Repeated games and cartel

Industrial organization – lecture 3

Benchmark

1. Write **my price** $p \in \{101, 102, 103, \ldots, 110\}$.
2. Determine the **market price** $p_M =$ minimum of prices in the group.
3. Calculate the **profit** $=$

$$\begin{cases} \frac{\text{market price} - 100}{\text{number of group members with the same price } (N)} & \text{if } p = p_M \\ 0 & \text{if } p > p_M \end{cases}$$

Communication

1. Do you want to communicate/form a cartel? (fill in yes or no in **column 1**)
2. Reveal your answer sheets: If all yes – 1 minute of price negotiations. Choice from $\{101, 102, 103, \ldots, 110\}$. The price is not binding.
3. Write **my price** $p \in \{101, 102, 103, \ldots, 110\}$.
4. Determine the **market price** p_M = minimum of prices in the group.
5. Calculate the **profit** =

$$\begin{cases} \frac{\text{market price} - 100}{N} & \text{if } p = p_M \\ 0 & \text{if } p > p_M \end{cases}$$

Antitrust

1. Do you want to communicate/form a cartel? (fill in yes or no in **column 1**)
2. Reveal your answer sheets: If all yes – 1 minute of price negotiations. Choice from $\{101, 102, 103, \ldots, 110\}$. The price is not binding.
3. Write **my price** $p \in \{101, 102, 103, \ldots, 110\}$.
4. Determine the **market price** = minimum of prices in the group.
5. Cartel is detected with 15% probability. Fine = 10 % of **revenue**.
6. Calculate the **profit** =

$$\begin{cases} \frac{\text{market price} - 100}{N} - 0.1\frac{\text{market price}}{N} & \text{if } p = p_M \text{ and you are in cartel and detected} \\ \frac{\text{market price} - 100}{N} & \text{if } p = p_M \text{ and not in cartel or not detected} \\ 0 & \text{if } p > p_M \end{cases}$$

Leniency

1. Do you want to communicate/form a cartel? (fill in yes or no in **column 1**)
2. Reveal your answer sheets: If all yes – 1 minute of price negotiations. Choice from $\{101, 102, 103, \dots, 110\}$. The price is not binding.
3. Write **my price** $p \in \{101, 102, 103, \dots, 110\}$.
4. Determine the **market price** = minimum of prices in the group.
5. If all say yes in 1., you may report the cartel for a cost equal to 1. The 1st (no fine) and 2nd (50% fine) report will be chosen randomly.
6. If not reported, cartel detected with 15%. Fine = 10 % of **revenue**.
7. Calculate the **profit** =

$$\begin{cases} \frac{\text{market price}-100}{N} - 0.1\frac{\text{market price}}{N}(0/0.5/1) & \text{if } p = p_M \text{ and cartel reported} \\ \frac{\text{market price}-100}{N} - 0.1\frac{\text{market price}}{N} & \text{if } p = p_M\text{, cartel and detected} \\ \frac{\text{market price}-100}{N} & \text{if } p = p_M\text{, not cartel or not detected} \\ 0 & \text{if } p > p_M \end{cases}$$

Cartel – stability, deterrence and detection

Pepall et al. (2010, pp. 237–250, 264–274)

- One-shot or finitely repeated game
- Infinitely repeated game
- Effect of antitrust and leniency

One-shot or finitely repeated game

Pepall et al. (2010, pp. 237-245)

Simultaneous game:

- two firms 1 and 2
- each firm has two actions:
  – cartel quantity q_i^m
  – Nash equilibrium (Cournot, Bertrand) quantity q_i^n
- preferences given by profits of firms:
  π_i^d (**d**efault) $> \pi_i^m$ (**m**onopoly) $> \pi_i^n$ (**N**ash) $> \pi_i^s$ (**s**ucker)

Payoff matrix of the game:

		firm 2	
		q_2^m	q_2^n
firm 1	q_1^m	$\pi_1^m; \pi_2^m$	$\pi_1^s; \pi_2^d$
	q_1^n	$\pi_1^d; \pi_2^s$	$\pi_1^n; \pi_2^n$

