Lecture 15
Game Theory III: Price competition and collusion

MITSloan
MANAGEMENT

15.011/0111 Economic Analysis for Business Decisions
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Competition among few: Oligopoly

Two types of market (types of product)

- <u>Homogeneous goods</u>: Consumers cannot distinguish among "brands." Examples: Salt, Farmers' market where all corn look the same!
- <u>Differentiated goods</u>: Brands matter to consumers due to advertising, quality differences, or just snob effects. Example: Nike vs. Adidas shoes.

All Corn looks the same

vs

Price versus quantity (capacity) competition

Economists model two types of market competition

- Price competition: Sellers set prices (simultaneously or sequentially)

- Quantity (capacity) competition: Sellers set quantities or build inventories (simultaneously or sequentially)

  - Agenda for today: Price competition
  - Next class: Quantity (capacity) competition

Single-stage (one-shot) price game

Firm 2

a_1 / a_2	Low Price (L)		High Price (H)	
Low Price (L)	100	100	700	0
High Price (H)	0	700	200	200

Firm 1

$$BR_1(a_2) = \begin{cases} L & \text{if } a_2 = L \\ L & \text{if } a_2 = H \end{cases} \qquad BR_2(a_1) = \begin{cases} L & \text{if } a_1 = L \\ L & \text{if } a_1 = H \end{cases}$$

(*L*, *L*) is both a Nash equilibrium and an equilibrium in dominant actions. Note that the outcome (*L*, *L*) is Pareto dominated by outcome (*H*, *H*) [Prisoner's Dilemma game]

Consumers are "happy" (pay low prices)
Shareholders are "not happy" (firms earn low profits)

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Price (Bertrand) competition in <u>homogeneous</u> goods with downward sloping demand (equal MC case)

- Suppose there are no fixed costs (only variable costs)
- If both firms charge the same price, they split the market equally
- Because consumers cannot distinguish among brands, they will buy the lowest-priced brand
- Hence, firms will undercut each other's' price to grab the entire market ($70 to $50...)
- Under equal MC, the game ends where each firm prices at marginal cost (P = $40 = MC, $q_1=q_2=3,000$, both firms earn $0)

$$P = 100 - \frac{1}{100}Q$$
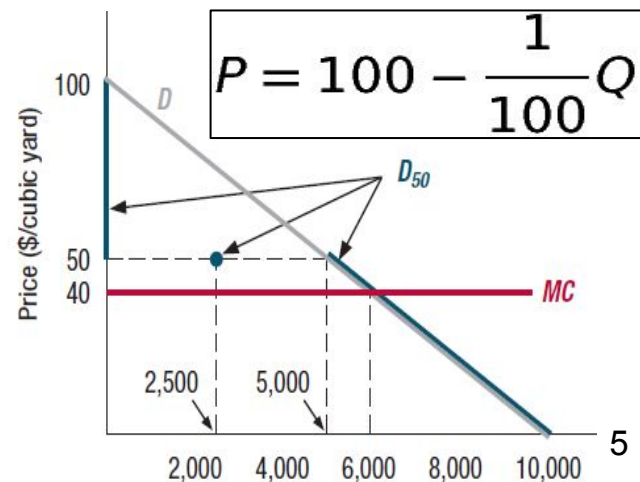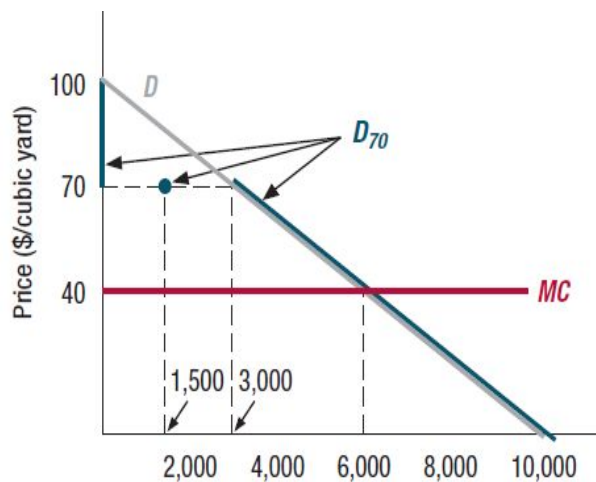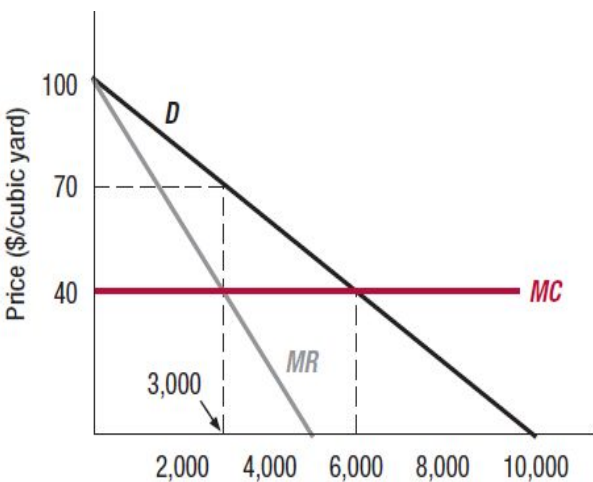
Price (Bertrand) competition in <u>homogeneous</u> goods: Best response (reaction) functions

