

Part IV. Pricing strategies and market segmentation

Chapter 8. Group pricing and personalized pricing



Slides

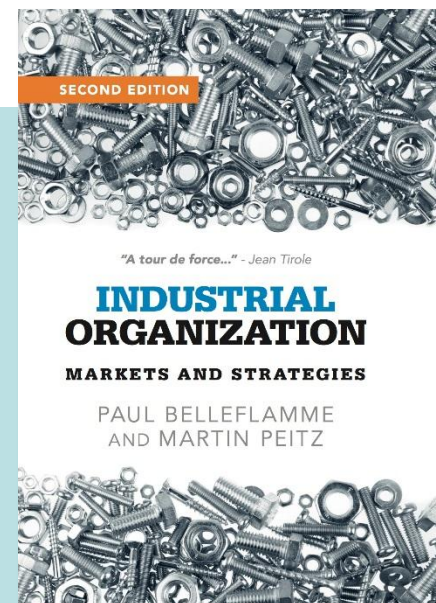
Industrial Organization: Markets and Strategies

Paul Belleflamme and Martin Peitz, 2d Edition

© Cambridge University Press 2015

Case. How to sell this book?

- Suppose it's the only IO book on the market
 - Profits we can make depend on
 - *Information* we have on consumers
 - *Instruments* we can use to design tariffs
 - If limited information and instruments
 - Only available strategy: uniform price
 - If more information → price discrimination
 - Ideally, know exactly what each consumer is willing to pay
 - If not, identify characteristics related to willingness to pay and segment market into several groups (e.g., US market vs. European market)
→ Personalized and group pricing (Chapter 8)



Case. How to sell this book? (cont'd)

- If more information → **price discrimination** (cont'd)
 - If no identifiable characteristics, design different versions and induce consumers to self-select (e.g., hard-back vs. paperback)
→ **Menu pricing** (Chapter 9)
- If more instruments → **several possibilities**
 - Sell different versions (menu pricing)
 - Sell at different prices over time (e.g., discount future prices, condition prices on purchase history)
→ **Intertemporal pricing** (Chapter 10)
 - Set a special price for a bundle of product (e.g., book + instructor manual + CD-rom with slides and exercises)
→ **Bundling and tying** (Chapter 11)
- More information & more instruments → higher profits

Case. How to sell this book? (cont'd)

- What if other IO books on the market?
 - More information or more instruments *don't necessarily translate into more profits.*
 - Why?
 - Competitors can use the same strategies.
 - Competition can be exacerbated for some groups of consumers.
- We study
 - Effects of imperfect competition
 - Impacts on welfare

