

## Lecture 11

Oligopoly – part III



microeconomics II  
first module

### Before we begin...

- ★ Test
- ★ Homework 4 available – due next Monday
- ★ **Voice recordings** in the lecture are **prohibited**
  - ◆ Disincentive to keep notes
  - ◆ Distributed to people who do not come
  - ◆ This is not a distance course
  - ◆ Photos or videos are allowed

### Competition in prices

Oligopoly

- ★ So far we **assumed** that competition was in **quantities**  
 $q_1$  and  $q_2$  were the **choice variables**
- ★ What if firms compete by setting **prices instead** of quantities?
- ★ There is a **fundamental difference** between price and quantity competition
  - ◆ Any firm has an incentive to want to **sell more** than rivals
  - ◆ Any firm has an incentive to want to **sell for less** than rivals

### Bertrand competition (1883)

Bertrand

Assumptions

1. Two firms produce a **homogeneous good**
2. There is a **positive marginal cost** of production
3. Firms choose **prices simultaneously**

### The Bertrand model

Bertrand

- ★ Two firms with marginal **cost** is  $c$
- ★ Firms face **market demand**  $Q = a - bp$
- ★ **Who** will consumers buy from?  
since good is **homogeneous**, consumers buy from **cheapest** seller

- ★ Then, the **demand for firm 1** will be

$$q_1 = \begin{cases} a - bp_1 & \text{if } p_1 < p_2 \\ (a - bp_1)/2 & \text{if } p_1 = p_2 \\ 0 & \text{if } p_1 > p_2 \end{cases}$$

if firms charge **same price**, consumers are **indifferent** who they buy from

### Bertrand equilibrium

Bertrand

- ★ What is the **NE** in the Bertrand model?  
that is, the combination  $(p_1^*, p_2^*)$  from which no firm has an incentive to deviate alone
- ★ If you charge  $p_1 > c$  your rival will **respond** with  $p_2 < p_1$  will **undercut** you and grab your **entire market share** this way
- ★ If you charge  $p_1 < c$   
you will be **losing money**
- ★ If you charge  $p_1 = c$   
your rival will **follow suit** – neither you or your rival have **any incentive to deviate**
- ★  $p_1^* = p_2^* = c$  is the NE!

## The Bertrand paradox

- ★ In Bertrand, the incentive to cut price leads firms to produce **PC output**

- ★ At NE both firms earn **zero profit**

$$p = c, \quad q_1^* = q_2^* = \frac{a - bc}{2}, \quad \pi_1^* = \pi_2^* = 0$$

- ★ This solution is **paradoxical**

do firms have **market power**?

- ★ The Bertrand model demonstrates the importance of the **strategic variable**

price versus output

## Paradox resolutions

- ★ What is the **source** of this paradox?

a slight difference in price changes the market shares dramatically

- ★ This may **not be the case** under:

- ◆ **Capacity** constraints
- ◆ **Repeated** interaction
- ◆ **Differentiated** products

## Differentiated products

- ★ We will try to **resolve the Bertrand paradox** by lifting the assumption for product homogeneity

- ★ Market shares are now determined not just by prices, but by **differences** in design, performance, or durability of each firm's product

- ★ In markets of differentiated goods it **makes sense** to compete using price instead of quantity

your customers **will not desert** you if you increase the price more than your rival

## Differentiation model

- ★ Firms face **symmetric demand** curves

$$q_1 = a - dp_1 + p_2$$

$$q_2 = a - dp_2 + p_1$$

- ◆  $q_i$  **decreasing** in  $p_i$  but **increasing** in  $p_j$
- ◆ The effect of own-price **dominates** the cross-price effect