$p_1 = BR_1(p_2)$ = Firm 1's profit maximizing price for any given p_2
$p_2 = BR_2(p_1)$ = Firm 2's profit maximizing price for any given p_1
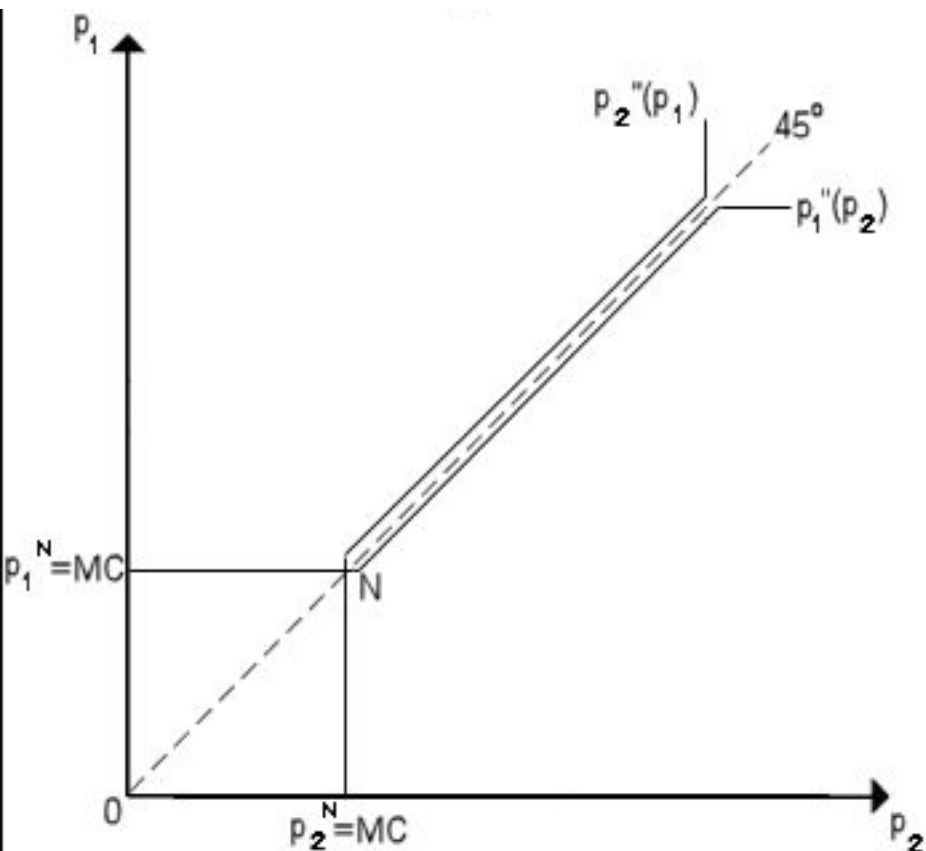
Suppose $p_1 < p^m$ and $p_2 < p^m$ (both firms price below the monopoly price, p^m). Then, $BR_1(p_2) = p_2 - \mathcal{E}$ and $BR_2(p_1) = p_1 - \mathcal{E}$, where $\mathcal{E}$ is a 'small' number or the minimum unit of account (1¢)