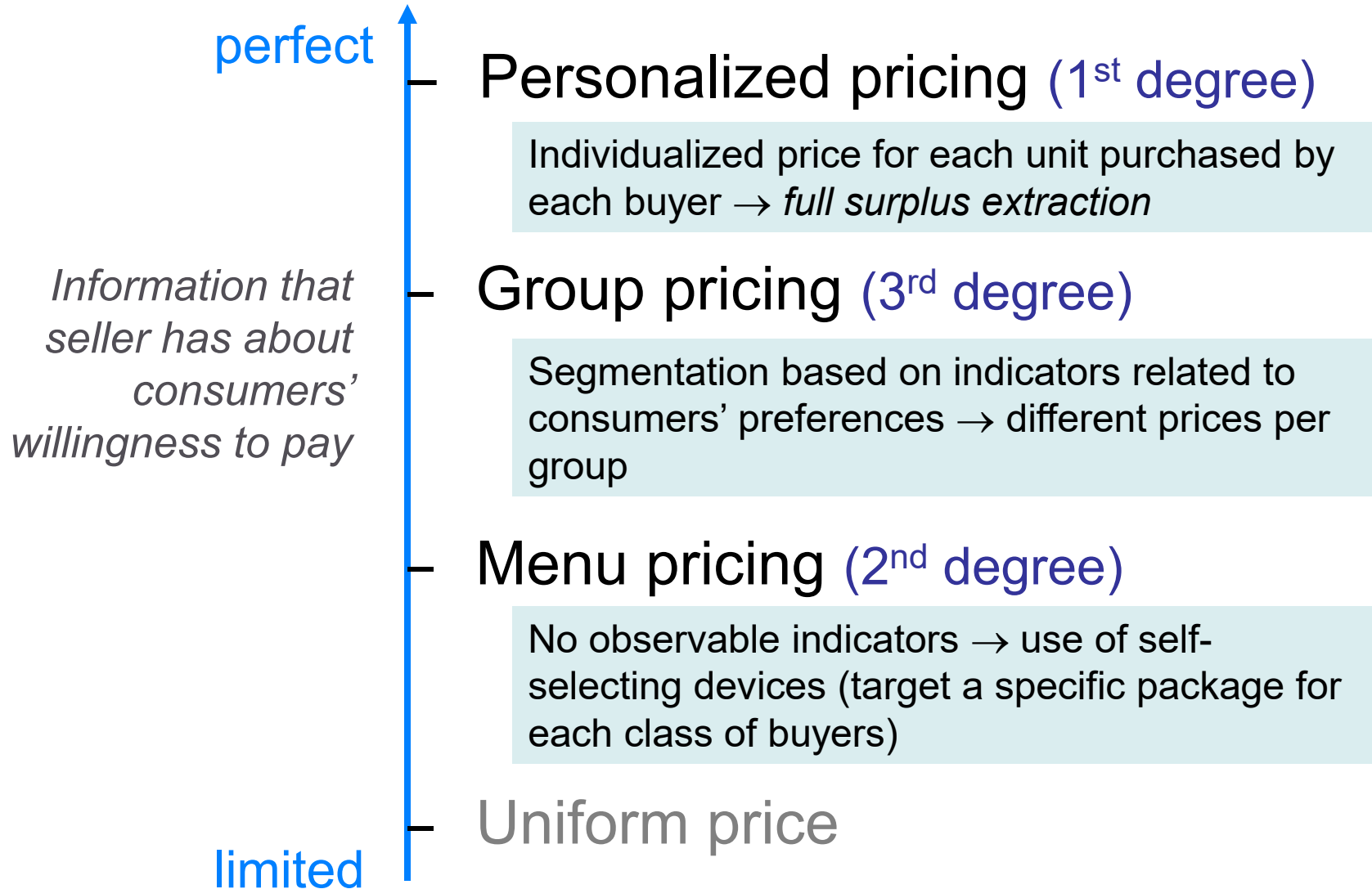
Chapter 8. Learning objectives

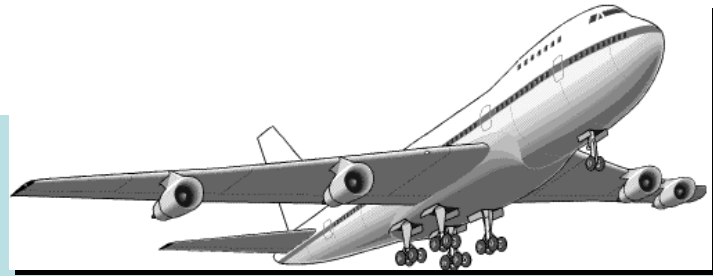
- Be able to distinguish between the 3 types of price discrimination.
- See how personalized and group pricing allow a monopolist to extract more consumer surplus and, thereby, to increase profits.
- Understand how to set different prices for different groups.
- Understand that in oligopoly settings, the positive surplus extraction effect of price discrimination may be outweighed by a negative competition enhancing effect.

Definition

- 2 varieties of a good are sold (by the same seller) to 2 buyers at different net prices
 - Net price = price (paid by the buyer) – cost associated with product differentiation
- Feasibility?
 - Market power
 - No arbitrage
 - Consumers find it impossible or too costly
 - ‘Physical arbitrage’ → transfer of the good itself between consumers
 - ‘Personal arbitrage’ → transfer of demand between different packages aimed at different consumers (see Chapter 9)

Typology



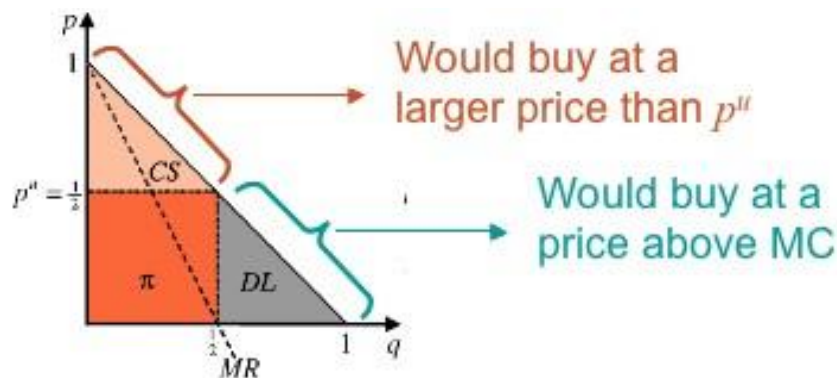


Case. Airline fares

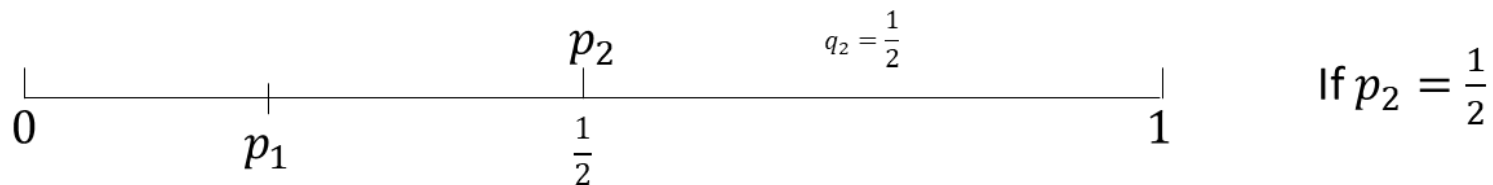
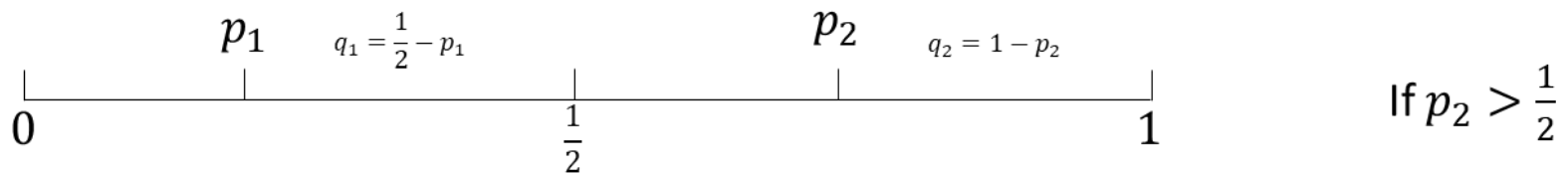
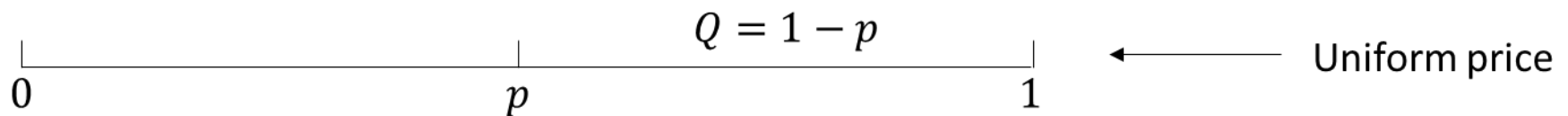
- Favorable context
 - Great heterogeneity across consumers
 - Limited arbitrage opportunities
 - Negligible marginal cost (up to capacity)
- Discount fares based on restrictions
 - Restrictions fostering self-selection
 - Purchase in advance, Saturday-night stay over, surcharge for one-way tickets, ...
 - Restrictions based on observable characteristics
 - Family, age, students
- Strategy of low cost carriers
 - Eliminate above restrictions (except intertemporal pricing)
 - New form of geographical group pricing (see Chapter 9)

