Inspecting Cartels over Time: with and without Leniency Program

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New version coming soon! SSRN 4063062

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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 compare

1. **constant policies** = status quo
   same detecting prob. for every period.
2. **stochastic policies**
   detecting prob. fluctuates over time.
   colluding firms face multiple “states”.

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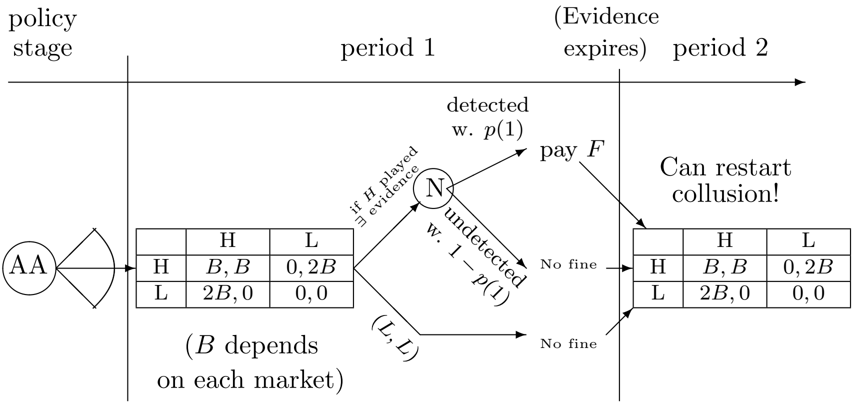
Under a **reduced Bertrand game**

- Without leniency: mean-preserving fluctuation does not matter! (Prop. 1, 2)
- With leniency: it matters!
  leniency + stochastic policy more effective (Prop. 3)

Chen-Rey Model: No Leniency



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

A constant policy: $p(t) = p$ for all $t = 1, 2, \ldots$ (status quo)

A stochastic policy: $p(t)$ follows some density g and firms learn $p(t)$ before the stage game in t

(Chen-Rey (2013) J Law Econ)

Status Quo: Constant Policy

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

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

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

- One-step deviation $\to (L, L)$ forever: $2B - pF + \delta\{0 + \cdots\}$

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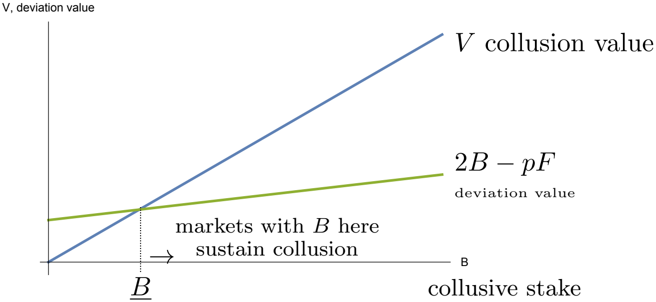

(Parameters: $(p, F, \delta) = (0.4, 100, 0.9)$)

- B varies across industries:
  - $\underline{B} \uparrow \Rightarrow$ collusion in **less** industries: policy **effective**

The police will conduct an intensive monitoring operation, lasting 24 hours,

(Finland police & Japanese police websites)

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- A stochastic policy: a (finite-support) stationary density function g with the support $\{p_1, p_2, \ldots, p_K\}$
  $(0 < \underline{p} \leqq p_1 < p_2 < \cdots < p_K \leqq \overline{p} < 1)$

Assumptions

(i) $p < \overline{p}$. (Temporarily strong monitoring.)

(ii) However, the total resource of the AA is the same as the status quo: **Mean preservation**

$$\sum_{k=1}^{K} p_k \cdot g(p_k) = p.$$

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- AA announces g and realization every period $\rightarrow$ stochastic policy
  No announcement = constant policy with p

Equal Effect without Leniency

Proposition 1

Collusion is sustained in a SPE under the status quo constant p $\iff$ full collusion in all states is sustained in a SPE under **any** stochastic policy with mean p.