That is, firms undercut each other's price to grab the entire market until p=MC

$p_1 = BR_1(p_2)$ = Firm 1's profit maximizing price for any given p_2
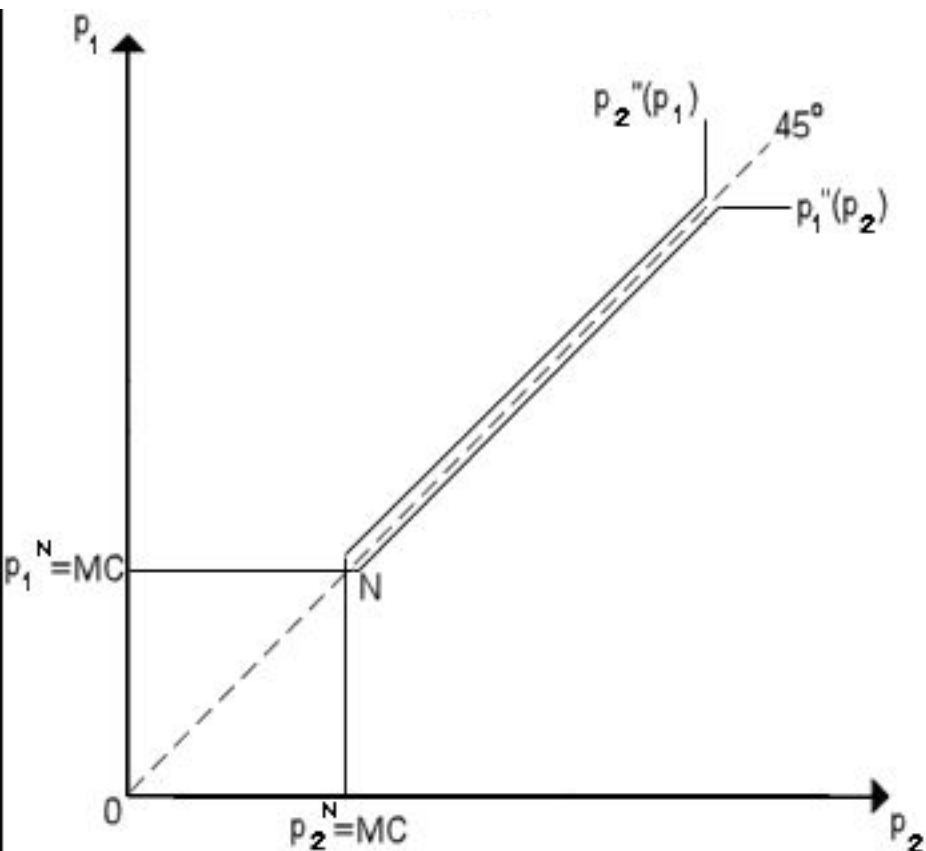$p_2 = BR_2(p_1)$ = Firm 2's profit maximizing price for any given p_1
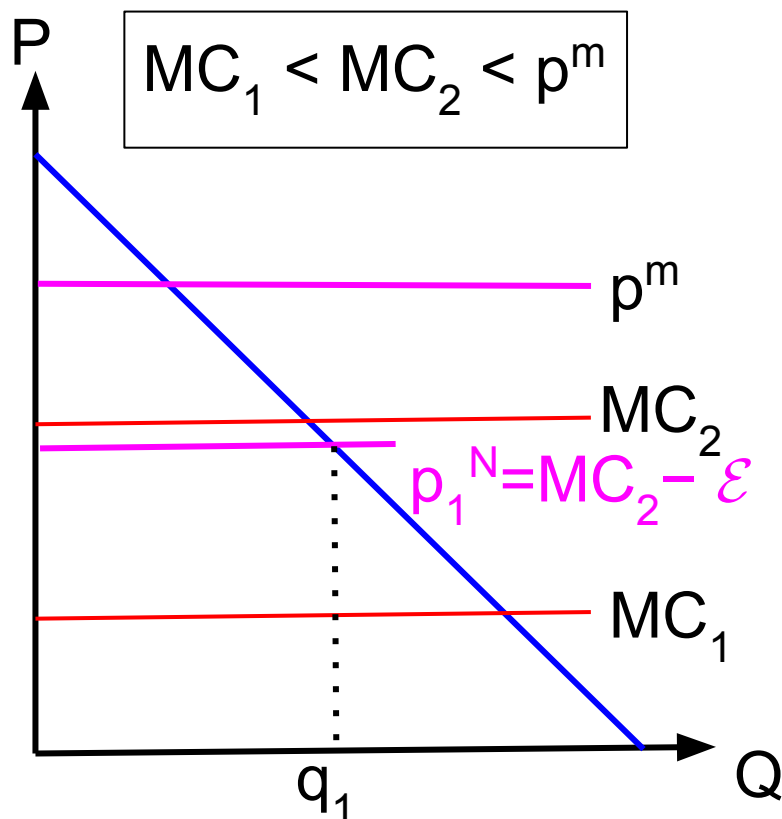

<u>Remark</u>: Price game generate upward-sloping best response functions

Upward-sloping best-response functions are called 'strategic complements'

Why? Because if one firm raises (lowers) its price, the other firm will respond with a higher (lower) price

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Firm 1 uses its cost advantage to price undercut just below firm 2's marginal cost

