Price Fixing, Collusion, and Cartels

Reference: Pepall, Richards, and Norman, chapter 14

Introduction

- What is a cartel?
    - An association of firms that **reduces competition** by coordinating actions:
        - setting prices
        - allocating market shares
        - creating exclusive territories
- Cartels are fairly common but hidden since collusion is illegal in the US, the European Union, Singapore, and other countries. But some cartels are out in the open: OPEC (oil) and De Beers (diamonds)

Introduction

- Evidence shows that cartels raise prices by a substantial amount
  - Connor and Lande (2005) found that the median cartel price increase was 22%
- Governments have agencies to combat collusion:
  - US Antitrust Division and US Department of Justice
  - European Commission
  - Competition Commission of Singapore
- Fines and jail sentences are used as punishment
- Antitrust authorities have been reasonably successfully in recent years

US DOJ fines

Defendant	Product	Year	Fine	Geographic Scope
F. Hoffman-LaRoche Ltd.	Vitamins	1999	$500M	International
BASF AG (1999)	Vitamins	1999	$225	International
SGL Carbon AG	Graphite Electrodes	1999	$135	International
UCAR International Inc.	Graphite Electrodes	1998	$110	International
Archer Daniels Midland co.	Lysine and Citric Acid	1997	$100	International
Haarman & Reimer Corp.	Citric Acid	1997	$50	International
HeereMac v.o.f.	Marine Construction	1998	$49	International
Hoechst AG	Sorbates	1998	$36	International
Showa Denko Carbon Inc.	Graphite Electrodes	1998	$32.5	International
Fujisawa Pharmaceuticals Co.	Sodium Gluconate	1998	$20	International
Dockwise N.V.	Marine Transportation	1998	$15	International
Dyno Nobel	Explosives	1996	$15	Domestic
F. Hoffman-LaRoche Ltd.	Citric Acid	1997	$14	International
Eastman Chemical Co.	Sorbates	1998	$11	International
Jungblunzlauer International	Citric Acid	1997	$11	International
Lonza AG	Vitamins	1998	$10.5	International
Akzo Nobel Chemicals BV & Glucona BV	Sodium Gluconate	1997	$10	International

Source: U.S. Department of Justice, http://www.usdoj.gov/atr/public/press_releases/1999/2456.htm

Introduction

- What have our models told us so far?
  - **Cournot** competition induces firms to **overproduce**
  - **Bertrand** competition induces **low prices**
- Firms would be better off if they **coordinated** their activities
  - e.g., **restricting their output** increases the market price and profits
- However in a **one-shot** game each firm finds it profitable to cheat ➔ firms can't commit (they can't exactly sign contracts agreeing to price fix!!!) ➔ **prisoner's dilemma**
- Since firms typically **interact repeatedly**, they may have an incentive to coordinate activities ➔ look for strategies that will sustain cooperation

Ex. One-shot Cournot game

- Two identical Cournot firms produce identical products
- **c** = \$30 for both firms
- Inverse market demand: ***p* = 150 – *Q***
- Reaction functions:

$$q_1^* = 60 - \frac{1}{2} q_2, \quad q_2^* = 60 - \frac{1}{2} q_1,$$

- Cournot-Nash equilibrium:

$$q_1^* = q_2^* = 40,\ p^* = 70,\ \pi_1^* = \pi_2^* = 1600$$

Ex. One-shot Cournot game

- If they are able to coordinate and behave as a monopoly:

$$\pi = (150 - Q)Q - 30Q$$

$$\frac{\partial \pi}{\partial Q} = 150 - 2Q - 30 = 0 \Rightarrow Q^* = 60$$

- The firms split the output: $q_1^* = q_2^* = 30, \;\; p^* = 90, \;\; \pi_1^* = \pi_2^* = 1800$

