Inspecting Cartels over Time: with and without Leniency Program

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Outline

Most papers on cartel inspection in the literature

- consider only dynamic behaviors of firms, but
- assume constant or myopic policies by the regulator.

We allow that the antitrust authority (AA) can choose a dynamic pattern of cartel monitoring intensities from

1. **constant policies**
   same detecting prob. for every period.
2. **stochastic policies**
   detecting prob. fluctuates over time.

Our results:
Under a reduced Bertrand game

- Without leniency: mean-preserving fluctuation does not matter! (Prop. 1)
- With leniency: it matters!
  leniency + stochastic policy most effective (Prop. 2)

Base Model: No Leniency

Following **Chen and Rey (2013)** "On the design of leniency programs" *Journal of Law and Economics*, 56(4), 917-957.

Model Infinitely repeated duopoly game with

- two identical firms: 1 and 2
- discrete time horizon: $t = 1, 2, \dots$ w. common discount factor δ
- stage game: reduced Bertrand game
  $\Rightarrow H \setminus L$: collusive\defective action

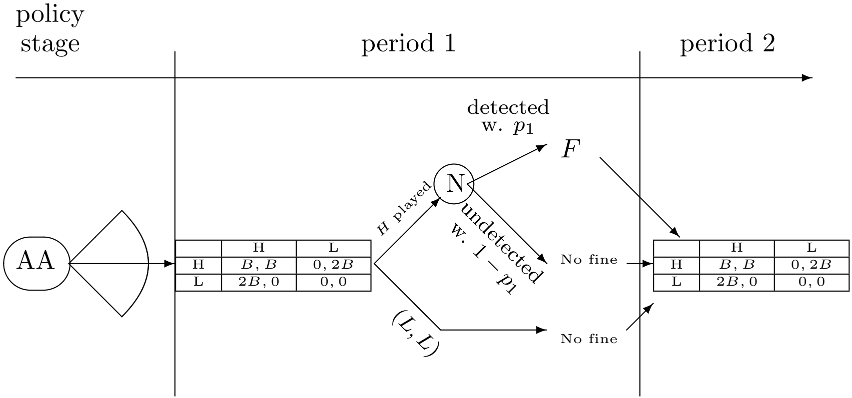
	H	L
H	B, B	0, $2B$
L	$2B$, 0	0, 0

Table: Reduced Bertrand Game

- collusive stake: $B \Rightarrow$ varies across industries

- **Any action combination with** $H \rightarrow$ evidence of "collusion" (L,H)\(H,L): L = slight undercut of the monopoly price
- Inspection by AA is not perfect.
  $\Rightarrow$ AA can choose only the probability $p \in (0,1)$ of cartel detection if $\exists$ evidence.
- If a cartel is detected, each firm pays a fine F (fixed over time). After that, the firms can restart collusion, if they choose so. ($\leftarrow$ special feature of Chen-Rey model)

Timeline



A constant policy: $p_t = p$ for all $t = 1, 2, \ldots$

A stochastic policy: p_t follows some dist. G and firms learn p_t before the stage game in t

Policy and Effect Measure

- p (or its dist. G) as the policy variable: the AA controls the intensity of investigation
- Measurement of policy effect: The minimum B (=: $\underline{B}$) that sustains collusion
  - Industries differ in B (collusive stake)

	H	L
H	B, B	0, $2B$
L	$2B$, 0	0, 0

  - (Given δ, F) Under each policy, $\exists \underline{B}$ such that
    $B < \underline{B}$: firms in such markets cannot collude
    $\underline{B} \leqq B$: firms in such markets can collude
  - **The higher this $\underline{B}$ is, the more difficult to collude**

Dynamic Investigation Policies

Constant Policies: CP

- $p_t = p \in (0,1)$ for all t.

Stochastic Policies: SP

- $p_t \sim G$ with the support of two prob. or a continuum
- $p_t = \begin{cases} p+\alpha & \text{w. prob. } x \text{ (\textbf{risky} state)} \\ p-\beta & \text{w. prob. } 1-x \text{ (\textbf{safe} state)} \end{cases}$
- AA randomizes or visits industries alternatingly, etc.

- CP with p and SP with G having the mean p: comparable

  Mean-preservation for two prob.