Firm 1 uses its significant cost advantage to undercut firm 2 by setting the monopoly price

$$MC_1 < MC_2 < p^m$$

p^m

MC_2

$p_1^N = MC_2 - \mathcal{E}$

MC_1

q_1

$$MC_1 < p^m < MC_2$$

MC_2

$p_1^N = p^m$

MC_1

q_1

8
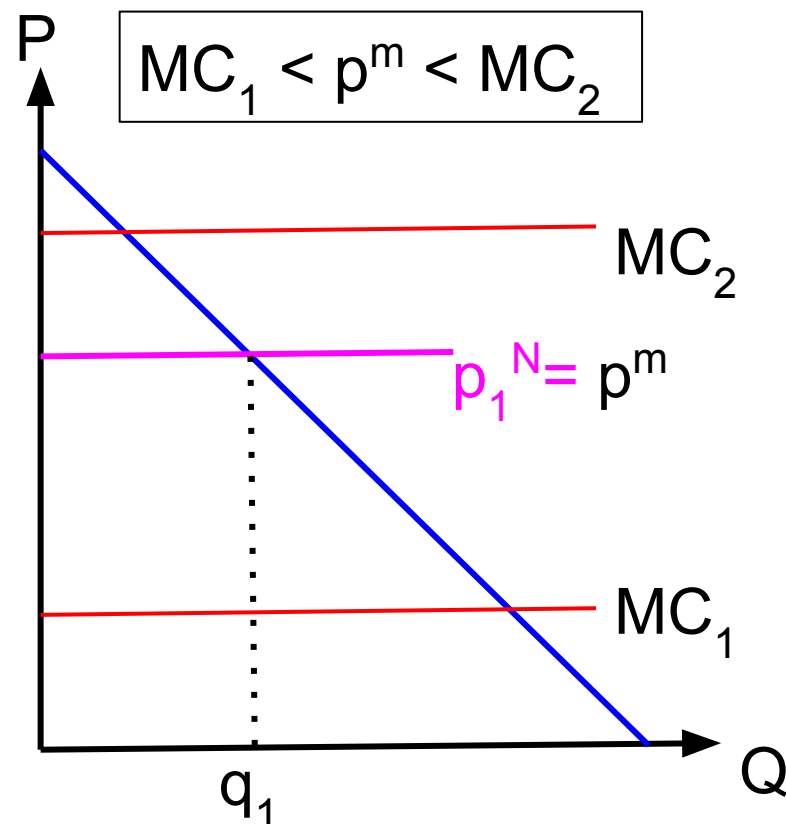
Price (Bertrand) competition in <u>homogeneous</u> goods: Second-mover advantage

Firm 2 uses its second-mover advantage to undercut firm 1's price by setting its price at: $p_2 = p_1 - \varepsilon$

P

p_1

$p_2 = p_1 - \varepsilon$

MC

q_2

Q
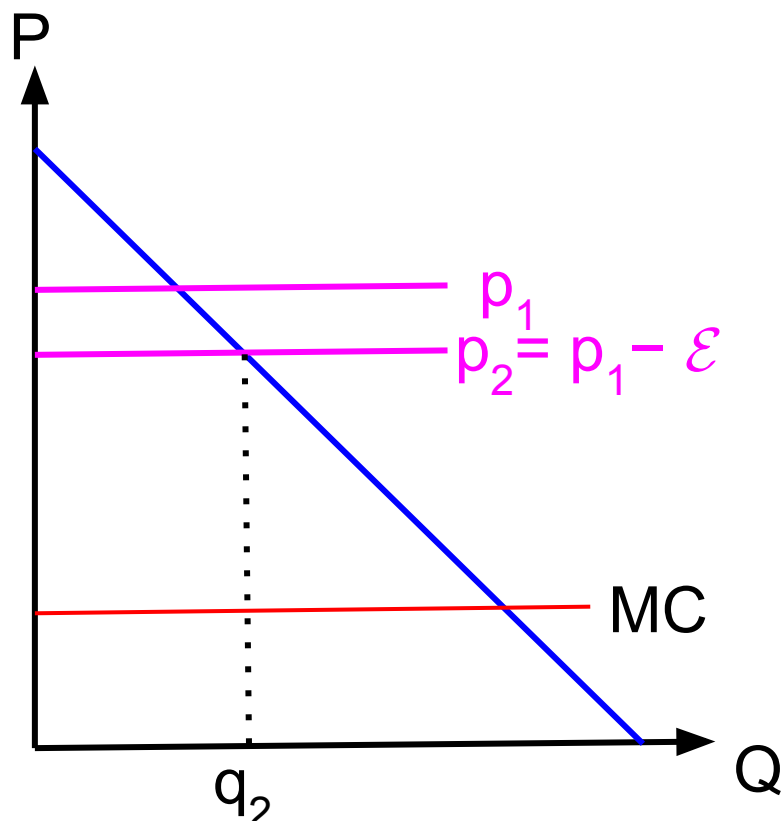
Online sellers could be viewed as having a second-mover advantage as they can readjust their prices after observing prices in brick-and-mortar stores

(Dell vs. HP)

Price and capacity collusion (cartels)

Cartel pricing: Highest possible joint industry profit is achieved when both firms set the monopoly price $p^{collusion} = p^m$