- But there is an incentive to cheat ➔ firm 1's output of 30 is *not* the best response to firm 2 producing 30:

$$q_1^* = 60 - \frac{1}{2} q_2 = 45, \;\; p^* = \$75$$

$$\pi_1^* = \$2025, \;\;\; \pi_2^* = \$1350$$

Ex. One-shot Cournot Game

- So indeed firm 1 prefers to cheat (deviate from the agreement)
- Of course firm 2 can anticipate this
- The best response for firm 2 is also to cheat

➢ **prisoners' dilemma**

		Firm 2	
		Cooperate	Deviate
Firm 1	Cooperate	(1800,1800)	(1350,2025)
	Deviate	(2025,1350)	(1600,1600)

NE

Ex: One-shot Bertrand Game

- Assume that firms have to set price in 1 cent increments
- p^* = \$90 is the collusive price ➔ $\boldsymbol{\pi_1^* = \pi_1^* = 1800}$

➢ When both firms deviate, the outcome is the NE with prices 1 cent above **mc** (profit ε is a small, positive number)

		Firm 2		
		Cooperate	Deviate	
Firm 1	Cooperate	(1800,1800)	(0,3600)	
	Deviate	(3600,0)	(ε, ε)	NE

Finitely repeated games

- Suppose now that the game is played repeatedly a finite number of times
- In a repeated game cooperation ***may*** make sense:
  - the (discounted) profits from colluding over time may be greater than the profits from deviating today
- This may allow a **reward & punishment** strategy:
  - "If you cooperate this period, I will cooperate next period"
  - "If you deviate this period, then I will deviate next period"
- But such a strategy is not subgame perfect

Finitely repeated games

- Firm 1's dominant strategy in period 2 is to **not cooperate** because it knows that period 2 is the **last period**
- Moving backwards, period 1 is now effectively the "last period" given that cooperation is not possible in period 2 ➔ firm 1 will also deviate in period 1 ➔ collusion cannot happen
- The same problem arises for finite games of T > 2 periods
  - in period T, any promise to cooperate is worthless ➔ deviate in period T
  - but then period T-1 is effectively the last period ➔ so deviate in period T-1
  - and so on

Infinitely repeated games

- In many situations the assumption of infinitely repeated games makes more sense then finitely repeated games
  - firms are usually regarded as having an indefinite life
  - the firm may not last forever but players **do not know when the game will end**
    - there is a high probability that the game will continue to the next period
- In an **infinitely repeated game:**
  - Good behavior can be **rewarded**
  - Bad behavior can be **punished**
- **Why?** Because there is no final period in which cooperation breaks down

Infinitely repeated games

- Consider the following strategy called a ***trigger strategy:***
  - **Cooperate as long as the other firm cooperated** in the previous period
  - **Punish forever** by deviating to non-cooperative behavior **if the other firm deviated** in the previous round
- This is called a *trigger strategy* because a switch to non-cooperative behavior is *triggered* by deviation from the agreement

Infinitely repeated games

larger discount factor, increasing indifference between period 1 and 2

- Let firm profit in period t be π_t
- The discount factor is $0 \le \delta \le 1$ (how the firm values future profits)
- The present value (PV) of the infinite sequence of profits is then:

$$PV = \pi_1 + \delta\pi_2 + \delta^2\pi_3 + \dots$$

- Suppose that profit is the same in each period: $\pi \equiv \pi_1 = \pi_2 = \pi_3 = \dots$, then:

$$PV = \pi\left(1 + \delta + \delta^2 + \delta^3 + \dots\right) = \frac{\pi}{1-\delta}$$

Infinitely repeated games

- Payoff from honoring the agreement forever (***C***):

$$V^C = 1800 + 1800\delta + 1800\delta^2 + \ldots = \frac{1800}{1-\delta}$$

- Deviation gives a one-time payoff but thereafter the partner will punish by deviating forever. Payoff from deviating from the agreement (***D***) :

$$V^D = 2025 + 1600\delta + 1600\delta^2 + \ldots = 2025 + 1600\frac{\delta}{1-\delta}$$

Infinitely repeated games

- Cooperation is better if:

$$V^C > V^D \Leftrightarrow \frac{1800}{1-\delta} > 2025 + 1600\frac{\delta}{1-\delta}$$

$$\Leftrightarrow \delta > \bar{\delta} \equiv \frac{2025-1800}{2025-1600} = 0.529$$

threshold value of $\boldsymbol{\delta}$

assumption that both firm has the same delta, but do not have to be the same at all.