  For each period t,

$$E[p_t] = x(p+\alpha) + (1-x)(p-\beta) = p \tag{1}$$

(Full) Collusion by a Trigger Strategy

- Repeated Game with the stage game

	H	L
H	B, B	0, $2B$
L	$2B$, 0	0, 0

  over the time horizon $t = 1, 2, \dots$

- Target collusive action profile (H, H)
- (Grim) Trigger Strategy
  In any period t,
  if the history is $\emptyset$ or $[(H, H), \dots, (H, H)]$, play H;
  otherwise, play L.
- If both firms follow this strategy, (H, H) is repeated forever.

(In the paper, we also analyze **partial** collusion in which firms collude only in some periods.)

Incentive Condition

- The trigger strategy played by both firms is a subgame perfect equilibrium if

  (in any period)
  total long-run profit from repeated $(H, H) \geqq$ total long-run profit from **any** one-step deviation — Incentive Condition
  $\iff$
  today's profit from (H, H) + continuation value from repeated (H, H)
  $\geqq$ today from (L, H) + continuation value from repeated (L, L)

- The IC often requires high δ and other parameter condition.

- (After a history with a deviation, following (L, L) is a Nash equilibrium for any δ.)

Collusion under a Constant Policy

	H	L
H	B, B	$0, 2B$
L	$2B, 0$	$0, 0$

- The expected long-run profit V from repeated (H, H)

$$V := B - pF + \delta(B - pF) + \delta^2(B - pF) + \cdots = \frac{B - pF}{1 - \delta}.$$

Note Evidence lasts only one period. (Chen-Rey model)
$\Rightarrow$ Firms pay F only for that period, if detected, and can restart the cartel.

- One-step deviation gives $2B - pF + \delta\{0 + \cdots\}$

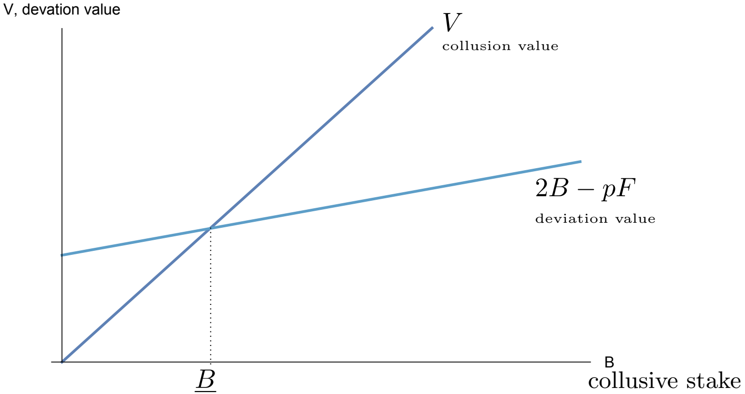
Note A firm may need to pay the fine even at (L, H).

- Collusion is sustainable (by the trigger strategy) iff

$$V = \frac{B - pF}{1 - \delta} \geqq 2B - pF \iff \delta \geqq \frac{B}{2B - pF} \quad \left(\geqq \frac{1}{2}\right) \tag{2}$$

$$\iff B \geqq \underline{B} := \frac{\delta pF}{2\delta - 1}. \tag{3}$$

- Assume $\delta > 1/2$: collusion feasible.



- B varies across industries:
  - $\underline{B} \uparrow \Rightarrow$ in **less** industries, full collusion sustainable

Collusion under a Stochastic policy with mean p

$$p_t = \begin{cases} p+\alpha & \text{w. prob. } x \text{ (\textbf{risky} state)} \\ p-\beta & \text{w. prob. } 1-x \text{ (\textbf{safe} state)} \end{cases}$$

- Naivete: Harder to collude?
  - Risky states, harder to collude
  - reduce the continuation value of collusion
  - harder to collude in safe states as well?