Assuming firms sell equal quantity: Profits are: $\pi_1 = \pi_2 = \dfrac{\Pi^m}{2}$

Capacity cartel: Firms agree to limit their production levels so that $q_1 + q_2 = Q^m$ (OPEC countries set production quotas)
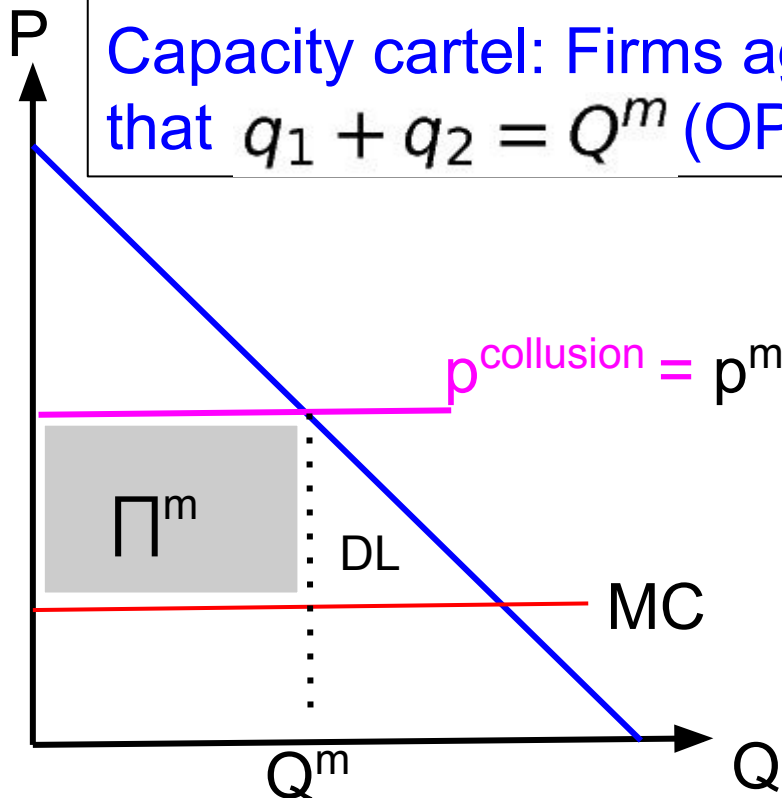
Cartels are <u>unstable</u> because:
1. Homogenous products are hard to monitor (oil looks the same)
2. Secret price cuts and output expansion
3. Price fixing is illegal (create deadweight loss)

P

$p^{collusion} = p^m$

Π^m

DL

MC

Q^m

Q

Price and capacity collusion (cartels): Elements for "success"
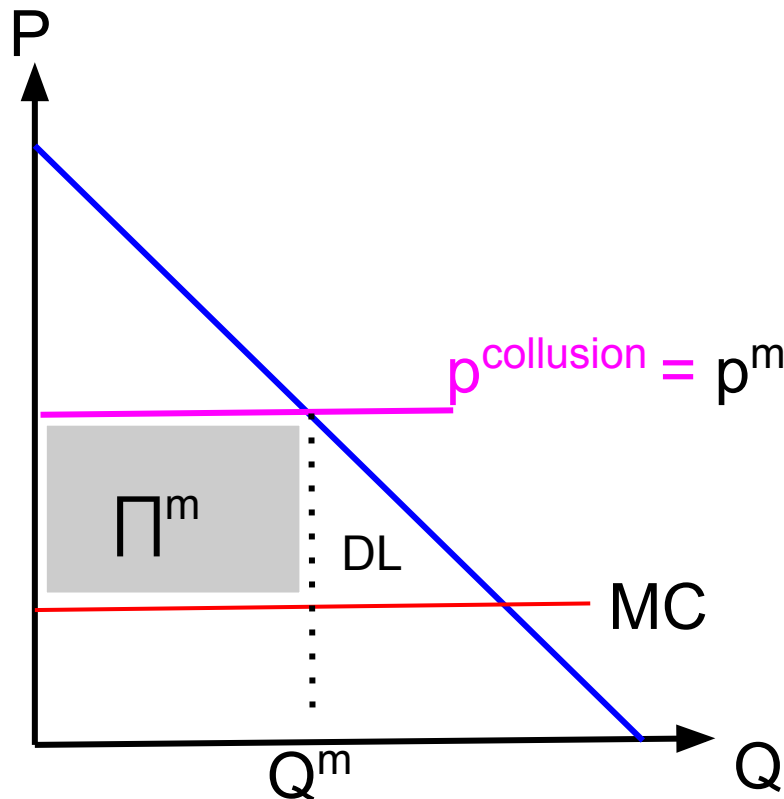
1. Fewer players in the market (easier to monitor)

2. Transparent pricing

3. Less elastic demand (higher benefits from raising price)

4. No legal impediments (collusion in international markets) [play FBI recordings]

Price fixing: The great electrical consipiracy

- In 1962, GE published the price book, lowered book prices significantly
- Prices calculated by multiplying book price by a standard multiplier, set at 0.76, which the designated firm 'chose' according to the phase of the moon
- Announced: GE will sell to all customers at this published price without exception!

