

# Collusion

25 septembre 2025

- Competition between **imperfect substitutes** : **source externality** between firms
- Firms may increase profits and market power by coordinating pricing/output policy
- Coordination :
  - merger between competitors
  - cartel formation : price/output agreement between competitors
- This chapter : how do cartels work ?

- Survey on Cartels : "What determines cartel success?", Levenstein and Suslow, 2006, *JEL* (stylized facts)
- \*\*Collusion : Tirole (chapter 6) and BP (chapter 15)
- \*\*"Leniency programs and cartel prosecution", M. Motta and M. Polo, *IJIO*, 2003
- "Cartel destabilization effect of leniency programs", Borrell et al. WP, 2022
- \*\*"Can Collusion promote sustainable consumption and production?", *IJIO*, 2022, Schinkel and Spiegel
- Paper presentation : "Does enforcement deter cartels? A tale of two tails"

- Cartels : a way to coordinate prices and output
  - Between a higher number of firms
  - Without productive efficiency (in most cases)
  - Illegal informal coordination
- Horizontal price/output agreements are prohibited
  - In the US : Section 1 Sherman Act : "Every contract, combination in the form of trust or otherwise, or conspiracy, in restraint of trade or commerce among the several States, or with foreign nations, is declared to be illegal."
  - In Europe : article 101 "The following shall be prohibited (...) : all agreements between undertakings, decisions by associations of undertakings and concerted practices which (...) have as their **object** or **effect** the prevention, restriction or distortion of competition."

- AA aim at deterring and detecting cartels
- Main questions :
  - How do cartels operate ?
  - How deterring and detecting cartels ?
- New question arising : should we accept price/output coordination for environmental purposes ?
- "Chicken for Tomorrow" case

- This chapter :
  - Basic stylized facts
    - "Analyse statistique des affaires d'ententes dans l'UE..." 2002-2014 ; Gauthier et al.
    - "What determines cartel success?", Levenstein and Suslow, 2006, *JEL*
  - A basic theory of cartels
  - What facilitates collusion ?
  - AA and fight against cartels
  - Coordination and sustainable investments

European cartels ("Analyse statistique des affaires d'ententes dans l'UE..."2002-2014 ; Gauthier et al.) :

Nombre d'affaires	52		
Nombre d'entreprises	333		
	<b>Min</b>	<b>Max</b>	<b>Moyenne</b>
Nombre d'entreprises/affaire	2	17	6,4
Durée de l'entente (mois/années)	0/0	419/34,9	83,36/6,9
Amende/entreprise (millions d'euros)	0	896	52,33
Amende/affaire (millions d'euros)	2,5	1470,5	310,73
Durée de la procédure (mois/années)	7,5/0,6	64,6/5,3	18,23/1,5
Délai de publication (mois/années)	0/0	56/4,7	9,8/0,8

Tableau 1 : Affaire d'ententes, décisions de la Commission

Cartels are unstable :

TABLE 3  
EXAMPLES OF EPISODIC CARTELS:  
CROSS-SECTION STUDIES

<i>Industry</i>	<i>Length of Cartel Episodes (years); Beginning year of each cartel episode shown in superscript</i>							<i>Author</i>
Aluminum	5 <sup>1901</sup>	2 <sup>1906</sup>	2 <sup>1912</sup>	3 <sup>1923</sup>	4 <sup>1929</sup>	5 <sup>1931</sup>	Eckbo	
Coffee	1 <sup>1937</sup>	1 <sup>1938</sup>	3 <sup>1939</sup>				Eckbo	
Copper	2 <sup>1888</sup>	4 <sup>1918</sup>	6 <sup>1926</sup>	4 <sup>1935</sup>	19 <sup>1968</sup>		Griffin	
Steel	4 <sup>1926</sup>	0.5 <sup>1930</sup>	0.17 <sup>1931</sup>	6 <sup>1933</sup>			Eckbo	
Sugar	2 <sup>1926</sup>	4 <sup>1931</sup>	2 <sup>1937</sup>	2 <sup>1939</sup>	5 <sup>1968</sup>	3 <sup>1974</sup>	3 <sup>1978</sup>	Griffin
Sulfur	3 <sup>1907</sup>	10 <sup>1922</sup>	5 <sup>1934</sup>	11 <sup>1947</sup>				Griffin
Tin	2 <sup>1929</sup>	3 <sup>1931</sup>	2 <sup>1935</sup>					Eckbo