Group & personalized pricing in monopoly

- Monopolist $\uparrow$ profits when it obtains more refined information about consumers' reservation prices
- Model
 - Unit mass of consumers with unit demand
 - Valuation θ uniformly distributed over $[0,1]$
 - Buy if $\theta \geq p \rightarrow$ demand: $q = 1 - p$
 - Zero marginal cost; profits: $p(1 - p)$
 - If uniform price: $p^u = 1/2$, $\pi^u = 1/4$, $CS^u = 1/8$, $DL^u = 1/8$
 - Not satisfactory:



Group & personalized pricing in monopoly (cont'd)



Group & personalized pricing in monopoly (cont'd)

- If $p_2 \geq \frac{1}{2}$

$$\begin{aligned} & \max_{p_1} p_1 \left(\frac{1}{2} - p_1 \right) \\ \Rightarrow p_1 &= \frac{1}{4} \quad \Rightarrow \pi_1 = \frac{1}{16} \end{aligned}$$

$$\begin{aligned} & \max_{p_2} p_2 (1 - p_2) \\ \Rightarrow p_2 &= \frac{1}{2} \quad \Rightarrow \pi_2 = \frac{1}{4} \end{aligned}$$

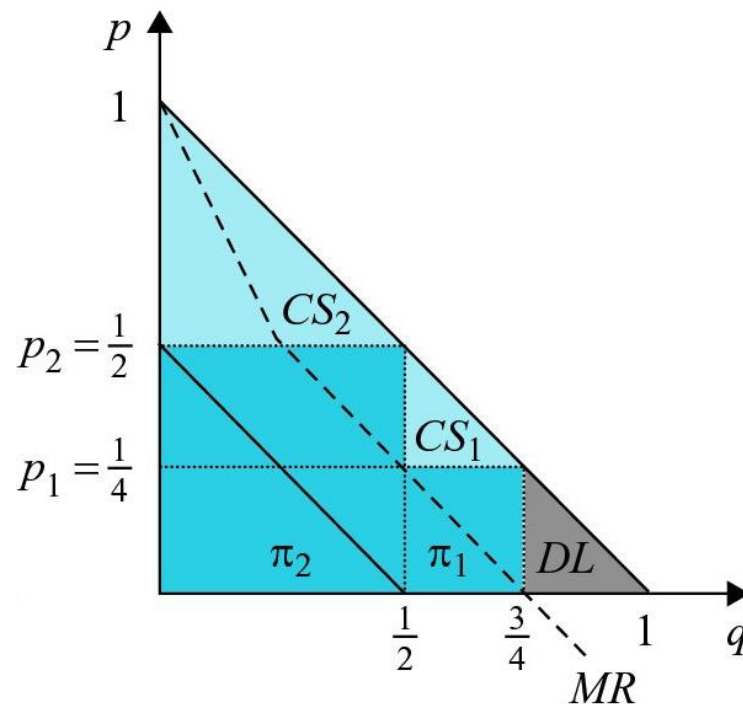
Group & personalized pricing in monopoly (cont'd)

- Refined information
 - Partition $[0,1]$ into N subintervals of equal length
 - Monopolist knows from which group each consumer comes & can charge a different price for each group
 - Take $N = 2$
 - $[0, 1/2] \rightarrow q_1 = 1/2 - p_1$
 - $[1/2, 1] \rightarrow q_2 = \max\{1/2, 1 - p_2\}$

$$\pi(2) = \frac{1}{4} + \frac{1}{16} > \pi^u$$

$$CS(2) = \frac{1}{8} + \frac{1}{32} > CS^u$$

$$DL(2) = \frac{1}{32} < DL^u$$



Group & personalized pricing in monopoly (cont'd)

- **N segments.** Segment m contains the consumers with $\theta \in \left[\frac{m-1}{N}, \frac{m}{N}\right]$, for $m = 1, \dots, N$.

- **Step 1. Demand in segment m .** At a price p_m inside the segment, consumers with $\theta \geq p_m$ buy:

$$q_m = \frac{m}{N} - p_m \quad \text{for} \quad \frac{m-1}{N} \leq p_m \leq \frac{m}{N}$$

- Charging less than $\frac{m-1}{N}$ never pays: the whole segment already buys.
- **Step 2. Unconstrained price.** Maximizing $p_m \left(\frac{m}{N} - p_m\right)$ gives $p_m = \frac{m}{2N}$. It lies inside the segment only if

$$\frac{m}{2N} \geq \frac{m-1}{N} \quad \Leftrightarrow \quad m \leq 2$$

Group & personalized pricing in monopoly (cont'd)

- **Step 3. Lowest segment ($m = 1$).** Interior solution:

$$p_1 = q_1 = \frac{1}{2N}, \quad \pi_1(N) = \left(\frac{1}{2N}\right)^2, \quad CS_1(N) = DL_1(N) = \frac{1}{2} \left(\frac{1}{2N}\right)^2$$

- **Step 4. Other segments ($m \geq 2$).** Corner solution: the monopolist sets the lowest valuation in the segment and serves all of it:

$$p_m = \frac{m-1}{N}, \quad q_m = \frac{1}{N}, \quad \pi_m(N) = \frac{m-1}{N^2}, \quad CS_m(N) = \frac{1}{2} \left(\frac{1}{N}\right)^2, \quad DL_m(N) = 0$$

- Only the lowest segment has a deadweight loss.