- ★ **Marginal cost** for both firms is  $c$

- ★ Firms choose prices **simultaneously**

announced price is **binding** for the firm – cannot take it back

## Bertrand with differentiation – reactions

- ★ **Profit** for the two firms is

$$\Pi_1 = (a - dp_1 + p_2) \cdot p_1 - c \cdot (a - dp_1 + p_2)$$

$$\Pi_2 = (a - dp_2 + p_1) \cdot p_2 - c \cdot (a - dp_2 + p_1)$$

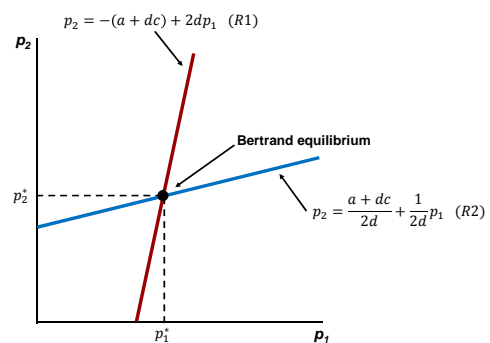
- ★ Each firm  $i = 1, 2$  will **maximize profit** as  $\partial \Pi_i / \partial p_i = 0$ , which yields the **reaction curves** for each firm

$$p_2 = -(a + dc) + 2dp_1 \quad (R1)$$

$$p_2 = \frac{a + dc}{2d} + \frac{1}{2d}p_1 \quad (R2)$$

- Both reaction functions are **positively sloped**
- They both **intersect** at the positive quartile, where  $p_i^* > c$

## NE in prices



## Example

- ★ Firms face **symmetric demand** curves

$$q_1 = 10 - 2p_1 + p_2$$

$$q_2 = 10 - 2p_2 + p_1$$

- ★ Marginal **cost** for both firms is  $c = 1$

- ★ **Reaction functions** are calculate as

$$p_2 = -12 + 4p_1 \text{ (R1)} , \quad p_2 = 3 + \frac{1}{4}p_1 \text{ (R2)}$$

- ★ **Equilibrium** will be

$$p_1^* = p_2^* = 4 , \quad q_1^* = q_2^* = 6 , \quad \Pi_1^* = \Pi_2^* = 18$$

## If firms collude...

- ★ Firms **collude** setting one common price  $p_1 = p_2 = p$

- ★ The two firm demand curves

$$q_1 = 10 - 2p_1 + p_2 \text{ and } q_2 = 10 - 2p_2 + p_1$$

- ★ **collapse into one demand curve**

$$q = 20 - 2p \text{ or } p = 10 - 0.5q$$

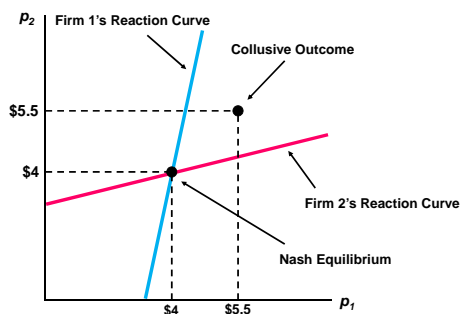
- ★ With  $c = 1$ , **maximization** of profit yields

$$q_1^* = q_2^* = 4.5, \quad p_1^* = p_2^* = 5.5$$

$$\Pi_1^* = \Pi_2^* = 20.25$$

- ★ **Firms benefit** if they collude

## NE in prices



## Sequential Bertrand

- ★ What if firm 1 **sets price first** and then firm 2 makes pricing decision?

- ◆ Firm 1 would be at a **distinct disadvantage** by moving first
- ◆ The firm that moves second has an opportunity to **undercut slightly** and capture a larger market share

## Bertrand model – criticisms

- ★ When firms produce a homogenous good, it is **more natural** (?) to compete by setting quantities rather than prices
- ★ When firms set the same prices, what **share of total sales** will go to each one?  
it may **not** be **equally** divided

## The prospect of collusion

- ★ Collusion **improves** profits for both firms
- ★ Although collusion is **illegal**, why don't firms cooperate without **explicitly** colluding?  
that is, set profit maximizing collusion price and **hope others follow**
- ★ Collusive price is **never on the optimal response curve**, thus, collusion is **never a NE**

## Waiting for the rival

- ★ If you select the collusive price and then **wait for your rival** to do the same
  - ◆ Your rival most likely **will not follow**
  - ◆ Because **has a better response** than following you
  - ◆ Can do better by setting slightly **lower price** and “steal” your market share
- ★ NE is a **non-cooperative equilibrium**  
each firm maximizes profit, **given** actions of competitors.  $\triangleleft$