St. Petersburg Times

Florida's Best Newspaper

Rain—Maybe
Partly cloudy with afternoon and evening thundershowers over 30 per cent of the area. Easterly winds 5-15 m.p.h. High near 90. Low near 70. Details Page 2-A.

Vol. 82—No. 39   46 PAGES   ST. PETERSBURG, FLORIDA, WEDNESDAY, SEPTEMBER 1, 1965

ANTI-TRUST DECISION

GE, Westinghouse Fined $16.9-Million

Price-Fixing Ruled By Judge

Multi-stage (repeated) price game

Suppose that the single-shot game is repeated each period. There are two types of game (differ by duration of the game):

● Finitely-repeated games: Example, the game is repeated 1000 times
Will not induce cooperation because the last period is a single-shot game. Then, work it backwards

● Infinitely-repeated games: Players behave as if they don't know when the repeated game will end
Here, if players care about the future (don't discount future earnings very heavily), cooperation (collusion) may be sustainable.

Firm 2

a_1 / a_2	Low Price (L)		High Price (H)	
Firm 1 **Low Price (L)**	100	100	700	0
High Price (H)	0	700	200	200

Grim strategy (a.k.a. trigger strategy) for Firm 1 (similarly firm 2):

(a) I will charge a high price c as long as all players (including myself) charged H price.

(b) If any player has deviated, I will set P_1 = L price forever! No forgiveness!!!

If all firms price H, each earns \$200/period. If firm 1 deviates, it earns \$700 for one period and \$100 thereafter. If future earnings matter, firm 1 won't benefit from deviation.

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Infinitely-repeated game and the grim strategy (profits under collusion)

Firm 2

a_1 / a_2	Low Price (L)		High Price (H)	
Firm 1 Low Price (L)	100	100	700	0
High Price (H)	0	700	200	200

$200 \quad $200 \quad $200 \quad $200 \quad $200

```
|----+----+----+----+----+----------> t
0    1    2    3    4
```
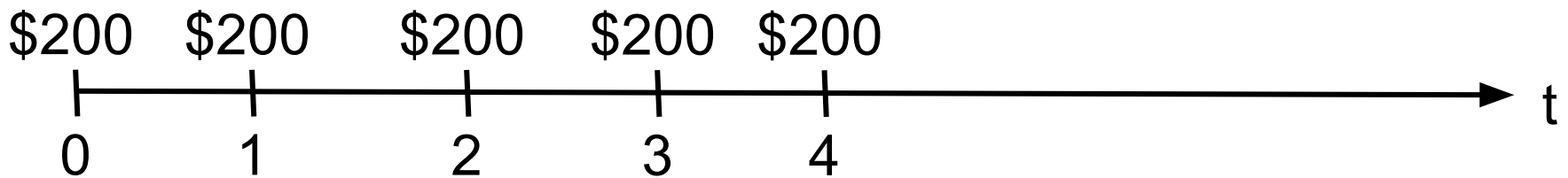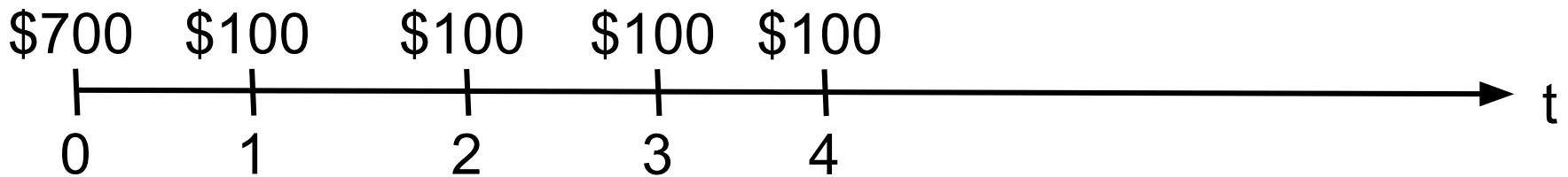
If both firms tacitly collude on setting $P_1 = P_2 = H$, the present value of the discounted stream of profits earned by *each* firm is:

$$\pi_1^c = \pi_2^c = 200 + \frac{200}{r} \quad (r = \text{interest rate}, c \text{ denotes 'collusion'})$$

Infinitely-repeated game and the grim strategy (firm 1 deviates at t = 0)

Firm 2

a_1 / a_2	Low Price (L)		High Price (H)	
Firm 1 Low Price (L)	100	100	700	0
High Price (H)	0	700	200	200

$700 $100 $100 $100 $100

```
|        |          |          |      |                    → t
0        1          2          3      4
```

If firm 1 deviates and sets p1=H in t=0. Hence, starting t =1 both firms 'retaliate' by P$_1$ =P$_2$ = L. The PV of firm 1's profit becomes:

$$\pi_1^d = 700 + \frac{100}{r}$$ (*r* = interest rate, *d* denotes 'deviation')

Infinitely-repeated game and the grim strategy (should firm 1 deviate from the collusive outcome at t=0?)