Cartels die for different reasons :

TABLE 13  
CAUSES OF CARTEL BREAKDOWN:  
INTERNATIONAL CROSS-SECTION CARTEL STUDIES

<i>Causes of Cartel Breakdown</i>	<i>Eckbo— Sample 1</i>	<i>Eckbo— Sample 2</i>	<i>Griffin<sup>a</sup></i>	<i>Suslow</i>
Cheating and Disagreement	43.5%	58.6%	33.3%	23.9%
External Shock	30.4%		50.0% <sup>c</sup>	42.3%
Entry and Substitution <sup>b</sup>	26.1%	41.4%	33.3%	15.5%
Entry	13.0% <sup>b</sup>		25.9%	15.5%
Substitution	8.7% <sup>b</sup>		9.3%	
Technological Change			9.3%	
Antitrust Indictment				18.3%
TOTAL # EPISODES	23	29	54	71

## Main questions

- Need of a theory of cartel formation and cartel stability
- Identify the key aspects of cartels
- Market conditions that facilitate collusion
- The role of AA

# A theory of collusion

- Competition game repeated twice
- Symmetric duopoly. Imperfect substitutes.
- Prices :
  - One period Nash equilibrium :  $p^N$
  - Monopoly price :  $p^m > p^N$
- Game :
  - 1 Both firms set their price (non cooperatively) :  $p_1^1, p_2^1$
  - 2 Both firms set their price (non cooperatively) :  $p_1^2, p_2^2$
- What is the equilibrium of this dynamic game ?
- Is-it possible for the firms to enforce a price  $p > p^N$ ?

# A theory of collusion : infinitely repeated competition

- Competition game repeated infinitely
- Discount factor :  $\delta$
- Perfect information
- Consider a possible collusive price :  $p^c > p^N$ .
- Per period profits :
  - $p_i = p^N, \pi^N$
  - $p_i = p^c, \pi^c$
  - $p^d = BR(p^c) = p^d, \pi^d$

# A theory of collusion : infinitely repeated competition

- Strategy of firm  $i$  to sustain collusion : "grim trigger strategy"
- Two different types of subgames according to the history of the game at period  $t$ 
  - (1)  $p_i^{t'} = p^c > p^N$  for all  $t' < t$
  - (2)  $p_i^{t'} \neq p^c$  at at least one period  $t' < t$
- Strategy of firm  $i$  :
  - (1)  $p_i^t = p^c$
  - (2)  $p_i^t = p^N$
- Incentives to deviate :
  - (2) Repetition of the static Nash Equilibrium. No incentives to deviate.
  - (1) Most profitable deviation :  $p_i^t = BR_i(p^c) = p^d$ . Profit :  $\pi^d$ . Deviation ?
- Cartel stable iff

$$\delta \geq \frac{\pi^D - \pi^C}{\pi^D - \pi^N}$$

# How do cartels operate

- Coordination : the best  $p^c$
- Monitoring : to detect deviation
- Enforcement : to punish deviation

# How do cartels operate : monitoring

- To monitor the price agreement :

Station	Distance (km)	SP95 OU SP95-E10	GAZOLE
IF	10 km	1,56	1,39
Carrefour	26 km	1,56	1,39
Shell	65 km	1,58	1,41
TFI	119 km	1,58	1,41



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Si vous trouvez moins cher ailleurs,  
nous baissions nos prix dans les 24H\*

