

EconS 594 – Ph.D. Industrial Organization

Fall 2026

Collusion, Leniency Programs, and Whistleblower Rewards

Setup

Consider two firms selling a homogeneous product and competing à la Bertrand. They face a linear demand function $Q(p) = 1 - p$, where Q denotes aggregate output and p represents the market price. Both firms have the same marginal cost, normalized to $c = 0$. Firms interact in an infinitely repeated game with common discount factor $\delta \in (0, 1)$ and use grim-trigger strategies: any deviation from a collusive agreement triggers permanent reversion to the static Bertrand–Nash equilibrium.

We use the following notation throughout:

- π^m : monopoly profit. Solving $\max_{p \geq 0} p(1 - p)$ yields $p^m = \frac{1}{2}$ and $\pi^m = \frac{1}{4}$.
- $\pi^c = \frac{\pi^m}{2} = \frac{1}{8}$: each firm's collusive profit (equal split).
- $\pi^d = \pi^m = \frac{1}{4}$: deviation profit (undercut the collusive price by ε and capture all sales).
- $\pi^n = 0$: Nash equilibrium profit (Bertrand with symmetric costs).

Part (a). No fines

When the competition authority (CA) does not monitor collusion, each firm compares the present value of colluding forever with the payoff from a one-shot deviation followed by permanent Nash punishment. Collusion is sustainable if

$$\frac{\pi^c}{1 - \delta} \geq \pi^d + \frac{\delta}{1 - \delta} \pi^n.$$

Substituting $\pi^c = \frac{1}{8}$, $\pi^d = \frac{1}{4}$, and $\pi^n = 0$, and rearranging:

$$\frac{1}{8} \geq (1 - \delta) \frac{1}{4} \quad \implies \quad \delta \geq \bar{\delta} = \frac{1}{2}.$$

Interpretation. When firms are sufficiently patient ($\delta \geq 1/2$), the long-run gain from collusion outweighs the short-run temptation to deviate. This threshold, $\bar{\delta} = 1/2$, is the benchmark we compare against when enforcement tools are introduced below.

Part (b). Antitrust audits

Suppose the CA audits the industry in every period with probability $\alpha \in [0, 1]$. If collusion is detected, each firm pays a fine $F > 0$. Both colluding and deviating firms face the expected fine αF in the current period (the cartel was active that period). The sustainability condition becomes

$$\frac{1}{1 - \delta} (\pi^c - \alpha F) \geq (\pi^d - \alpha F) + \frac{\delta}{1 - \delta} \pi^n.$$

Since $\pi^c = \frac{1}{8}$, $\pi^d = \frac{1}{4}$, and $\pi^n = 0$:

$$\frac{1}{8} - \alpha F \geq (1 - \delta) \left(\frac{1}{4} - \alpha F \right).$$

Solving for δ :

$$\delta \geq \bar{\delta}_A(\alpha, F) \equiv \frac{1}{2(1 - 4\alpha F)}.$$

This threshold falls below one, $\bar{\delta}_A < 1$, only when $\alpha F < \frac{1}{8}$, that is, when

$$F < \frac{1}{8\alpha}.$$

If instead $F \geq \frac{1}{8\alpha}$, then $\bar{\delta}_A \geq 1$ and no discount factor $\delta \in (0, 1)$ sustains collusion: the expected fine alone deters the cartel, leaving nothing for a leniency or whistleblower program to add. We therefore maintain

$$F < \frac{1}{8\alpha}$$

for the rest of the handout, so that collusion is sustainable in this audit benchmark and the enforcement tools below have a cartel to break.

Comparative statics.

$$\frac{\partial \bar{\delta}_A}{\partial \alpha} = \frac{2F}{(1 - 4\alpha F)^2} > 0, \quad \frac{\partial \bar{\delta}_A}{\partial F} = \frac{2\alpha}{(1 - 4\alpha F)^2} > 0.$$

Both a more severe fine (F) and a more likely audit (α) raise the minimal discount factor, making collusion harder to sustain. Since $\bar{\delta}_A \geq \bar{\delta} = \frac{1}{2}$ for all $\alpha F \geq 0$, audits unambiguously hinder collusion.