Group & personalized pricing in monopoly (cont'd)

- Step 5. Summing over segments.** Using $\sum_{m=2}^N (m-1) = \frac{N(N-1)}{2}$,

$$\pi(N) = \frac{1}{4N^2} + \frac{N-1}{2N} = \frac{1}{2} - \frac{2N-1}{4N^2}$$

$$CS(N) = \frac{1}{8N^2} + \frac{N-1}{2N^2} = \frac{4N-3}{8N^2} \quad \text{and} \quad DL(N) = \frac{1}{8N^2}$$

N	$\pi(N)$	CS(N)	DL(N)
1 (uniform price)	0.250	0.125	0.125
2	0.313	0.156	0.031
3	0.361	0.125	0.014
10	0.453	0.046	0.001
$N \rightarrow \infty$ (personalized)	0.500	0	0

Group & personalized pricing in monopoly (cont'd)

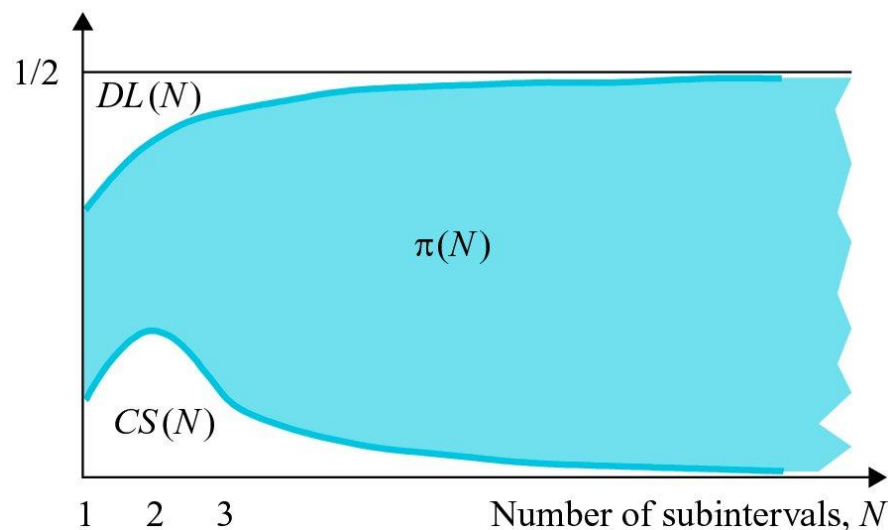
- Refined information (cont'd)

- N subintervals

$$\pi(N) = \frac{1}{2} - \frac{2N-1}{4N^2}$$

$$CS(N) = \frac{4N-3}{8N^2}$$

$$DL(N) = \frac{1}{8N^2}$$



- Lesson:** If information about consumers' reservation prices $\uparrow$, monopolist $\uparrow$ profits. Under personalized prices, monopolist captures entire surplus and deadweight loss vanishes.

Group pricing and localized competition

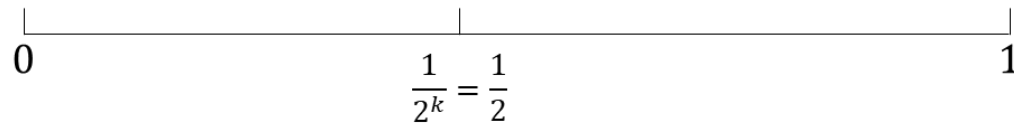
- Extension of Hotelling model
 - 2 firms ($MC = 0$) located at extreme points of $[0,1]$
 - Mass 1 of consumers uniformly distributed on $[0,1]$
 - Utility of consumer x (assuming linear transport costs):

$$\begin{aligned} &r - \tau x - p_1 \text{ if she buys 1 unit of good 1,} \\ &r - \tau(1 - x) - p_2 \text{ if she buys 1 unit of good 2.} \end{aligned}$$
- Information (exogenously and freely accessible to both firms) partitions $[0,1]$ into N subintervals of equal length
 - Let $N = 2^k$, with $k = 0, 1, 2, \dots$
 - k measures the quality of information

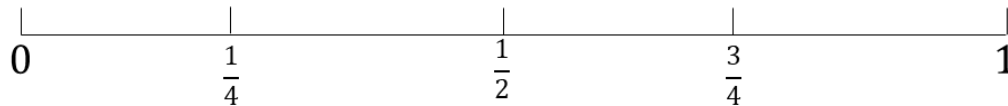
Group pricing and localized competition (cont'd)