# How do cartels operate : monitoring

## Frequent meeting :

Table 4.1 Frequency of Meetings

Market	Type	Allocation	Monitoring
Choline chloride	SQ, ET, CA	2/year	every 2-3 weeks
Citric acid	SQ	2/year	monthly*
Copper plumbing tubes	SQ	annual	every 1-2 months
District heating pipes	SQ, CA	every 2-3 weeks	?
Elec. mech. carb. graphite	SQ, CA	2/year	weekly/monthly
Graphite electrodes	SQ	1-2/year	2-3/year
Isostatic graphite	ET?	2-3/year	2/year
Lysine	SQ	quarterly	monthly*
Methionine	SQ?	2-4/year	n/a
Nucleotides	CA, ET	2/year	?
Organic peroxides	SQ, CA	2-4/year	quarterly*
Plasterboard	SQ	?	quarterly
Sorbates	SQ	2/year	2/year
Vitamins (A, E)	SQ	2-3/year	weekly/quarterly
Zinc phosphate	SQ	quarterly	monthly

\* Buy-backs occurred annually.

Source: Various European Commission Decisions

# How do cartels operate : enforcement

- Threat of price war if one firm deviates from the collusive price/output
- System of output buyback if one firm produces more than planned

# Facilitating practices, market structure and collusion

- Market conditions :
  - multi-market contacts
  - Firms' asymmetry (cost, production capacity)
  - Number of firms
- Information transparency : which impact of information exchanges between firms on collusion stability ?
  - A priori, more difficult to stabilize collusion without information of competitors' prices/output
  - Central question for AA : prohibit/allow exchanges of information
  - Information exchanges may have an ambiguous impact
- Our study : a simple model with aggregate information on demand without information on prices (Green and Porter)

- Duopoly with identical products
- Prices are unobserved and demand fluctuates
- Agregate demand unobserved
- $\tilde{D}(p) = \begin{cases} 0 & \text{with probability } \alpha \\ D(p) > 0 & \text{with probability } 1 - \alpha \end{cases}$
- Is it possible to sustain collusive prices?

# Cartel stability and information on prices

- At each period, each firm sets its price
- Strategy adopted at period  $t$  :
  - $p_i = p^m$  if demand positive at  $t - 1$
  - triggers punishment ( $p_i = c$ ) during  $T$  periods if demand zero at  $t - 1$
- SPE ?

# Cartel stability and information on prices

- Subgame with punishment : each firm plays its best response
- Subgame without punishment (positive demand observed or after  $T$  punishments) :
  - The firm sets  $p_i = p^m$ . Gets  $V^C$
  - The firm deviates and sets  $p_i = p^m - \varepsilon$ . Gets  $V^D$
- $V^C = \alpha\delta^{T+1}V^C + (1 - \alpha)(\frac{1}{2}\pi^m + \delta V^C)$
- $V^D = (1 - \alpha)\pi^m + \delta^{T+1}V^C$
- The firm does not deviate iff  $V^C > V^D$

# Cartel stability and information on prices

- Cartel stability iff  $1 \leq 2(1 - \alpha)\delta + \delta^{T+1}(2\alpha - 1)$
- If  $T = 0$ , cartel not stable
- Two cases :
  - $\alpha > \frac{1}{2}$ , never stable
  - $\alpha < \frac{1}{2}$ , there exists  $T$  to ensure stability
- At the equilibrium : periods with low prices and period with collusive prices
- Here, the lack of information affects negatively the cartel stability and profitability

# Enforcing cartel fighting : the LP

- How to deter cartels ?
- Objective of AA :
  - Deter cartel formation (the best)
  - Improve the cartel detection (if cartels formed)
- Instruments :
  - Investigation
  - Incentives for the firms to cooperate via a fine reduction : the leniency program (LP)

# Enforcing cartel fighting : the LP

- The model (based on Motta and Polo, 2003)
- Profits :  $\Pi^C = B$ ,  $\Pi^N = 0$  and  $\Pi^D = 2B$
- Investigation with probability  $\alpha$
- Find hard evidence with probability  $p$
- Fine :  $F$  (without revelation) or  $R$  (reduced by revelation)