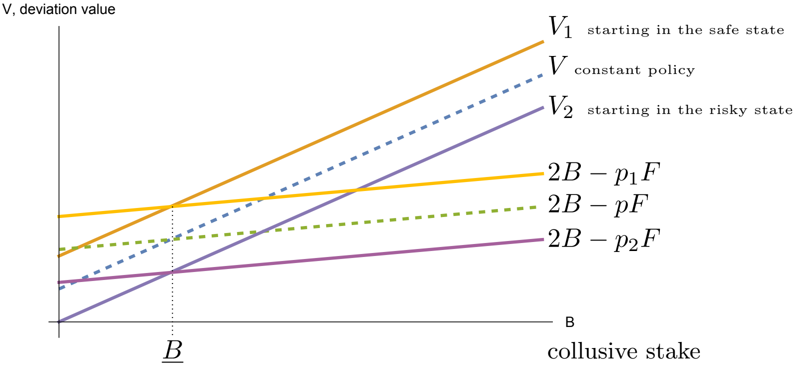
Intuition

Collusion in state p_k is sustained iff comp

$$V_k = B - p_k F + \delta \frac{\overbrace{B - pF}^{V}}{1-\delta} \geqq 2B - p_k F$$
$$\iff V = B - pF + \delta \frac{B - pF}{1-\delta} \geqq 2B - pF (\iff B \geqq \underline{B}).$$

Same condition as the status quo's.

Example: $p = 0.4 \to \text{supp}(g) = \{p_1, p_2\} = \{0.2, 0.6\}$



(Parameters: $(p, F, \delta, p_1, p_2) = (0.4, 100, 0.9, 0.2, 0.6)$)

Note For this result,

the detection prob. at (H, H) and (L, H) need not be the same.

Enough to assume: $p(L, H) = p(H, H) - \gamma$ and γ is a constant.

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- Firms can choose to collude only in low p_k states
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- **Lemma**: Take $\text{supp}(g) = \{p_1, p_2\}$, $p_1 < p_2$.
  Partial collusion in only the (safer) state p_1 is deterred for **any** B

$$\iff g(p_1) \leqq \frac{1-\delta}{\delta} \quad (< 1 \Leftarrow \delta > \frac{1}{2}).$$

Prop 2: Extended Equal Effect

both constant p
& binary with $g(p_1) \leqq \frac{1-\delta}{\delta}$
prevent full
and partial collusion

neither constant p
nor stochastic policy w. mean p
can prevent full collusion

B

$\underline{B}$ collusive stake

Leniency Program

- A colluding firm can report to the AA
- Assumption: Only the first informant gets a reduced fine at qF $(q < 1)$.

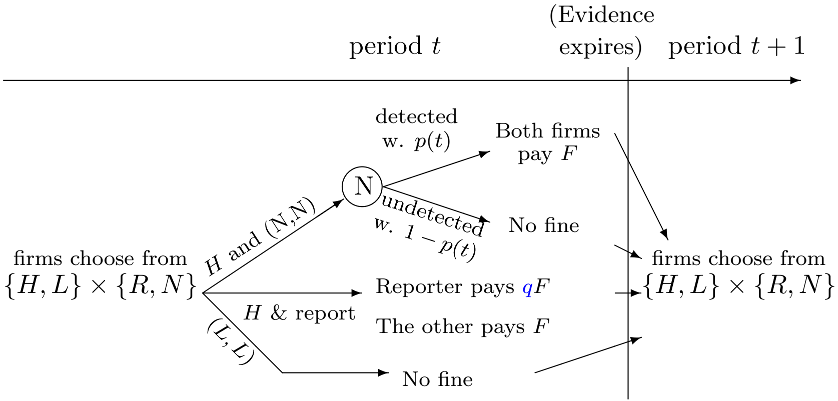
New stage game

- Additional action choice: Report (R) to AA or Not (N)
- Firms simultaneously choose an action from $\{H, L\} \times \{R, N\}$
- Collusion target $= (H, N)$ played by both.