## Competition vs. collusion

- ★ In our **previous example** with differentiated products:
- ★ The **Bertrand equilibrium** was at  $p = 4$  and the **collusion outcome** was at  $p = 5.5$ 
  - ◆ If both charge 4, they make a **profit** of 18 each
  - ◆ If both charge 5.5 they make a **profit** of 20.25 each
- ★ If **you** charge 5.5 but **your rival** charges 4  
you make profit 13.5 and your rival makes 22.5 !!
- ★ Charging 5.5 and waiting **leaves you “open”** to your rival.  $\triangleleft$

## Collusion – sum up

- ★ Collusion will lead to **greater joint profits**  
explicit or implicit collusion is possible
- ★ Once collusion is established, a **strong motive to break it** arises  
there is a significant incentive for **cheating** by **undercutting**
- ★ Collusion is **not a NE** – it is **unsustainable**.  $\triangleleft$

## Intension of competition

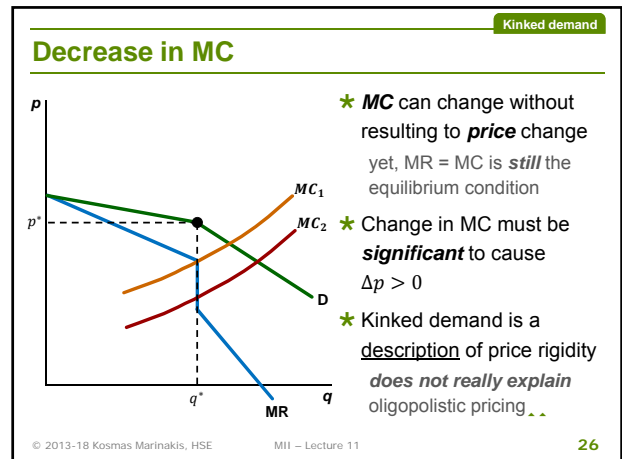
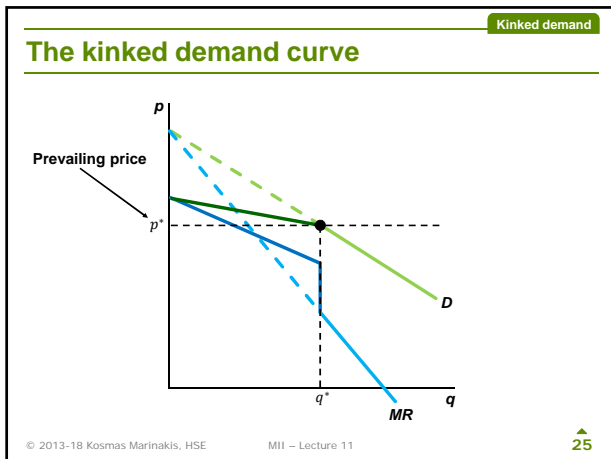
- ★ In some oligopoly markets, pricing behavior **in time** creates a **predictable pricing pattern**  
*implicit collusion* may occur
- ★ In other oligopoly markets, firms are **aggressive** and collusion is **not easy**
  - ◆ This creates **high tension**
  - ◆ A change in price may give the **wrong signal** to rivals
  - ◆ Firms become **reluctant** to lower the price even when this is **economically necessary**
  - ◆ In this case, prices tend to be relatively **rigid**.  $\triangleleft$

## Price rigidity

- ★ Firms have strong **desire for stability**
- ★ Managers might be **worried** that a price cut may send a **signal of price war** to competitors
  - ◆ Even when cost or demand change, managers might be reluctant to **adjust prices downwards**
  - ◆ They **give up** proper profit maximization to **avoid the risk** of causing a price war
- ★ This is an **one-way behavior**, though  
increasing price does not carry a risk of starting a price war – competitors **may or may not follow**.  $\triangleleft$

## Demand under price rigidity

- ★ Each firm faces a demand curve **kinked** at the current **prevailing price,  $p^*$**
- ★ The **response** of rivals to a price change is **asymmetric**
- ★ **Above  $p^*$** , demand is **more elastic**  
if the firm increases price above  $p^*$ , other firms **may not follow**
- ★ **Below  $p^*$** , demand is **less elastic**  
if the firm decreases price below  $p^*$ , other firms **will follow suit**
- ★ With a **kinked demand curve**, marginal revenue curve is **discontinuous**.  $\triangleleft$