if $k = 0, N = 2^0 = 1$ interval



if $k = 1, N = 2^1 = 2$ intervals

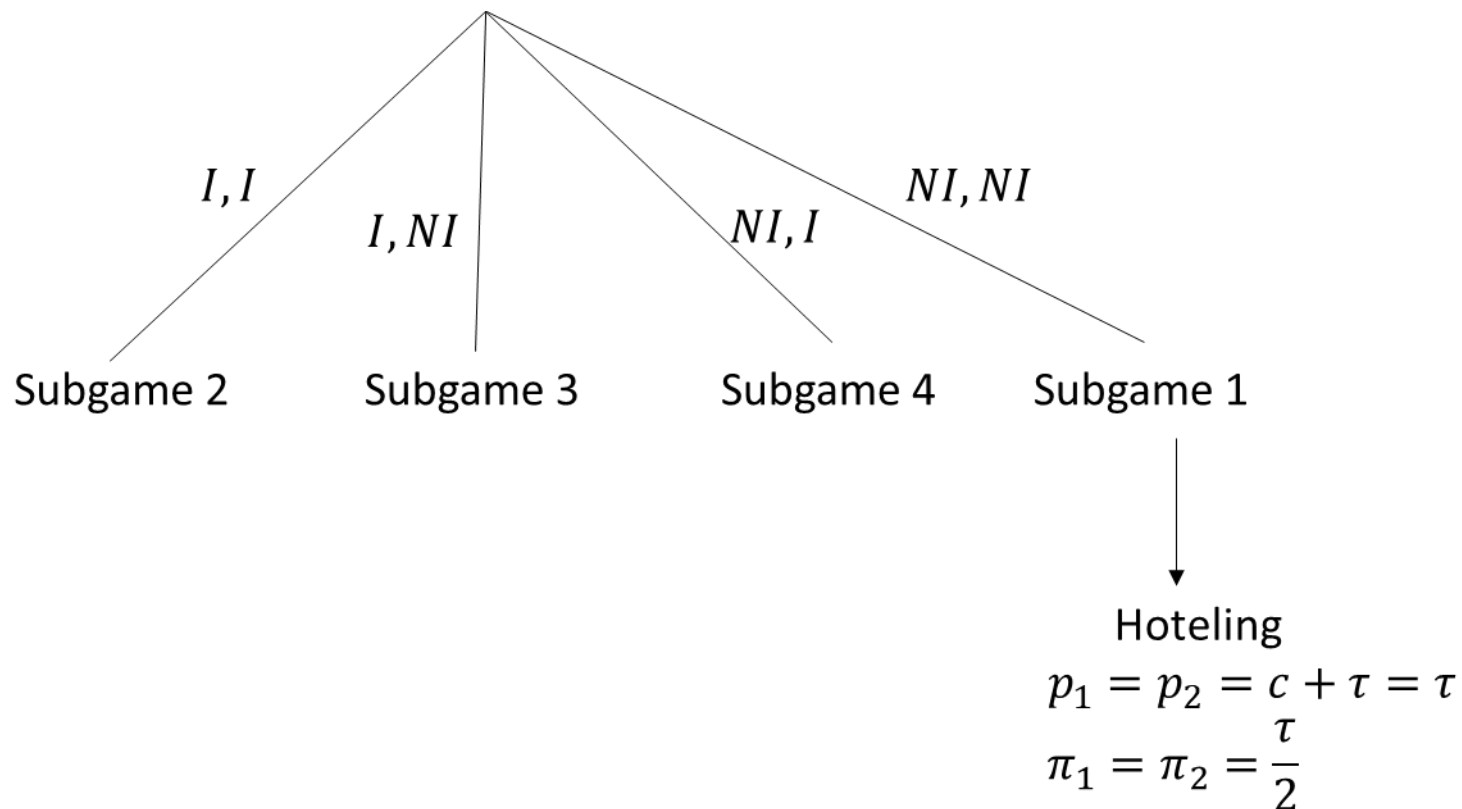


if $k = 2, N = 2^2 = 4$ intervals

Group pricing and localized competition (cont'd)

- Time structure
 - I. Given k , every firm independently and simultaneously decide whether to acquire information or not. $\rightarrow I/NI$
 - II. Firms choose p
 - III. Firm(s) that acquired information offer price discount to consumers.

Group pricing and localized competition (cont'd)



Group pricing and localized competition (cont'd)

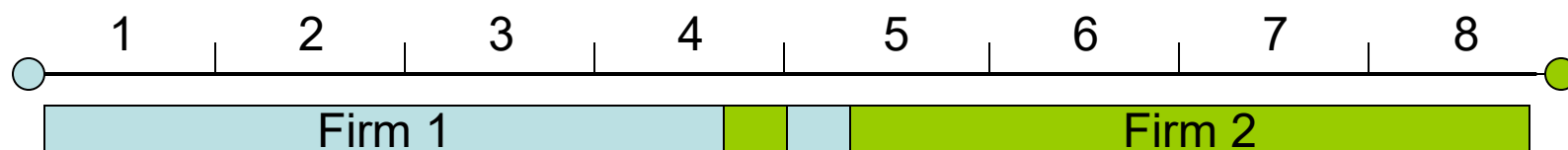
- 3-stage game
 1. Firms decide to acquire information of quality k or not
 - 2a. Firms choose their regular price
 - 2b. Firm(s) with information target(s) specific discount to consumer segments
- Pricing decisions (stages 2a and 2b) → 4 subgames
 - Neither firms acquires information
 - Same as linear Hotelling model (see Chapter 5)
 - $\pi^{\text{NI,NI}} = \tau/2$
 - Both firms acquire information
 - Firm i acquires information; firm j doesn't

Group pricing and localized competition (cont'd)

- Both firms acquire information
 - In each segment, firms are in asymmetric positions: firm 1 has an advantage in segments in $[0, 1/2]$, and firm 2 in segments in $[1/2, 1]$.
 - In segments close to the extremes, the closest firm gets the whole segment.
 - Head-to-head competition only exists for the two middle segments, where poaching occurs.

Group pricing and localized competition (cont'd)

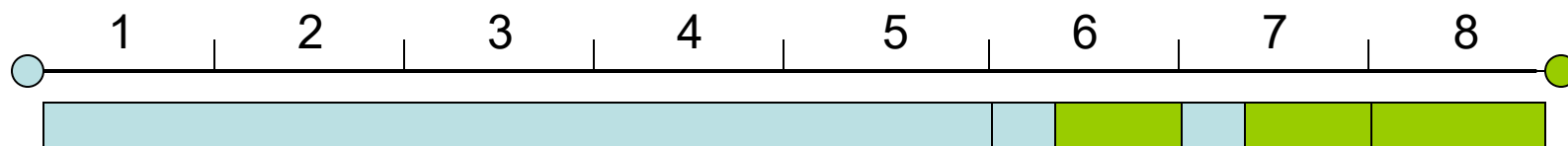
- Both firms acquire information (cont'd)
 - Example with $k = 3$ (8 segments)



- We can compute $\pi^{l,l}(k)$
 - Properties
 - U-shaped** $\rightarrow$ interplay between 2 effects of improved information: higher competition (dominates for low k) and surplus extraction (dominates for large k)
- $\pi^{l,l}(k) < \pi^{NI,NI}(k) = \tau/2$ for all k

Group pricing and localized competition (cont'd)

- Only one firm acquires information
 - Equilibrium: asymmetric version of previous subgame
 - Suppose firm 1 has information
 - 3 groups of segments, from left to right
 - 1st group: firm 1 acts as a constrained monopolist
 - 2nd group: both firms have positive demand
 - 3rd group: firm 2 acts as a constrained monopolist
 - Differences with case where they both have information
 - 1st group is larger
 - Only firm 1 poaches consumers in 2nd group
 - Illustration with $k = 3$ (8 segments)