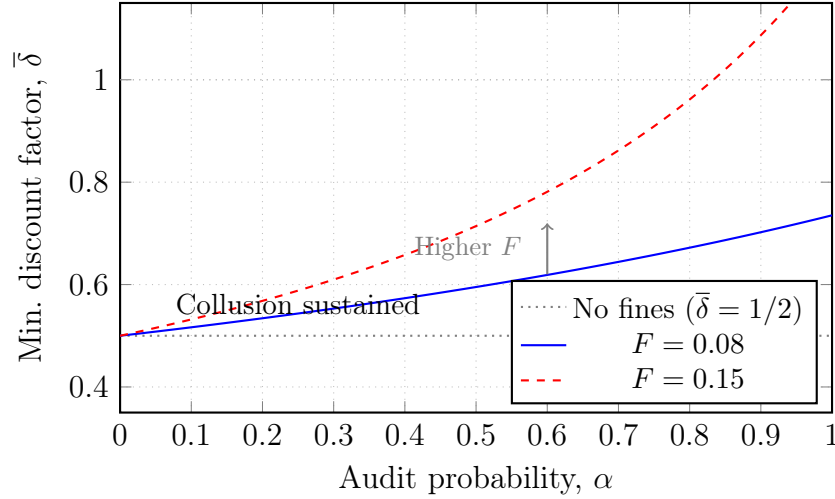


Figure 1. Minimal discount factor under audits, $\bar{\delta}_A(\alpha, F) = \frac{1}{2(1 - 4\alpha F)}$. An increase in F shifts the curve upward, shrinking the region where collusion can be sustained ($\delta \geq \bar{\delta}_A$).

Part (c). Leniency programs

The CA now offers a leniency program: a firm that provides evidence about collusion receives a reward R , where $R > -\alpha F$. The reward can be negative (a reduced sentence, $0 > R > -\alpha F$) or positive (a cash bounty plus no jail time, $R > 0$). A deviating firm can simultaneously deviate and report the cartel, collecting R instead of facing the expected fine. Recall from Part (b) that we maintain $F < \frac{1}{8\alpha}$, so that collusion is sustainable to begin with and the program has a cartel to deter.

The sustainability condition becomes

$$\frac{1}{1 - \delta} (\pi^c - \alpha F) \geq (\pi^d + R) + \frac{\delta}{1 - \delta} \pi^n.$$

The colluding firm still faces the expected fine αF , but the deviating firm now receives R instead. Substituting and simplifying:

$$\frac{1}{8} - \alpha F \geq (1 - \delta) \left(\frac{1}{4} + R \right).$$

Solving for δ :

$$\delta \geq \bar{\delta}_L(\alpha, F, R) \equiv \frac{1 + 8(R + \alpha F)}{2(1 + 4R)}.$$

Comparison with audits. We have $\bar{\delta}_L \geq \bar{\delta}_A$ if and only if

$$\frac{1 + 8(R + \alpha F)}{2(1 + 4R)} \geq \frac{1}{2(1 - 4\alpha F)}.$$

Cross-multiplying:

$$[1 + 8(R + \alpha F)](1 - 4\alpha F) \geq 1 + 4R.$$

Expanding and simplifying yields $4(R + \alpha F)(1 - 8\alpha F) \geq 0$, which holds since $R + \alpha F > 0$ and, because $\alpha F < \frac{1}{8}$ from Part (b), $1 - 8\alpha F > 0$. Therefore $\bar{\delta}_L \geq \bar{\delta}_A$: leniency programs hinder collusion beyond audits alone.

Comparative statics.

$$\frac{\partial \bar{\delta}_L}{\partial R} = \frac{2(1 - 8\alpha F)}{(1 + 4R)^2}, \quad \frac{\partial \bar{\delta}_L}{\partial \alpha} = \frac{4F}{1 + 4R} > 0, \quad \frac{\partial \bar{\delta}_L}{\partial F} = \frac{4\alpha}{1 + 4R} > 0.$$

A more severe or more likely fine increases $\bar{\delta}_L$, hindering collusion. Since $F < \frac{1}{8\alpha}$ from Part (b), we have $1 - 8\alpha F > 0$, so a more generous reward R also increases $\bar{\delta}_L$, making collusion harder to sustain.

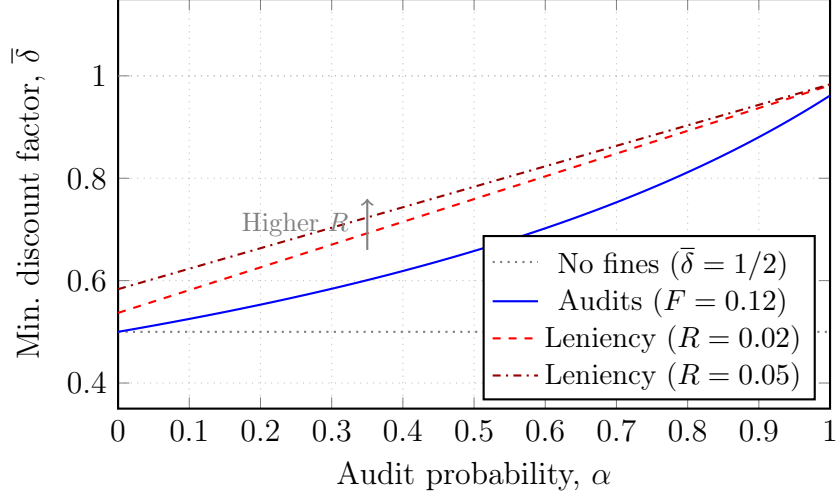


Figure 2. Minimal discount factor under audits vs. leniency (with $F = 0.12$). The leniency curve lies above the audit curve for all α , and an increase in R shifts it further upward.