  $\Leftarrow$ Frezal (2006, IJIO), Fujiwara-Greve and Yasuda (2014, WP)

- $V_r \setminus V_s$: expected payoff **starting in** the risky\safe state + always collude.

$$V_r := B - (p+\alpha)F + \delta\{xV_r + (1-x)V_s\}$$
$$V_s := B - (p-\beta)F + \delta\{xV_r + (1-x)V_s\}$$

- To sustain (H, H) for all t in both states,

$$V_r = B - (p+\alpha)F + \delta\{xV_r + (1-x)V_s\} \geqq 2B - (p+\alpha)F + \delta\{0 + \cdots\}, \tag{4}$$

$$V_s = B - (p-\beta)F + \delta\{xV_r + (1-x)V_s\} \geqq 2B - (p-\beta)F + \delta\{0 + \cdots\}. \tag{5}$$

- Mean-preservation $\Rightarrow$ continuation value under SP $= V$ (under CP)

$$xV_r = x\big[B - (p+\alpha)F + \delta\{xV_r + (1-x)V_s\}\big]$$
$$(1-x)V_s = (1-x)\big[B - (p-\beta)F + \delta\{xV_r + (1-x)V_s\}\big]$$

Add both sides

$$\begin{aligned}
\iff & xV_r + (1-x)V_s \\
&= B - [x(p+\alpha) + (1-x)(p-\beta)]F + \delta\{xV_r + (1-x)V_s\} \\
&= B - pF + \delta\{xV_r + (1-x)V_s\} \\
\iff & xV_r + (1-x)V_s = \frac{B - pF}{1-\delta} (= V)
\end{aligned}$$

IC conditions for CP, risky state, and safe state are equivalent!

By mean-preservation,

$$xV_r + (1-x)V_s = V$$

Incentive Conditions are the same:

$$\begin{aligned} V = B - pF + \delta V &\geqq 2B - pF, \\ V_r = B - (p+\alpha)F + \delta V &\geqq 2B - (p+\alpha)F, \\ V_s = B - (p-\beta)F + \delta V &\geqq 2B - (p-\beta)F. \end{aligned}$$

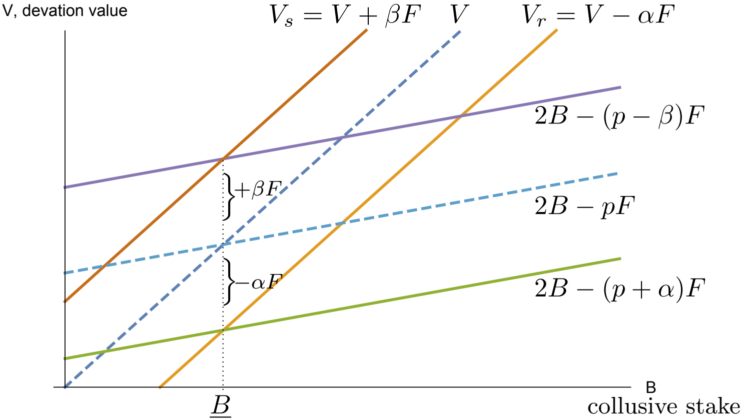
- Generalizes to any G

Note A firm pay the fine with the same prob. in (H, H) and (L, H).
L at (L, H): slight undercut of the monopoly price.

Proposition 1

Collusion is sustained under a CP $\iff$ collusion is sustained under ANY of its mean-preserving SP.

$$V = B - pF + \delta V \geqq 2B - pF,$$
$$V_r = B - (p+\alpha)F + \delta V \geqq 2B - (p+\alpha)F,$$
$$V_s = B - (p-\beta)F + \delta V \geqq 2B - (p-\beta)F.$$



Leniency Program

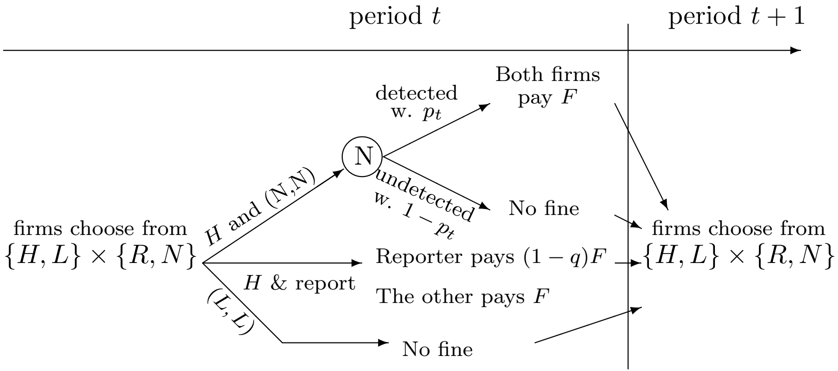
- Only the first informant gets a reduced fine at $(1-q)F$
  - The other firm must pay F.
- $0 < q \leqq 1$: amnesty rate (reduction of the fine)

New stage game

- Additional action choice: Report (R) to AA or Not (N)
- Firms simultaneously choose an action from $\{H, L\} \times \{R, N\}$

Note If (L, L), it is impossible to uncover collusion.
$\Rightarrow$ No difference between R and N.