Infinitely repeated games

- We can look at the same problem generally:
  - profits under a collusive agreement: $\boldsymbol{\pi}^{\mathbf{C}}$
  - profits from deviating: $\boldsymbol{\pi}^{\mathbf{D}}$
  - profits in the Cournot-Nash equilibrium: $\boldsymbol{\pi}^{\mathbf{N}}$
  - reasonable to assume that $\boldsymbol{\pi}^{\mathbf{D}} > \boldsymbol{\pi}^{\mathbf{C}} > \boldsymbol{\pi}^{\mathbf{N}}$
- Deviating is not optimal if $\delta > \overline{\delta} \equiv \dfrac{\pi^D - \pi^C}{\pi^D - \pi^N}$
- Collusion is sustainable if:
  - **Short-term gains from cheating are low relative to long-run losses**
  - **Cartel members highly value future profits (high discount factor)**

Infinitely repeated games

- In fact, as long as $\boldsymbol{\pi}^{\mathbf{D}} > \boldsymbol{\pi}^{\mathbf{C}} > \boldsymbol{\pi}^{\mathbf{N}}$, there are always discount factors for which cooperation is optimal

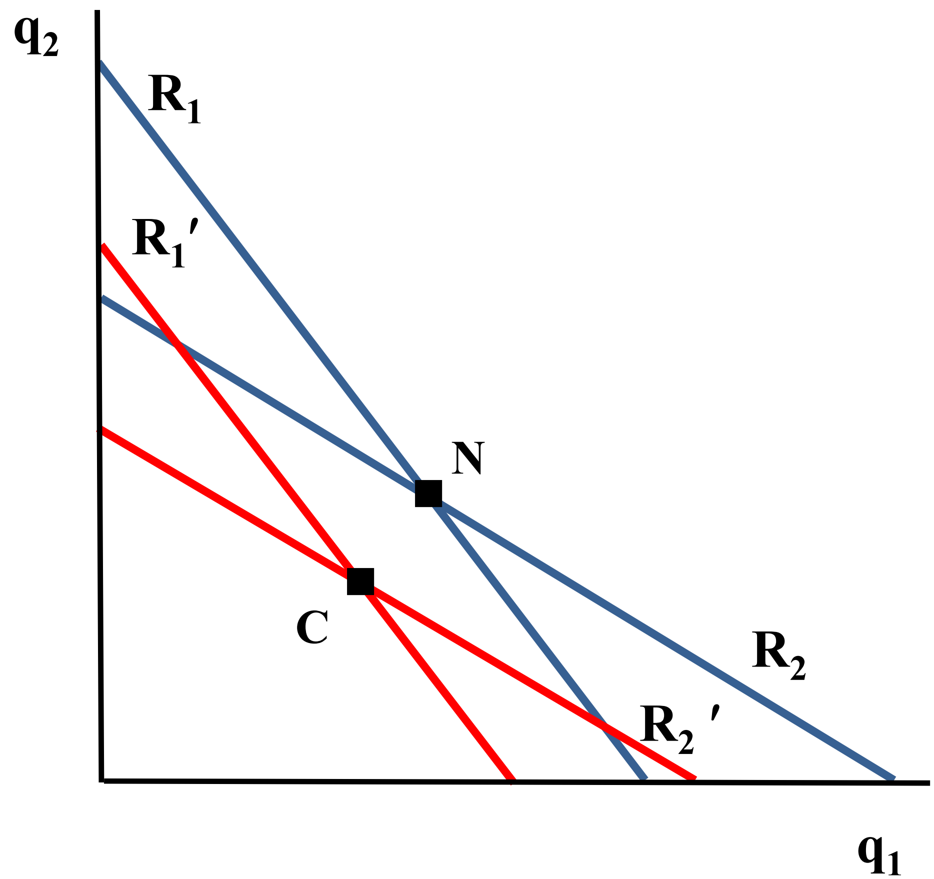
- But there are some objections to trigger strategies:
  - o the strategies are based on the assumption that cheating on the cartel agreement is detected quickly and that punishment is swift. What if it takes time?
    - collusion is still possible but the discount factor has to be higher
  - o the **punishment** is **harsh** and **unforgiving** because it does not permit mistakes ➔ **what if demand is uncertain?**
    - if there is a decrease in sales and profit is it because the other firm is cheating or is because there was a decrease in demand?
    - can modify trigger strategy based on a range of prices or outputs
    - punish for a limited number of periods