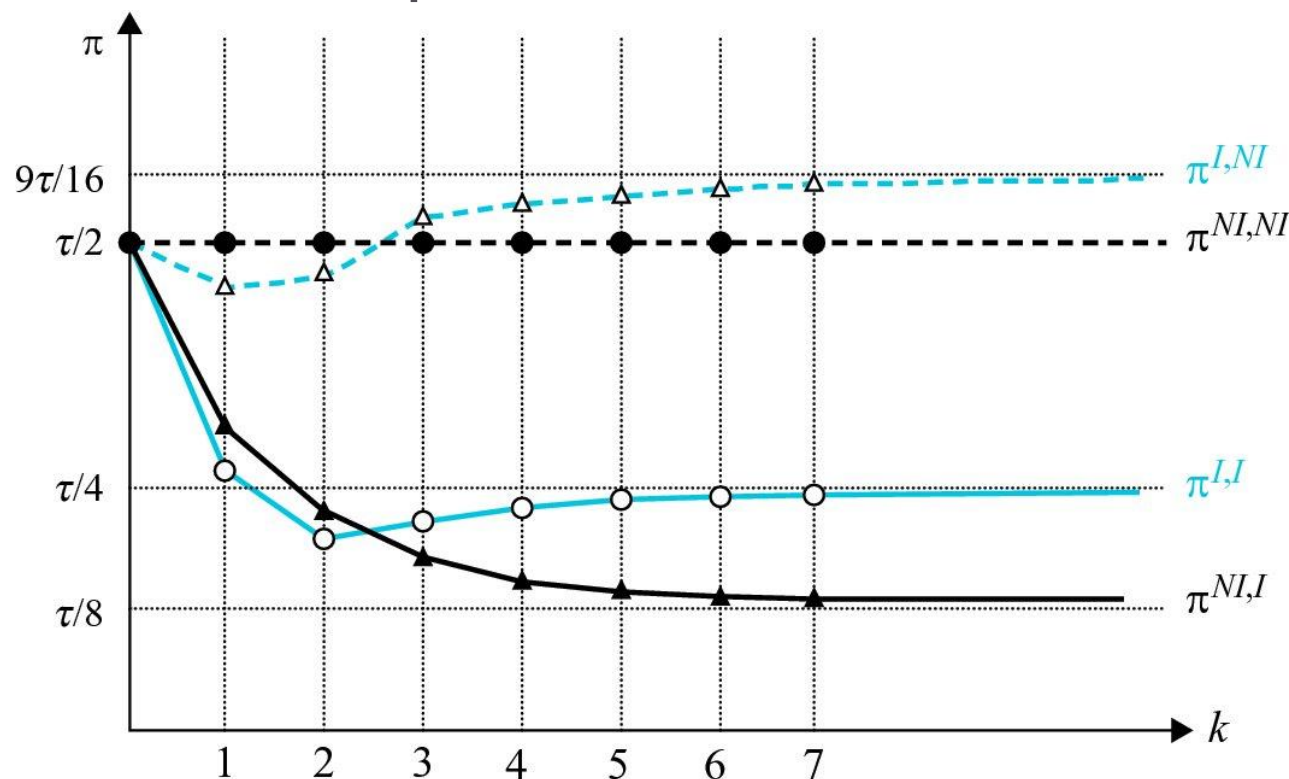
Group pricing and localized competition (cont'd)

- Only one firm acquires information (cont'd)
 - We can compute $\pi^{I,NI}(k)$ and $\pi^{NI,I}(k)$
 - Profits of informed firm are U-shaped
 - Same 2 effects as before
 - But, eventually, $\pi^{I,NI}(k) > \pi^{NI,NI}(k)$
 - Profits of uninformed firm $\downarrow$ with quality of information
- Information acquisition decision (stage 1)

	NI	I
NI	π^{NI}, π^{NI}	π^{NI}, π^I
I	π^I, π^{NI}	π^I, π^I

Group pricing and localized competition (cont'd)

- Information acquisition decision (cont'd)



- $k < 3 \rightarrow NI$ is a dominant strategy
- $k \geq 3 \rightarrow I$ is a dominant strategy $\rightarrow$ prisoner's dilemma

Group pricing and localized competition (cont'd)

- **Lesson:** In a competitive setting, customer-specific information impacts firms in 2 conflicting ways:
 - firms can extract more surplus from each consumer;
 - price competition is exacerbated.

When the quality of information is sufficiently large, the former effect dominates the latter. Then, firms use the information and price discriminate at equilibrium.

However, they may well be better off if they could jointly agree not to use information.

Personalized pricing and location decisions

- Two-stage game
 - Firms choose their location on the Hotelling line.
 - Firms compete with personalized prices (i.e., there is Bertrand competition in each and every location)
- Equilibrium
 - Price schedules at stage 2:
 - Firm with the lowest cost prevails → price = other firm's MC
 - Otherwise, price = firm's own MC

$$p_1^*(x) = p_2^*(x) = \max \left\{ \tau |x - l_1|, \tau |x - l_2| \right\}$$

- → π_1 = (total transportation cost of firm 2 as a monopolist) – (total transportation cost of the two firms together)

Personalized pricing and location decisions (cont'd)

- Equilibrium (cont'd)
 - Location at stage 1
 - To maximize profits, a firm must choose a location generating the largest decrease in total transportation costs.
 - → no deviation if both firms locate at the transportation cost minimizing points:

$$l_1^* = 1/4, l_2^* = 3/4$$

- **Lesson:** When both firms set personalized prices and locations are endogenous, firms choose the socially optimal locations.

Group pricing in monopoly: basic argument

- Extension of multi-product monopoly (see Chapter 2)
 - Monopolist can sell its product on k separate markets
 - $Q_i(p_i)$: distinct demand curve for market i
 - $C(q)$: monopolist's total cost (q : total quantity)
 - Monopolist chooses vector of prices to maximize

$$\Pi(p_1, p_2, \dots, p_k) = \sum_{i=1}^k p_i Q_i(p_i) - C\left(\sum_{i=1}^k Q_i(p_i)\right)$$

- For any i , markup is given by inverse elasticity rule:

$$\frac{p_i - C'(q)}{p_i} = \frac{1}{\eta_i} \rightarrow \text{if } \eta_i > \eta_j, \text{ then } p_i < p_j$$

- **Lesson:** A monopolist optimally charges less in market segments with a higher elasticity of demand.