Part (d). Whistleblower programs

This part extends the analysis following Aubert, Rey, and Kovacic (2006). That paper distinguishes between leniency programs (which reduce the fine paid by a cartel *firm* that self-reports) and whistleblower programs (which pay a bounty to *employees* who report the cartel to the CA).

Model. Suppose each firm employs $n \geq 1$ workers who observe whether the firm participates in the cartel. The CA offers a whistleblower bounty $B > 0$ to any employee who reports evidence of collusion. If an employee reports, the CA obtains hard evidence, convicts the cartel, and the employee collects B .

To prevent its n employees from reporting, each colluding firm must pay each worker a “bribe” of at least B per period. The total cost of silencing all employees is therefore nB per period per firm, as in Aubert et al. (2006). A deviating firm must also pay the bribe in the current period, since its employees observed past collusive communication and could still report to the CA. After the cartel collapses (Nash reversion), there is no collusive evidence to report, so no bribes are needed.

Collusion condition. With the whistleblower program in place (alongside audits), per-period collusive profits become $\pi^c - \alpha F - nB$, deviation profits become $\pi^d - \alpha F - nB$, and

Nash-reversion profits remain $\pi^n = 0$. The sustainability condition is

$$\frac{1}{1-\delta} (\pi^c - \alpha F - nB) \geq (\pi^d - \alpha F - nB) + \frac{\delta}{1-\delta} \pi^n.$$

Substituting and simplifying:

$$\frac{1}{8} - \alpha F - nB \geq (1-\delta) \left(\frac{1}{4} - \alpha F - nB \right).$$

Solving for δ :

$$\delta \geq \bar{\delta}_W(\alpha, F, n, B) \equiv \frac{1}{2(1 - 4\alpha F - 4nB)}.$$

This expression has the same structure as the audit threshold $\bar{\delta}_A$ but with αF replaced by $\alpha F + nB$. It is well defined when $\alpha F + nB < \frac{1}{8}$.

Comparative statics.

$$\frac{\partial \bar{\delta}_W}{\partial B} = \frac{2n}{(1 - 4\alpha F - 4nB)^2} > 0, \quad \frac{\partial \bar{\delta}_W}{\partial n} = \frac{2B}{(1 - 4\alpha F - 4nB)^2} > 0.$$

A larger bounty (B) and more informed employees (n) both raise $\bar{\delta}_W$, making collusion harder to sustain. The mechanism operates through the cost of keeping employees silent: higher B or more employees forces each firm to spend more on bribes, which erodes the per-period return from collusion.

Comparison with audits. Since $nB > 0$, the denominator in $\bar{\delta}_W$ is smaller than that in $\bar{\delta}_A$, so $\bar{\delta}_W > \bar{\delta}_A$ for all parameter values: whistleblower programs provide additional deterrence beyond audits alone.

Comparison with leniency. The ranking between $\bar{\delta}_W$ and $\bar{\delta}_L$ depends on the magnitude of the total bribe nB relative to the leniency reward R . Comparing:

$$\bar{\delta}_W = \frac{1}{2(1 - 4\alpha F - 4nB)} \quad \text{vs.} \quad \bar{\delta}_L = \frac{1 + 8(R + \alpha F)}{2(1 + 4R)}.$$

The whistleblower program is more effective ($\bar{\delta}_W \geq \bar{\delta}_L$) if and only if

$$1 + 4R \geq [1 + 8(R + \alpha F)](1 - 4\alpha F - 4nB) \quad \Longleftrightarrow$$

$$nB \geq \frac{\left(\frac{1}{8} - \alpha F\right)(\alpha F + R)}{\frac{1}{8} + \alpha F + R}.$$

Under the maintained assumption $\alpha F < \frac{1}{8}$, the right-hand side is positive, so the whistleblower program dominates leniency only if the total bribe nB exceeds this threshold.