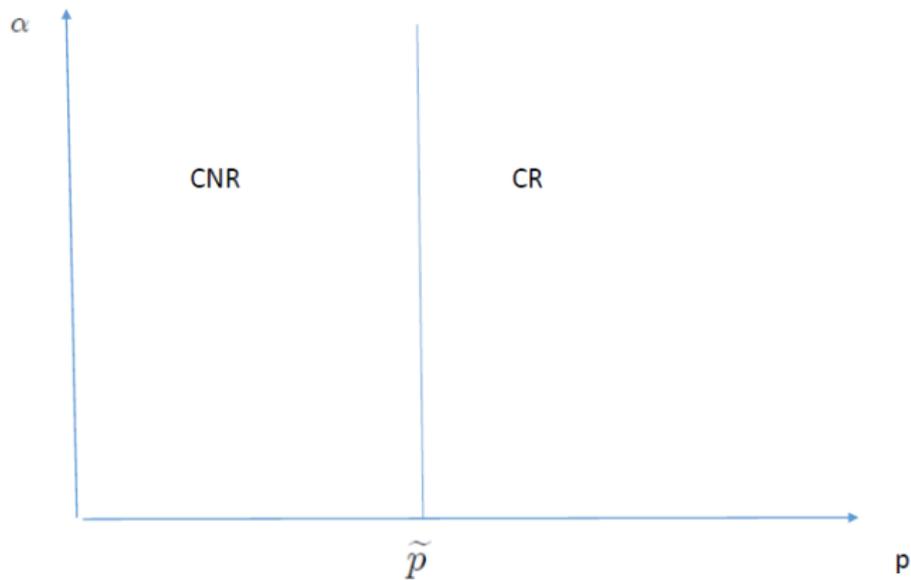
# Enforcing cartel fighting : the LP

- The game at each period
  - stage 1 : Each firm decides to collude
  - stage 2 : the CA starts an investigation with probability  $\alpha$
  - stage 3 : if investigation, the firms decide to reveal information
  - the CA finds hard evidence and fines the cartel :  $p$  or 1
- If the CA does not find hard evidence there is no investigation in the future
- If a cartel is convicted, the firms never form again the cartel
- If no investigation, the game starts again

# Enforcing cartel fighting : the LP

- Stage 3 : the revelation subgame
- The investigation begins :
  - No revelation :  $(1 - p) \frac{\Pi^C}{1-\delta} + p(\frac{\Pi^N}{1-\delta} - F)$
  - Revelation :  $\frac{\Pi^N}{1-\delta} - R$
- Revelation iff  $p > \tilde{p}(R, F) = \frac{B+R(1-\delta)}{(1-\delta)F+B}$