If $\quad \pi_1^d = 700 + \dfrac{100}{r}\quad$ is larger than $\quad \pi_1^c = \pi_2^c = 200 + \dfrac{200}{r}$

$$r = 0.1 \Rightarrow \pi_1^d = 700 + \frac{100}{0.1} = \$1,700 < \$2,000 = 200 + \frac{200}{0.1} = \pi_1^c$$

Low interest rate: Firms care more about future profits (current profit become less important) Hence, tacit collusion is maintained

$$r = 0.4 \Rightarrow \pi_1^d = 700 + \frac{100}{0.4} = \$950 > \$700 = 200 + \frac{200}{0.4} = \pi_1^c$$

High interest rate: Firms care less about future profits (current profit become more important) Hence, firm 1 deviates to L

Tit-for-Tat strategy in multistage games

Target has announced that they will offer Price Match Guarantees to select online competitors this Holiday Season!

- Each firm announces: I will set H today if you set H yesterday
- Each firm announces: I will set L today if you set L yesterday
- Hence, unlike the Grim Strategy, there is room for forgiveness

Firm 2

Firm 1	a_1 / a_2	Low Price (L)		High Price (H)	
	Low Price (L)	100	100	700	0
	High Price (H)	0	700	200	200

Tit-for-Tat strategy in multistage games: Example of how firm 1 responds to firm 2 (with a one-period lag)
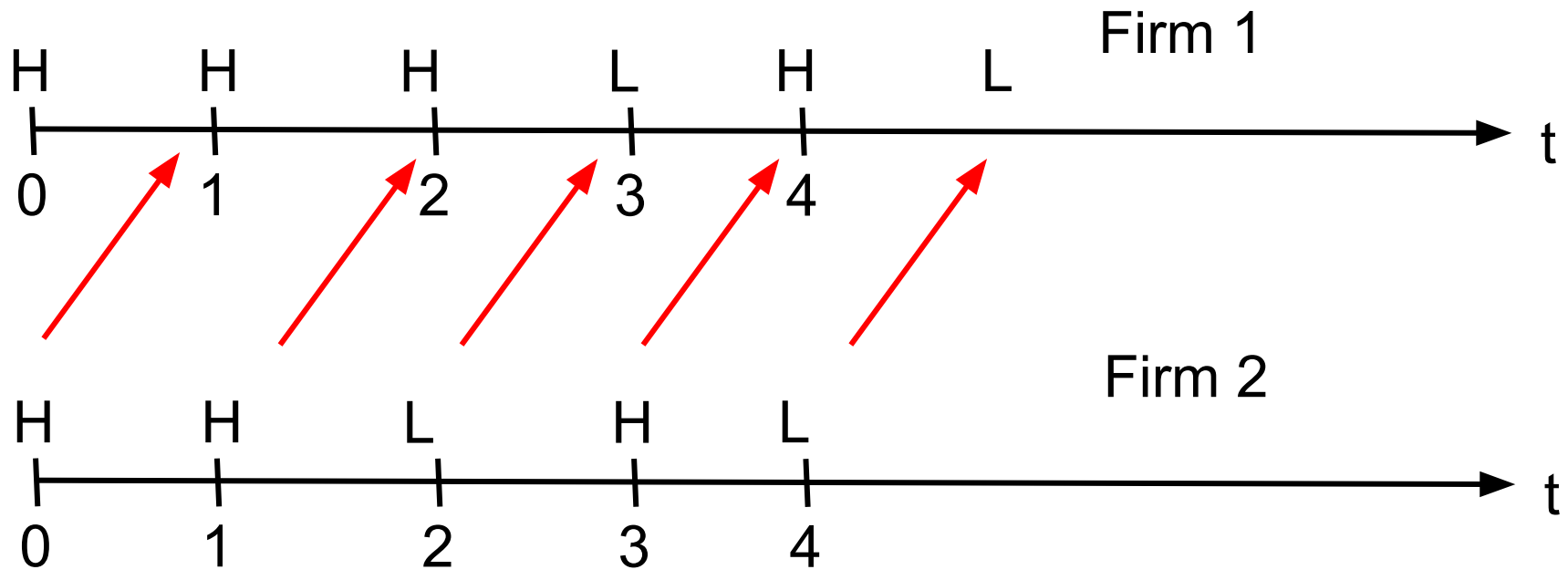
Antitrust Law

Two types of court ruling (judgements):

- <u>Per-se illegal</u>: To convict, we only need to prove that it occurred (example: Price fixing)

- <u>Rule of reason</u>: The court will also need to consider the intent of the business behavior and its effects on competition and welfare

Antitrust Law: The Sherman Act of 1890

Intended to strike against cartels, horizontal mergers of monopolistic nature, and predatory business activities.