Detecting collusion

- Detecting collusive behavior is really hard
  - most cartels get exposed by non-cartel firms in the industry or by former employees, *not* by the authorities!
- It is also hard to prove to the courts that a cartel exists
  - the cartel members try to make the market outcomes look competitive
    - ***indistinguishability theorem***

The Indistinguishability Theorem

- Start with a standard Cournot model: **N** is the non-cooperative equilibrium
- Assume the firms are colluding by restricting output: **C** is the collusive outcome
- **C** can be presented as non-collusive if the firms exaggerate their costs or underestimate demand
- Firms claim their best response functions are $\mathbf{R_1'}$ and $\mathbf{R_2'}$
- **C** now looks like the non-cooperative equilibrium



Detecting collusion: soda ash

- ICI and Solvay are two firms that have large shares in the European market for soda ash, a raw material used to produce glass
- ICI and Solvay maintained a number of cartel agreements for many years
- Solvay supplied continental Europe while ICI supplied the UK and Ireland
- These agreements ended in 1972 yet both firms continued to supply these markets exclusively
- In the 1980s prices in the UK rose 15 to 20% above those in continental Europe
- The European Commission argued that the lack of entry into each's market when prices differed by so much was a sign of continued collusive behavior

Detecting collusion: soda ash

- While the Commission's interpretation seems reasonable there was a counter-argument
- If the cost of transporting the product across the Channel was higher than the difference in prices, then market penetration wasn't profitable
- Problem for authority: it doesn't have good information on transportation costs, production costs or the nature of demand
- ➢ It cannot make a definite case against the cartel's defense which also sounds reasonable

Testing for collusion

- Osborne and Pitchik (1987) suggest a way to detect collusion
- They argue that capacity may provide helpful clues
- Suppose that two firms:
  - choose capacities before they form a cartel
  - compete in price
- Since capacity is chosen non-cooperatively it is unlikely that each firm chooses the same amount
- They show that:
  - under competition profits per capacity unit should be identical across firms
  - when firms collude:
    - the firm with smaller capacity should make higher profits per capacity unit
    - the difference in unit profit increases when total capacity increases relative to market demand

Empirical example: salt duopoly

British Salt and ICI Weston Point were suspected of collusion

BS is the smaller firm and makes more profit per unit of capacity

The profit difference grows with excess capacity

	1980	1981	1982	1983	[illegible]4
BS Profit	7,065	7,622	10,489	10,1[illegible]	10,882
WP Profit	7,273	7,527	6,841	[illegible],297	6,204
BS profit per unit of capacity	8.6	9.3	12.7	12.3	13.2
WP profit per unit of capacity	6.6	6.9	6.3	5.8	5.7
Total Capacity/Total Sales	1.5	1.7	1.7	1.9	1.9

BS capacity: 824 kilotons WP capacity: 1095 kilotons

But will this test be successful once it is widely known and applied?