Assumption

$qF < pF$ (the leniency system relevant)

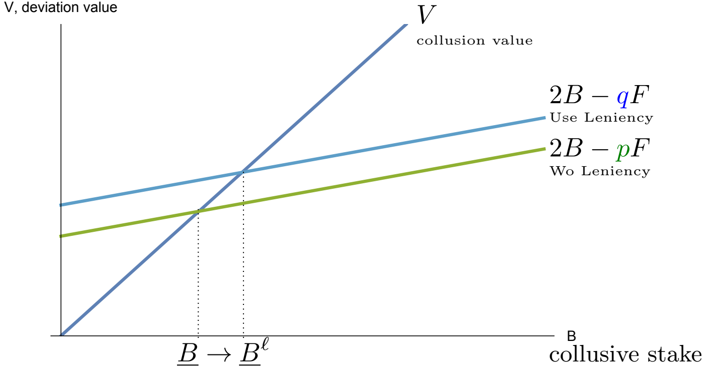
New Timeline



Constant Status Quo with Leniency

Collusion is sustainable iff

$$V = \frac{B - pF}{1 - \delta} \geqq 2B - \min\{pF, qF\} = 2B - qF. \quad (1)$$



(Parameters: $(p, q, F, \delta) = (0.4, 0.35, 100, 0.9)$)

Attractive leniency makes deviation tempting = collusion more difficult! (Even if evidence lasts a short time.)

Stochastic Policy with Leniency

- Focus on binary stochastic policies with the support $0 < \underline{p} \leqq p_1 < p_2 \leqq \overline{p}$ & density g.

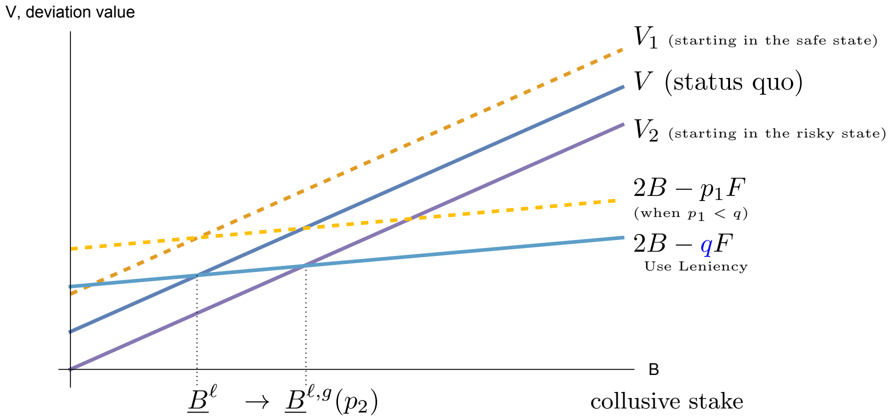
  to minimize the variety of possible partial collusion.

- $g(p_1)p_1 + g(p_2)p_2 = p \Rightarrow \overbrace{q < p}^{\text{assumption}} < p_2$

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

$$V_1 = B - p_1 F + \delta V \geqq 2B - \min\{p_1 F, qF\} \quad (2)$$
$$V_2 = B - p_2 F + \delta V \geqq 2B - qF \quad (3)$$

- Leniency weakly increases the deviation value in all states

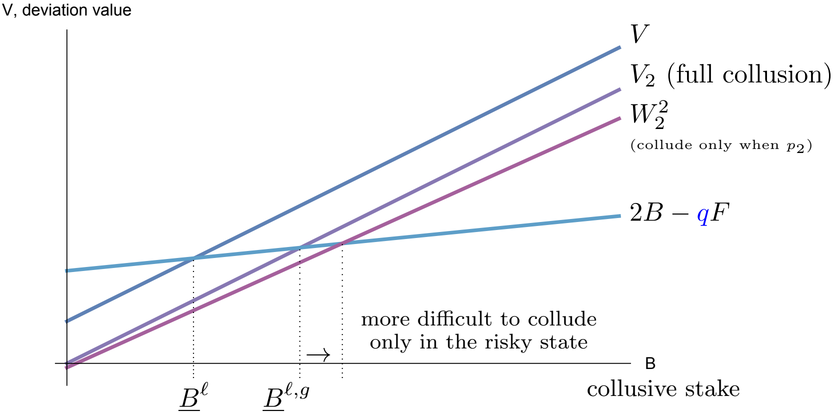


(Parameters: $(p, q, F, \delta, p_1, p_2) = (0.4, 0.35, 100, 0.9, 0.2, 0.6)$)

Lemma

With leniency,
full collusion (in all states) sustainable iff [(H,H),(N,N)] sustained in the risky state 2.

Partial Collusion?