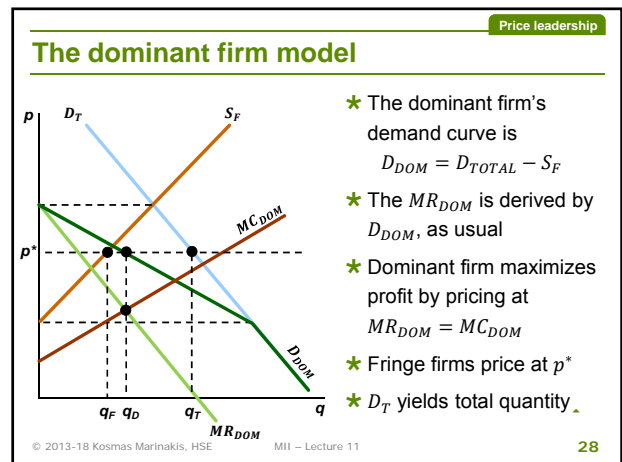


Price leadership

### Price leadership

- \* In many markets there is one firm who is the **undisputable leader** usually because of *size* or *superior skill*
- \* The leader **regularly signals** the price changes and other firms **follow** immediately this can be *implicit* or *explicit* collusion
- \* If the leader serves a **significant portion** of the market, it may want to act as a **dominant firm**
  - ◆ Set the price that **maximizes its own profits**
  - ◆ **Fringe firms** become followers and serve the **residual demand**

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Price leadership

### \*Cartels

- \* A subset of producers, who produce the main mass of quantity for the market, **explicitly agree to collude** in setting prices and output
- \* The cartel, then, acts as a **dominant firm** and those who do not join become the **fringe firms**
- \* The fringe firms **may benefit, too**, from the choices of the cartel if demand is sufficiently inelastic and cartel is **enforceable**, prices may be well **above competitive** levels

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Price leadership

### \*Cartel pricing

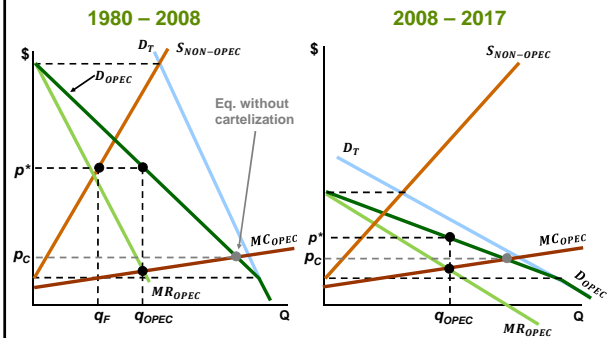
- \* Members of cartel must **take into account** the actions of non-members when making pricing decisions
- \* Examples of **successful** cartels
  - ◆ OPEC, International Bauxite Association, Mercurio Europeo
- \* Examples of **unsuccessful** cartels
  - ◆ CIPEC (Copper), Tin, Coffee, Tea, Cocoa
- \* We will use the **dominant firm model** to analyze OPEC cartel

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## OPEC

- ★ Organization of Petroleum Exporting Countries (OPEC) is an intergovernmental organization that was created in 1960
- ★ **12 members**  
Iraq, Kuwait, Iran, Saudi Arabia, Venezuela, Libya, UAE, Qatar, Algeria, Nigeria, Ecuador, Angola
- ★ Its **mission** is to coordinate the policies of the oil-producing countries

## The OPEC back and now



## \*Cartels – 3 conditions for success

1. **Robust** organization
  - ◆ Members should **follow cartel's policy** without **cheating**
  - ◆ This is **hard** because members have different costs, assessments of demand and objectives
2. **Potential** for market power
  - ◆ Elastic demands offer little room to raise prices
  - ◆ If cartelization offers **large potential gains**, cartel members will have **stronger motive** to make it work
3. **Control** of supply
  - ◆ The cartel must either control a **substantial market share**
  - ◆ Or, the **fringe supply** must not be **too elastic**

Thank you!



Kosmas Marinakis  
www.kmarinakis.org  
kmarinakis@hse.ru

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