Numerical illustration. Set $F = 0.12$, $R = 0.04$, $n = 2$, $B = 0.02$ (so $nB = 0.04$). At $\alpha = 0$, the threshold equals $\frac{(1/8)(0.04)}{1/8 + 0.04} = \frac{0.005}{0.165} \approx 0.030$, which is less than $nB = 0.04$. As α increases, the threshold decreases further. Hence $\bar{\delta}_W > \bar{\delta}_L$ for all α under these parameters.

Full ranking. Combining the results across parts (a)–(d):

$$\bar{\delta}_W \geq \bar{\delta}_L \geq \bar{\delta}_A \geq \bar{\delta} = \frac{1}{2}.$$

Each enforcement tool shrinks the set of discount factors $[\bar{\delta}, 1)$ that sustain collusion. The whistleblower program provides the strongest deterrence (when nB is large enough), followed by leniency, audits, and no enforcement.

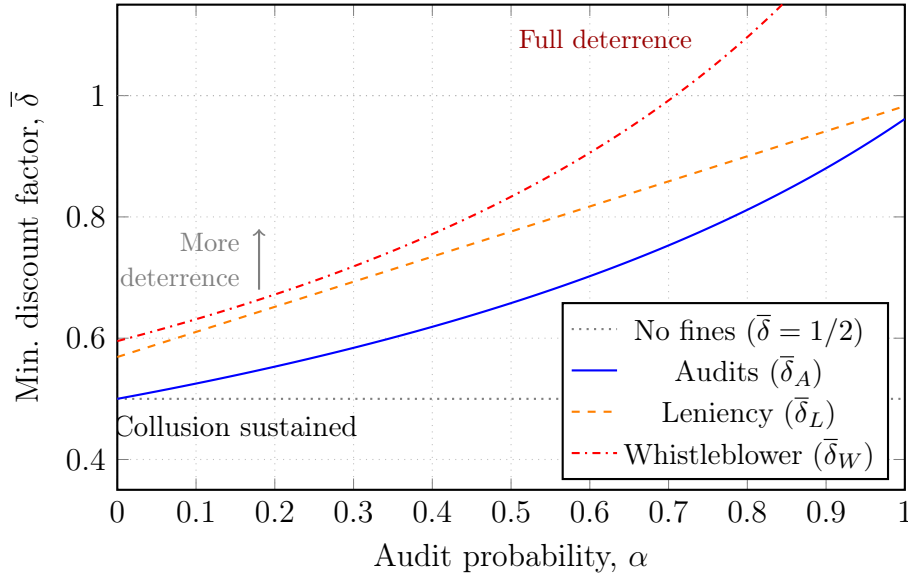


Figure 3. Minimal discount factor under all four regimes ($F = 0.12$, $R = 0.04$, $n = 2$, $B = 0.02$). For a given α , collusion is sustained for $\delta \geq \bar{\delta}$; above $\bar{\delta} = 1$, collusion is deterred for all discount factors. An increase in F , R , n , or B shifts the respective curve upward.

Interpretation. Aubert, Rey, and Kovacic (2006) emphasize that whistleblower programs attack cartel stability from a different margin than leniency: rather than rewarding a firm

for betraying its partner, they reward an *individual* for betraying the firm. This forces the cartel to internalize the cost of keeping employees silent (nB per period), which reduces the per-period return from collusion even when the firms themselves would never self-report. The two instruments are complementary: leniency programs destabilize the cartel agreement between firms (by making deviation more attractive via the reward R), while whistleblower rewards raise the operating cost of the cartel (by forcing silence payments to n employees).

These programs in practice

The two instruments in this exercise are used by competition authorities around the world. The modern leniency program began in the United States, where the Department of Justice adopted a corporate leniency policy in 1978 and, after it went almost unused, rewrote it in 1993 to grant automatic amnesty to the first firm that reports a cartel (the reward R of Part (c)). The European Commission issued its first Leniency Notice in 1996, revising it in 2002 and 2006. Adoption then spread to developing and emerging economies: Brazil enacted a leniency program in 2000, South Africa in 2004, and India in 2009, each granting the first cooperating firm full or near-full immunity. The whistleblower bounty B of Part (d) is also real. South Korea introduced individual informant rewards in 2002, paying an employee who reports a cartel up to 3 billion won, and the United Kingdom's Competition and Markets Authority raised its cartel whistleblower reward to £250,000 in 2023.

Two cases show the mechanism at work. In the international vitamins cartel, Rhône-Poulenc (later Aventis) escaped criminal fines in 1999 by being the first member to cooperate under the U.S. program, while its partners F. Hoffmann-La Roche and BASF pleaded guilty and paid \$500 million and \$225 million. In the air-cargo cartel, Lufthansa's leniency application set off a worldwide investigation that led the European Commission to fine 11 carriers about 799 million euros in 2010.

References

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