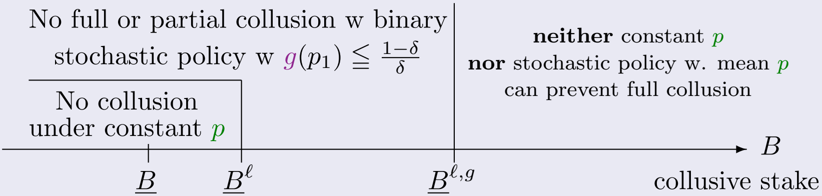
(Parameters: $(p, F, \delta, q, p_1, p_2, g(p_2)) = (0.4, 100, 0.9, 0.35, 0.2, \frac{19}{45} \approx 0.422, 0.9)$)

- Partial collusion in $\overset{\text{lowest}}{p_1}$ is deterred for **any** B iff $g(p_1) \leqq \frac{1-\delta}{\delta}$

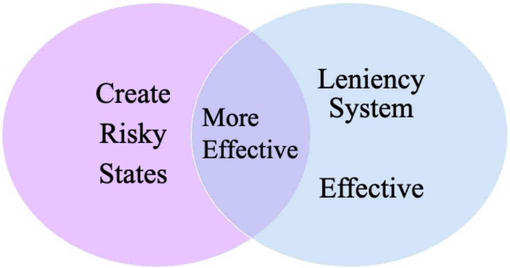
Synergy of Stochastic Policies and Leniency

Prop. 3: Stronger Effect

Under leniency with $q < p$,



Conclusion



- Extensions
  - n firms $\rightarrow$ analogous
  - Different stage game: given a full collusion trigger strategy, analogous
  - Optimal stochastic policy? Idea
  - Deterministic multi-state policy?

Thank you!

Continuation value same for all states

$$V_1 := B - p_1 F + \delta \sum_{k=1}^{K} g(p_k) V_k$$

$$\dots$$

$$V_K := B - p_K F + \delta \sum_{k=1}^{K} g(p_k) V_k.$$

$$\begin{aligned}
\Rightarrow \sum_{k=1}^{K} g(p_k) V_k &= \sum_{k=1}^{K} g(p_k)[B - p_k F + \delta \sum_{k=1}^{K} g(p_k) V_k] \\
&= B - \sum_{k=1}^{K} g(p_k) p_k F + \delta \sum_{k=1}^{K} g(p_k) V_k \\
\Rightarrow \sum_{k=1}^{K} g(p_k) V_k &= \frac{B - pF}{1-\delta} \quad (\Leftarrow \sum_{k=1}^{K} g(p_k) = 1, \sum_{k=1}^{K} p_k g(p_k) = p) \\
\Rightarrow V_k &= B - p_k F + \delta \frac{B - pF}{1-\delta}, \quad \forall k = 1, 2, \dots, K.
\end{aligned}$$

Back

"Optimal" Policy?

- Prevent all (endogenous) partial collusion (= impose $g(p_1) \leqq \frac{1-\delta}{\delta}$) + max $\underline{B}^{\ell,g}$
- $g(p_1) > \frac{1-\delta}{\delta}$ and maximize the range of B that prevents full and partial collusion

Optimal Partial-collusion-proof Binary Policy

Under leniency with $q < p$, the optimal binary policy such that
(i) firms have no strict incentive to partially collude, and
(ii) the range of markets that sustain full collusion is minimal
is as follows.

If $\overline{p} \leqq \frac{\delta p-(1-\delta)\underline{p}}{2\delta-1}$, then $\{p_1, p_2\} = \{\underline{p}, \overline{p}\}$ and $g(\underline{p}) = \frac{\overline{p}-p}{\overline{p}-\underline{p}} (\leqq \frac{1-\delta}{\delta})$.

If $\overline{p} > \frac{\delta p-(1-\delta)\underline{p}}{2\delta-1}$, then $\{p_1, p_2\} = \{\underline{p}, \frac{\delta p-(1-\delta)\underline{p}}{2\delta-1}\}$ and $g(\underline{p}) = \frac{1-\delta}{\delta}$.

- Binary + No partial collusion → set $g(p_1) \leqq \frac{1-\delta}{\delta}$ and increase p_2

Back to Conclusions