Example – Cournot duopoly cartel game

Pepall et al. (2010, p. 240)

Table 10.3 Pay-off matrix for a Cournot duopoly cartel game

		Strategy for Firm j	
		Cooperate	Deviate
Strategy for Firm i	Cooperate	$\frac{(a-c)^2}{8}, \frac{(a-c)^2}{8}$	$\frac{3(a-c)^2}{32}, \frac{9(a-c)^2}{64}$
	Deviate	$\frac{9(a-c)^2}{64}, \frac{3(a-c)^2}{32}$	$\frac{(a-c)^2}{9}, \frac{(a-c)^2}{9}$

Cartel stability in an infinitely repeated game

Pepall et al. (2010, pp. 245-250)

Future profits multiplied by $\rho = pR$, where

- p is the probability that the cartel continues
- R is the discount factor

Grim trigger - two options:

1. If firm i chooses cartel quantity, cartel survives – its profit is π_i^m.
2. If firm i deviates, it gets π_i^d in the first round and π_i^n in all future rounds.

When does *grim trigger* make the cartel stable?

The cartel is stable if

$$\rho > \rho^* = \frac{\pi_i^d - \pi_i^m}{\pi_i^d - \pi_i^n}$$

Antitrust policy

Pepall et al. (2010, pp. 264-266)

The same infinitely repeated game, but with antitrust – parameters:

- a – probability that the authority will investigate the cartel
- s – probability that it leads to successful prosecution
- F – fine if the prosecution is successful

What happens to the expected cartel profits? When is the cartel stable?

Expected profits of a firm in cartel:

- without autitrust:

$$V_m = \frac{\pi_i^m}{1-\rho}$$

- with autitrust:

$$V_m^a = \frac{\pi_i^m - asF + \frac{as\rho}{1-\rho}\pi_i^n}{1-\rho(1-as)}$$

Even if the fine $F = 0$, the cartel is stable if

$$\rho > \rho^a = \frac{\pi_i^d - \pi_i^m}{(1-as)(\pi_i^d - \pi_i^n)} > \rho^*$$

Leniency

Pepall et al. (2010, pp. 269-274)

The same infinitely repeated game with antitrust, but with leniency:

We assume that each firm may adopt on of the three strategies:

1. Collude, Not Reveal – the expected profits

$$V_{NR}^{C} = \frac{\pi_i^m - asF + \frac{as\rho}{1-\rho}\pi_i^n}{1-\rho(1-as)}$$

2. Collude, Reveal – if
   - there is no investigation – keep cartel: $V_1 = (1-a)(\pi_i^m + \rho V_R^C)$
   - there is investigation – stay in cartel until the end of the period and then reveal and pay a reduced fine $L < F$: $V_2 = a(\pi_i^m - L + \frac{\rho\pi_i^n}{1-\rho})$

$$V_R^C = V_1 + V_2 = \frac{\pi_i^m - L + \frac{a\rho\pi_i^m}{1-\rho}}{1-(1-a)\rho}$$

3. Defect – the expected profits are

$$V_d = \pi_i^d + \frac{\rho\pi_i^n}{1-\rho}$$

What are the possible equilibria? How does the equilibrium selection depend on antitrust parameters a and s and on the leniency fine L?

Leniency programs

Pepall et al. (2010, p. 274)

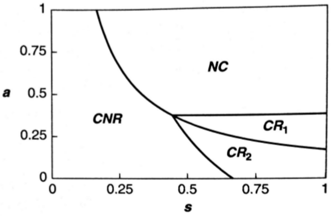

Figure 10.3(a) Equilibria with a leniency program; $L = 0$

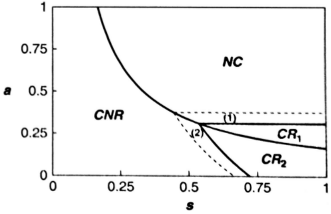

Figure 10.3(b) Equilibria with a leniency program; $L = 600$