# Enforcing cartel fighting : the LP

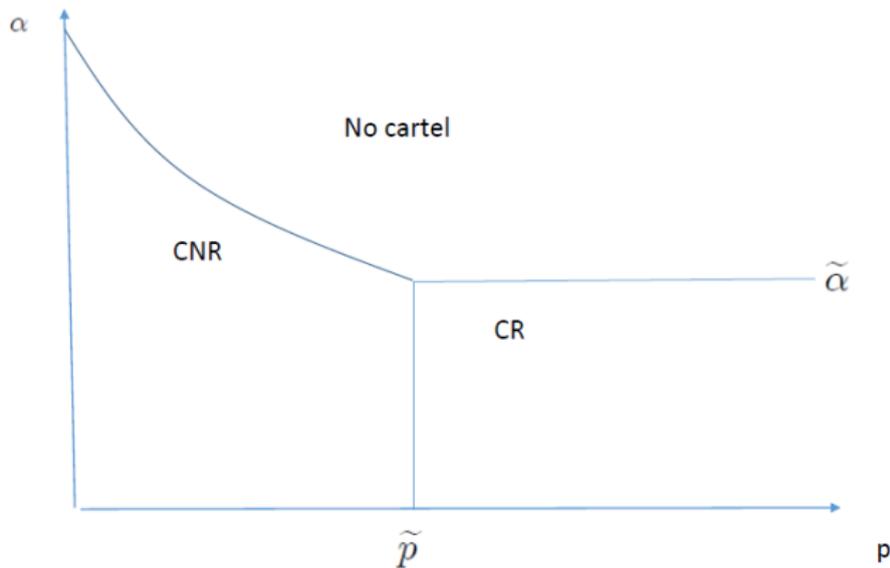


# Enforcing cartel fighting : the LP

- Stage 2 (investigation stage)
- Reveal information ( $p > \tilde{p}$ ) :  
$$\Pi_R = (1 - \alpha)(\Pi^C + \delta\Pi_R) + \alpha\left(\frac{\Pi^N}{1-\delta} - R\right)$$
- Does not reveal information ( $p < \tilde{p}$ ) :  
$$\Pi_{NR} = (1 - \alpha)(\Pi^C + \delta\Pi_{NR}) + \alpha\left(p\frac{\Pi^N}{1-\delta} - pF + (1 - p)\frac{\Pi^C}{1-\delta}\right)$$
- Stage 1 : collusion decision
  - If  $p < \tilde{p}(R, F)$  :  $V_{CNR} = \Pi^C + \delta\Pi_{NR} > \Pi^D + \frac{\Pi^N}{1-\delta}$  iff  
$$\alpha < \tilde{\alpha}_{NR}(p) = \frac{(1-\delta)(2\delta-1)B}{\delta(B(1-2\delta+p)+(1-\delta)pF)}$$
  - If  $p > \tilde{p}(R, F)$  :  $V_{CR} = \Pi^C + \delta\Pi_R > \Pi^D + \frac{\Pi^N}{1-\delta}$  iff  
$$\alpha < \tilde{\alpha}_{CR} = \frac{B(2\delta-1)}{\delta(2B+R)}$$

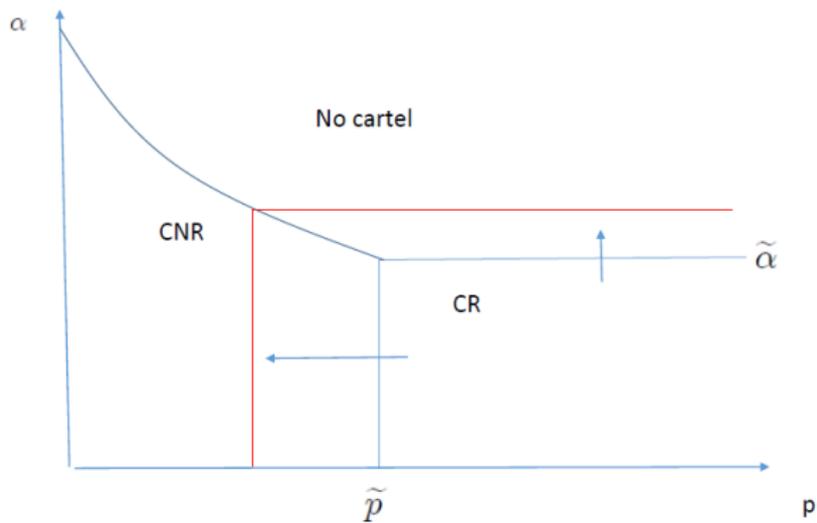
# Enforcing cartel fighting : the LP

The equilibria



# Enforcing cartel fighting : the LP

Impact of a lower  $R$ ?



# Enforcing cartel fighting : the LP

- Predictions :
  - LP increases the incentive to reveal information for existing cartels
  - LP increases the incentive to form a cartel
- In terms of cartel duration :
  - Stable cartels reveal information : higher average duration for observed cartels in the "short run"
  - Unstable cartels are formed and then may reveal information : lower average duration for observed cartels in the "long run"