Worked example: group pricing

- **Parameters.** Two markets with constant-elasticity demands, $Q_1 = p_1^{-2}$ and $Q_2 = p_2^{-4}$, and marginal cost $c = 1$.
- **Step 1. Inverse elasticity rule** in each market, $\frac{p_i - c}{p_i} = \frac{1}{\eta_i}$:

$$\frac{p_1 - 1}{p_1} = \frac{1}{2} \Rightarrow p_1 = 2$$

$$\frac{p_2 - 1}{p_2} = \frac{1}{4} \Rightarrow p_2 = \frac{4}{3} \approx 1.33$$

- The price is lower in market 2, where demand is more elastic.
 - This is the textbook case below: demand is less elastic in the US, so prices are higher there.



Case. International price discrimination in the textbook market (Cabolis *et al.*, 2006)

- Differences in book prices, US vs. elsewhere
 - No difference for general audience books
 - Textbooks substantially more expensive in the US
- Why?
 - No cost factor (most textbooks are printed in the US)
 - → must be due to different demand elasticities
 - Demand less elastic in the U.S. because teachers require a single comprehensive textbook per course (not so much the tradition in European universities)
 - Arbitrage is prevented: *“International edition. Not for sale in the US”*

Oligopolistic international pricing

- Effects of competition?
 - Geographical price discrimination exists in oligopolistic industries (e.g., car industry; [see Case 8.4](#))
 - **But**, strategic motives may lead firms to set a uniform price on all geographical segments.
 - Why?
 - Suppose firm active on several market segments.
 - Some segments are more competitive than others.
 - Commitment to set same price everywhere → price ↑ on competitive market segments → softened price competition → profits ↑ on these segments.
 - May outweigh benefit of adapting prices to local conditions.
 - ([Model in the next slides](#))

Oligopolistic international pricing (cont'd)

- 2 retailers, A and B

Market 1
Monopoly for A

Market 2
Monopoly for B

Market 3
Duopoly for A and B

Oligopolistic international pricing (cont'd)

- **Demand in markets 1 and 2** (monopoly markets): $p_i = \alpha - q_i$, with $\alpha < 1$.

- **Demand in market 3** (duopoly). Inverse demands are

$$p_{A3} = 1 - q_{A3} - \frac{1}{2}q_{B3} \quad \text{and} \quad p_{B3} = 1 - q_{B3} - \frac{1}{2}q_{A3}$$

- Solving this system for the quantities,

$$q_{A3} = \frac{2}{3}(1 - 2p_{A3} + p_{B3}) \quad \text{and} \quad q_{B3} = \frac{2}{3}(1 - 2p_{B3} + p_{A3})$$

- Market 3 is more competitive: a smaller α means that the home markets are relatively smaller.

Oligopolistic international pricing (cont'd)

- Time structure
 - I. Every firm i chooses whether to charge different/ local ($p_i \neq p_{i3}$) or uniform prices ($p_i = p_{i3}$).
 - II. Firms compete in prices

- Subgames
 1. Subgame 1, (L, L)
 2. Subgame 2, (U, U)
 3. Subgame 3, (L, U)
 4. Subgame 4, (U, L)

Oligopolistic international pricing (cont'd)

- **Subgame 1, (L, L) : both firms set local prices.** Each market is solved separately.
- **Step 1. Home market.** $\max_{p_i} (\alpha - p_i)p_i$ gives $p_i = \frac{\alpha}{2}$ and profit $\frac{\alpha^2}{4}$.
- **Step 2. Market 3.** $\max_{p_{i3}} \frac{2}{3}(1 - 2p_{i3} + p_{j3})p_{i3}$ gives $1 - 4p_{i3} + p_{j3} = 0$, so

$$p_{i3}(p_{j3}) = \frac{1}{4} + \frac{1}{4}p_{j3} \quad \Rightarrow \quad p_{i3}^{L,L} = \frac{1}{3}, \quad q_{i3} = \frac{4}{9}$$

- **Step 3. Profit.**

$$\pi^{L,L} = \frac{\alpha^2}{4} + \frac{1}{3} \times \frac{4}{9} = \frac{\alpha^2}{4} + \frac{4}{27}$$

Oligopolistic international pricing (cont'd)

- **Subgame 2, (U, U) : both firms set a uniform price p_i in their home market and in market 3:**

$$\max_{p_i} (\alpha - p_i)p_i + \frac{2}{3}(1 - 2p_i + p_j)p_i$$

- **Step 1. Best response.** The FOC is $\alpha - 2p_i + \frac{2}{3}(1 - 4p_i + p_j) = 0$, so

$$p_i(p_j) = \frac{2 + 3\alpha}{14} + \frac{1}{7}p_j$$

- **Step 2. Symmetric equilibrium.** Setting $p_i = p_j$,

$$p^{U,U} = \frac{\alpha}{4} + \frac{1}{6} \quad \text{and} \quad \pi^{U,U} = \frac{7(2 + 3\alpha)^2}{432}$$

Oligopolistic international pricing (cont'd)

- **Subgames 3 and 4, (L, U) or (U, L) .** Firm i sets local prices; firm j sets a uniform price.
 - Firm i : $p_i = \frac{\alpha}{2}$ at home and $p_{i3}(p_j) = \frac{1}{4} + \frac{1}{4}p_j$ in market 3 (as in subgame 1).
 - Firm j : $p_j(p_{i3}) = \frac{2+3\alpha}{14} + \frac{1}{7}p_{i3}$ (as in subgame 2).
- Solving the two best responses simultaneously,

$$p_{i3}^{L,U} = \frac{\alpha}{18} + \frac{8}{27} \quad \text{and} \quad p_j^{L,U} = \frac{2\alpha}{9} + \frac{5}{27}$$

$$\pi_i^{L,U} = \frac{\alpha^2}{4} + \frac{(16 + 3\alpha)^2}{2187} \quad \text{and} \quad \pi_j^{L,U} = \frac{7(5 + 6\alpha)^2}{2187}$$

Oligopolistic international pricing (cont'd)

- Stage 1: choice of pricing regime.** Comparing each firm's payoff given its rival's choice:

