

# Collusion

- What we just concluded was that total profits were lower in oligopolies than monopolies.
- This decrease stemmed from an externality.
- That is, a firm maximized its own profit not taking into account the profits of its competitor.
- So firms will attempt to establish agreements to increase their collective market power.
- As we'll see such agreements can result in all firms being better off.
- This type of behavior will be referred to as collusion.

# Collusion

- Cartel agreements are an institutional form of collusion.
- A leading example is OPEC but there are many others.
- More frequently collusion results from secret agreements, mostly because its illegal.
- We will model such agreements with the objective of reducing supply and or increasing prices.
- Though generally, collusion can also refer to advertising expenditures, setting quality standards etc.

# Collusion

- To start we will consider a simple duopoly with homogeneous products and constant marginal costs.
- If firms set prices we know this would correspond to the Bertrand model.
- We also know that in equilibrium firms would set price to marginal cost.
- But if prices are allowed to change over time we would want to model this somehow.
- Suppose time is  $t = 1, 2, \dots$ , and in each period firms simultaneously set prices.
- Firms will play a Bertrand game in each of an infinite series of periods.
- We'll refer to this as a repeated game.

# Collusion

- So we'll be interested in solving for the equilibrium of such games.
- One possible equilibrium is for firms to play Bertrand in each period regardless of the history.
- Specifically, if Firm 1 conjectures Firm 2 will set price to marginal cost in each time period, then Firm 1's optimal response is to do the same.
- But in this setting there will be other equilibria as well.
- For example, consider the following "carrot and stick" strategy:

# Collusion

- In the first period, both firms set monopoly prices and share monopoly profits, each denoted by  $\frac{1}{2}\pi^M$ .
- In the following periods each firm observes the history of prices.
- If historical prices have always been monopoly, then each firm stays the course.
- Otherwise, “send a message”, by setting prices equal to marginal costs in all subsequent periods.
- To show that this indeed is an equilibrium, as before we will show that neither firm has the incentive to unilaterally deviate.
- In the context of repeated games we will have to compute expected discounted payoffs.

# Collusion

- which is

$$\frac{1}{2}\pi^M + \delta\frac{1}{2}\pi^M + \delta^2\frac{1}{2}\pi^M + \dots$$

- where  $\delta$  is a discount factor, since future values are less than present values.
- The above expression is an infinite sum, which simplifies to

$$V = \frac{1}{2}\pi^M \frac{1}{1 - \delta}$$

- Let's compare that to what happens if Firm 1 deviates, by say, undercutting Firm 2 by an arbitrarily small amount in a period.
- It will receive all the monopoly profits in that period but zero profits afterwards.

# Collusion

- So be deviating Firm 1's profits are:

$$V = \pi^M$$

- So for the proposed strategies to form an equilibrium it has to be the case that

$$\frac{1}{2}\pi^M \frac{1}{1-\delta} \geq \pi^M$$

- which is equivalent to

$$\delta > \frac{1}{2}$$

- So the question then becomes what determines  $\delta$ ?
- It is directly related to the interest rate, or the rate of return on some low risk asset.
- If the interest rate is  $r$ , \$ 1 today is worth  $\$(1+r)$  in the next period, so

$$\delta = \frac{1}{1+r}$$