New Timeline



Constant Policy with Leniency

We focus on the trigger strategy such that

- Play $\{(H, N), (H, N)\}$, as long as no firm deviates, and
- $\{(L, N), (L, N)\}$ forever after, if a firm deviates.

Deviating firm can choose between R(eport) and N(ot), to minimize the expected fine in that period.

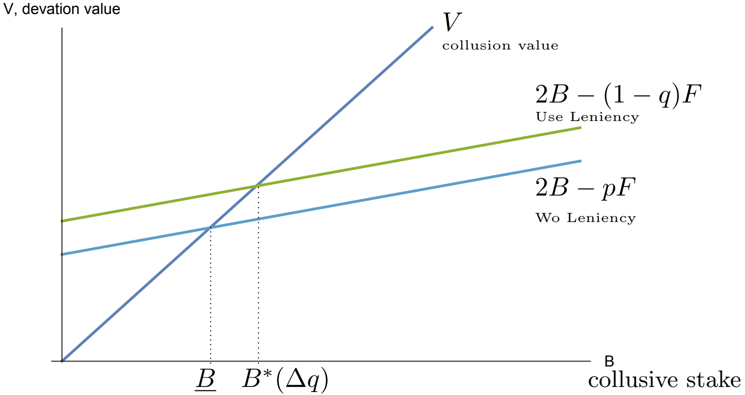
Collusion is sustainable iff

$$V = \frac{B - pF}{1 - \delta} \geqq 2B - \min\{pF, (1 - q)F\}. \tag{6}$$

- Attractive leniency: detection prob. > fine reduction

$$p > (1 - q) \iff q > 1 - p. \tag{7}$$

$\Rightarrow$ deviation payoff increases to $2B - (1-q)F > 2B - pF$
$\Rightarrow$ collusion more difficult



($\Delta q := q - (1-p) = q + p - 1$ (> 0): degree of fine reduction compared to stochastic detection)

Stochastic Policy with Leniency

Focus on

$$p_t = \begin{cases} p + \Delta p & \text{w. prob. } 1/2 \text{ (\textbf{risky} state)} \\ p - \Delta p & \text{w. prob. } 1/2 \text{ (\textbf{safe} state)} \end{cases}$$

- In each period, firms learn the realization of p_t **before** choosing actions.

  (Otherwise, the problem for firms is as if the detection prob. is always p = constant policy.)

- Collusion in both states (full collusion) is sustained iff

$$V_r := B - (p + \Delta p)F + \delta \frac{V_r + V_s}{2} \geqq 2B - \min\{(p + \Delta p)F, (1 - q)F\} \quad (8)$$

$$V_s := B - (p - \Delta p)F + \delta \frac{V_r + V_s}{2} \geqq 2B - \min\{(p - \Delta p)F, (1 - q)F\} \quad (9)$$

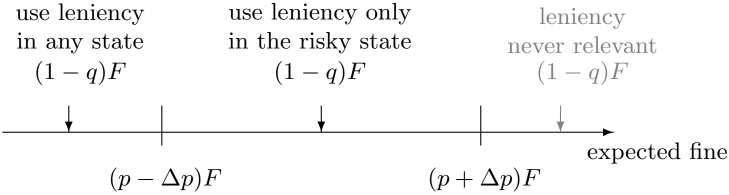
(V_x: starting in state x)

- Value of collusion: Starting in the safe state > starting in the risky state

  $V_s > V > V_r$

  (This generalizes to any dist. function G.)

