \rightarrow \pi = \$600, p_m = \$600 \rightarrow \pi = \$600,}$ total $\mathbf{\pi = \$1{,}200}$
- *Pure bundling*:
  - $\mathbf{p_b = \$1{,}650 \rightarrow \pi = \$1{,}400}$
- *Mixed bundling:*
  - Firm sets $\mathbf{p_c}$, $\mathbf{p_m}$, and $\mathbf{p_b}$
- Consumer 1:
  - not profitable to sell a computer since WTP < MC
  - monitor: $\mathbf{p_m = \$800 \rightarrow \pi = \$500}$
  - bundling: $\mathbf{p_b = \$1{,}650 \rightarrow \pi = \$350}$
  - ➢ $\mathbf{p_m = \$800}$

| | Computer | Monitor |
|---|---|---|
| **C1** | **\$850** | **\$800** |
| **C2** | **\$1,100** | **\$600** |
| **C3** | **\$1,300** | **\$400** |
| **C4** | **\$1,500** | **\$150** |
| **MC** | **\$1,000** | **\$300** |

# Mixed bundling

- Consumer 4:
  - not profitable to sell a monitor since WTP < MC
  - computer: $\mathbf{p_c = \$1{,}500 \Rightarrow \pi = \$500}$ extract the entire surplus
  - bundling: $\mathbf{p_b = \$1{,}650 \Rightarrow \pi = \$350}$
  - ➢ $\mathbf{p_c = \$1{,}500}$
- Consumer 2,3:
  - have negatively correlated demand
  - WTP > MC for each product
  - ➢ bundle products
  - ➢ $\mathbf{p_b = \$1{,}700 \Rightarrow \pi = \$800}$
- Profit is greater than under pure bundling and no bundling case (\$1,800 vs. \$1,400 and \$1,200)

| | Computer | Monitor |
|---|---|---|
| **C1** | **\$850** | **\$800** |
| **C2** | **\$1,100** | **\$600** |
| **C3** | **\$1,300** | **\$400** |
| **C4** | **\$1,500** | **\$150** |
| **MC** | **\$1,000** | **\$300** |

# Ex. McDonald's

- McDonald's meals with medium fries ($2.80) and small drink ($2.50)

| | Alone | Meal Items Purchased Separately | Value Meal | Discount |
|---|---|---|---|---|
| **Big Mac** | **$5.25** | **$10.55** | **$7.20** | **31.8%** |
| **6-pc McNuggets** | **$4.60** | **$9.90** | **$6.35** | **35.9%** |
| **Filet-O-Fish** | **$4.40** | **$9.70** | **$5.95** | **38.7%** |