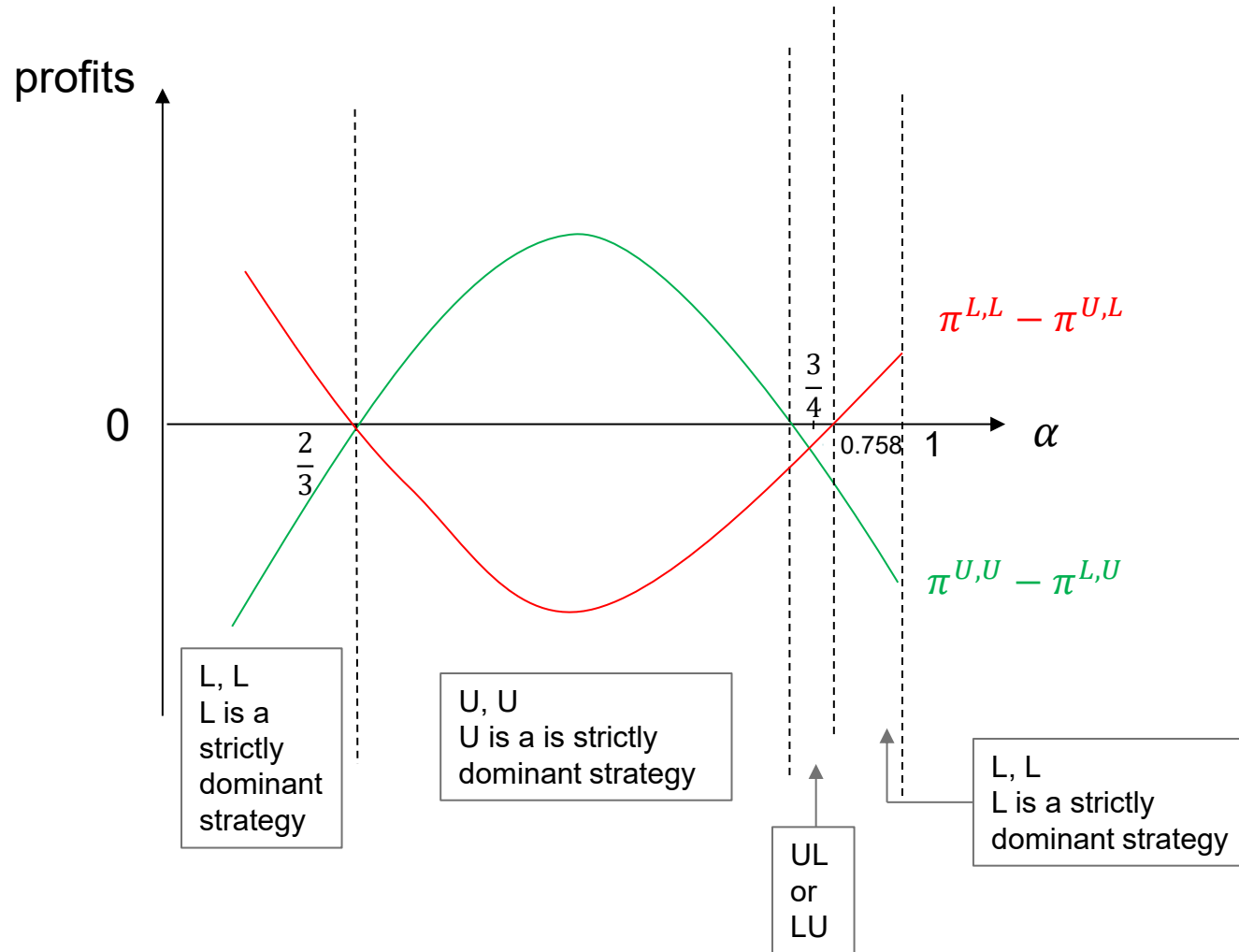
$$\pi^{L,L} - \pi^{U,L} = \frac{(3\alpha - 2)(393\alpha - 298)}{8748} \quad (\text{rival plays } L)$$

$$\pi^{L,U} - \pi^{U,U} = \frac{(3\alpha - 2)(1263\alpha - 914)}{34992} \quad (\text{rival plays } U)$$

- The figure on the next slide labels the second threshold as $3/4$; its exact value is $\frac{914}{1263} \approx 0.724$.

α	Equilibrium
$\alpha < 2/3$	L is dominant: (L, L)
$2/3 < \alpha < 0.724$	U is dominant: (U, U)
$0.724 < \alpha < 0.758$	Asymmetric: (L, U) or (U, L)
$\alpha > 0.758$	L is dominant: (L, L)

Oligopolistic international pricing (cont'd)



Worked example: international pricing

- **Payoffs** (row firm's profit; the game is symmetric):

	$\alpha = 0.7$: vs. L	$\alpha = 0.7$: vs. U	$\alpha = 0.9$: vs. L	$\alpha = 0.9$: vs. U
Play L	0.2706	0.2723	0.3506	0.3624
Play U	0.2709	0.2724	0.3462	0.3579

- **Result:** With $\alpha = 0.7$, U is dominant and firms commit to uniform prices, which softens competition in market 3. With $\alpha = 0.9$, L is dominant, yet both firms would earn more under (U, U): $0.3579 > 0.3506$, a prisoners' dilemma.

Case. Pricing by supermarkets in the UK

- Inquiry of UK Competition Commission
 - April 1999 to July 2000
- Among 15 leading supermarket groups
 - 8 priced uniformly
 - 7 adjusted prices to local conditions
 - For a limited number of products
 - Average level of difference between minimum and maximum prices for each product: 4.3 to 19.2%

TESCO

Sainsbury's

YOUR M&S

Costcutter

co op

ALDI UK

Waitrose.com

Iceland.co.uk

GREGGS

BUDGENS

ASDA

LONDIS

SPAR

Review questions

- In which industries do we observe group pricing? Provide two examples.
- Does an increase in competition lead to more or less (third-degree) price discrimination? Discuss.
- How does the ability to geographically price discriminate affect location decisions of firms?
- What is an empirical regularity concerning international price discrimination?