- Two possibilities of the optimal deviation values



• Use leniency in any state:

(8), (9) become

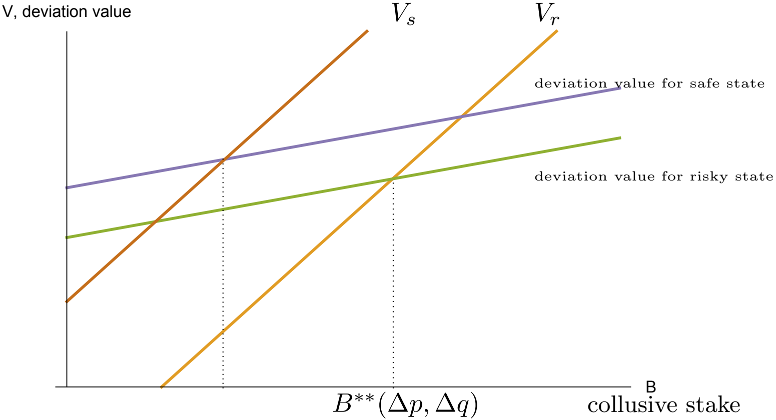
$$V_r \geqq 2B - (1-q)F$$
$$V_s \geqq 2B - (1-q)F$$

• Only in the risky state

$$V_r \geqq 2B - (1-q)F$$
$$V_s \geqq 2B - (p-\Delta p)F$$
$$(> 2B - (1-q)F)$$

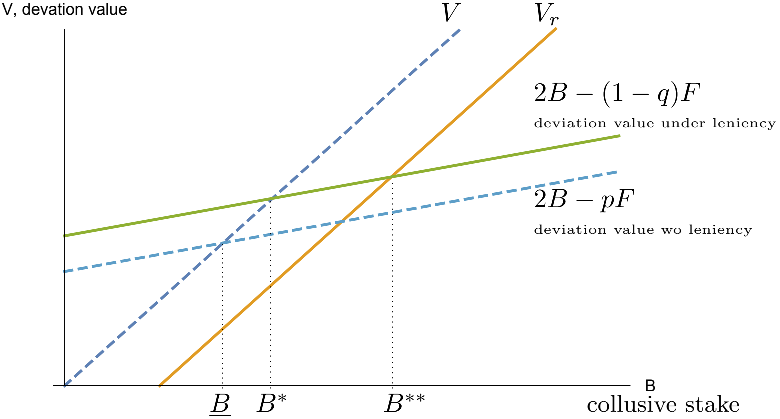
Enough to Deter Collusion in the Risky State

- $V_s > V_r$ for all B
- Deviation value same or higher for the safe state



$B \geqq B^{**}(\Delta p, \Delta q) \Rightarrow$ collusion in both states sustainable

Stochastic Policy w. Leniency Most Effective



Proposition 2

Leniency programs and stochastic cartel investigation policies complement each other.

Takeaways

- Without leniency

  mean-preserving stochastic policy vs. constant policy

  ⇒ same continuation value, same effect

- With leniency, **firms can choose the expected fine level**

  + By creating risky states, we can tempt firms to use the leniency.

  ⇒ Collusion in a risky state more difficult under SP
  Full collusion more difficult

- Stochastic policy:
  - Risky state occurs again and again!
  - Announce p_t

    (No announcement = constant policy)

Extensions

- n firms $\rightarrow$ analogous
- Different stage game: given a full collusion trigger strategy, analogous
- Generalize detection probability structure:
  - This model: same for (H, H) and $(L, H) \setminus (H, L)$
  - Other: higher under (H, H) than under $(L, H) \setminus (H, L)$

    If $p(L, H) = p(H, H) - \gamma$ and γ does not depend on the existence of a leniency program
    $\rightarrow$ same qualitative results Details
- "Partial collusion" (collude only in safe states)

  For some parameters, harder to do partial collusion than full collusion (lower long-run profit)

  enough to deter full collusion.

Thank you!

Higher prob. of fine under (H, H) than (L, H)

By the mean-preservation,

$$xV_r + (1-x)V_s = \frac{B - pF}{1-\delta} (= V)$$

New incentive Conditions:

$$\begin{aligned} V = B - pF + \delta V &\geqq 2B - (p - \gamma)F, \\ V_r = B - (p+\alpha)F + \delta V &\geqq 2B - (p + \alpha - \gamma)F, \\ V_s = B - (p-\beta)F + \delta V &\geqq 2B - (p - \beta - \gamma)F. \end{aligned}$$

The same analysis goes through.

Back to Extensions