Section 1 (abuse of collaborations):

"*Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce...is hereby declared illegal*."

Section 2 (Abuse of market power):

"*Every person who shall monopolize, or attempt to monopolize, or combine, or conspire to monopolize any part of the trade...*"

Note: Both sections are concerned with reduced competition

European equivalent: Article 82 (EC Treaty)

Antitrust Law: The Clayton Act and the Federal Trade Commission Act of 1914

Clayton Act: Section 7 (Mergers and Acquisitions):

"*No person engaged in commerce...shall acquire directly or indirectly...where the effect may be substantially to lessen competition, or tend to create a monopoly*."

Other issues in this Act: More refined legislation: Price discrimination, exclusive dealing, tying, bundling, that may lead to reduced competition were declared illegal

FTC Act: Section 7 (Prohibition of unfair and deceptive practices):

"*...unfair methods of competition in or affecting commerce, and unfair or deceptive acts or practices in or affecting commerce*."
This Act allows the FTC to challenge these practices

Antitrust Law: Other potential violations to be discussed in class

- Allocation of markets or customers
  (Often a consequence of price-fixing)

- Refusal to deal (often with a seller who may reduce the price)

- Resale price maintenance (RPM)
  (often via a 'recommended price')

- Exclusive dealers and territorial restrictions
  (often observed in international trade)

- Tying and bundling

- Predatory pricing

Antitrust Law: Mergers

Three types (type of merging firms):

1. Horizontal: Producing/selling in the same market
Example: Delta and Northwest

2. Vertical: Honda buys Takata (airbag producer)

3. Conglomerate (unrelated): Amazon buys the Washington Post

"Care for a merger?"

Horizontal mergers in the news

Beer giants AB InBev and SABMiller agree mega-merger

11 November 2015 | Business

Anheuser-Busch InBev - 20.8%, SABMiller - 9.7%
Heineken - 9.1%, Carlsberg - 6.1%
China Resources Enterprise - 6%

Anheuser-Busch InBev has agreed the terms of its £71bn takeover of rival SABMiller, in a deal that will combine the world's two largest beer makers.

AB InBev, the maker of Budweiser, will pay £44 for each share in SABMiller, the price it offered on 13 October.

To clear the way for the takeover, SABMiller is to sell its 58% stake in its US joint venture MillerCoors.

Antitrust Law: Horizontal mergers

- For this discussion, we don't distinguish between friendly mergers and hostile takeovers

- Horizontal mergers are more likely to reduce competition and increase prices
- Market definition matters to determine the effects on competition and future prices (e.g. geography)
- Firms generally petition with the FTC or Justice Dept. (JD) before they merge
- Guidelines make use of the Herfindahl-Hirschman Index (HHI)

Antitrust Law: Horizontal mergers

Let there be *N* firms. s_i is the market share (%) of firm i, so that: $\sum_{i=1}^{N} s_i = 100\%$ Then, $$\text{HHI} = \sum_{i=1}^{N} (s_i)^2$$

Example:

Country	Firms						Concentration Index	
	1	2	3	4	5	6	I_4	I_{HH}
Albania	40%	15%	15%	15%	15%	0%	85	2500
Bolivia	45%	11%	11%	11%	11%	11%	78	2630

The 4-largest firms' market share vs. the HHI:

$$I_4^A = 40 + 15 + 15 + 15 = 85 > 78 = 45 + 11 + 11 + 11 = I_4^B.$$

$$I_{HH}^A = 40^2 + 4 \cdot 15^2 = 2500 < 2630 = 45^2 + 5 \cdot 11^2 = I_{HH}^B.$$

Horizontal merger guidelines (FTC & DOJ)

DOJ is concerned with post-merger HHI and the change in HHI due to the proposed merger: Δ HHI

- Unconcentrated Markets: HHI below 1500
- Moderately Concentrated Markets: HHI betw 1500 and 2500
- Highly Concentrated Markets: HHI above 2500
- Mergers with Δ HHI < 100 less likely to be challenged

See the FTC & DOJ's recommendations online: http://www.justice.gov/atr/horizontal-merger-guidelines-08192010#5c