Review of Industrial Organization (2022) 61:297–315
https://doi.org/10.1007/s11151-022-09875-w

Ringleader Discrimination in Leniency Policies

Konstantinos Charistos[1,2]

Accepted: 15 June 2022 / Published online: 7 July 2022

Abstract
This paper studies whether excluding the cartel ringleader from "leniency programs" (LPs) hinders collusion. The ringleader's exclusion from any leniency right: (a) destabilizes cartels by creating asymmetry in the partners' collusive payoffs; and (b) fosters cartel activity by reducing the ringleader's payoff from deviation. The discriminatory LP can increase the ringleader's credibility as loyal partner and weaken firms' incentive to deviate. A partially discriminatory LP that allows the ringleader to receive leniency only when it denounces a cartel that is not under investigation but not when cooperating in an already launched investigation eliminates (b). By restoring the ringleader's payoff from deviation at its non-discriminatory level, partial discrimination is more effective in destabilizing collusion compared to both, full- and non-discrimination.

Keywords Antitrust enforcement · Collusion · Leniency programs · Ringleader discrimination

JEL Classification K21 · L12 · L41

1 Introduction

Most jurisdictions have adopted "leniency programs" (LPs) in an attempt to destabilize existing cartels and discourage the formation of new ones. LPs offer the possibility for cartel members to report the existence of the infringement and to cooperate

✉ Konstantinos Charistos
kostchar@uom.edu.gr

[1] Department of Economics, University of Macedonia, 156 Egnatia Street, 546 36 Thessaloniki, Greece

[2] Department of Economics, University of Crete, Rethymno, Greece

with competition authorities by offering evidence and/or information that can be used as proof of the illegal conduct in the prosecution phase. In exchange, any fines that are related to that firm's cartel participation are partially or completely waived.[1]

LPs may recognize and reward two distinct types of cooperation. *Pre-investigation* leniency encourages reporting to the antitrust authority (AA) by one or more members of a cartel that has not yet been detected. *Post-investigation* leniency rewards the voluntary provision of evidence that helps the AA to confirm whether an investigated market has been cartelized, and eventually provide legal proof of its accusations towards cartel participants in order to be able to administer penalties.[2]

The present paper investigates the impact of introducing discrimination in the treatment of cartel instigators or ringleaders on the sustainability of collusive agreements. There exist jurisdictions that exclude ringleaders from the possibility of receiving fine reductions: the United States (US) corporate leniency policy – which excludes firms that coerce others to participate or that were the leader in (originator of) the anticompetitive activity – is a prominent example.[3] On the other hand, the European LP does not include provisions for cartel instigators.[4]

Jurisdictions that deny leniency to ringleaders count on the fact that such a practice discourages cartel formation by making potential instigators less willing to engage in collusive arrangements, due to their eventually harsher treatment in case of conviction. However, the exclusion of the ringleader may increase trust among cartel participants by offering a credible commitment never to report the cartel to the AA. The final effect of excluding the ringleader from the LP is uncertain: It depends on the balance of these two effects.

1.1 Related Literature and Contribution

The LP-related literature highlights possible adverse effects of LPs and proposes their optimal design.[5] Harrington (2008) identifies the effects of leniency on cartel deterrence: He notes that LPs: i) destabilize collusion by increasing the (private) appeal of deviation (the *deviator's effect*); and ii) favor collusion through the implicit reduction of expected fines (the *cartel amnesty effect*). In addition, a sufficiently generous LP that offers leniency only to the first informant increases the expected penalties by inducing the "*race to the court*". This effect works against cartel stability. A well-designed policy must rely on a balanced tradeoff of these effects.

[1] Wils (2016) quotes statistics with regard to the European Commission's cartel decisions that indicate an increasing importance of the European LP on the frequency of cartel convictions.

[2] In the United States penalties are imposed directly by the courts. In Europe, the AA is able to impose penalties directly; but unless its arguments are legally sound, its decisions can be reversed by the courts.

[3] In addition, the LPs in Brazil and Switzerland disqualify a leniency applicant by the ringleader of the cartel.

[4] The European LP excludes coercers from receiving full immunity from fines. The term "ringleader" in this work refers to firms that have instigated the voluntary participation of other firms in forming a cartel, without using coercive methods.

[5] See Motta and Polo (2003), Spagnolo (2004), Harrington (2008), and Chen and Rey (2013), to name just a few.

Blatter et al. (2018) examine the impact of LP features on cartel deterrence under the assumptions that: a) a single firm's cartel reporting is not sufficient to secure conviction; and b) firms may possess asymmetric evidence. It is shown that ringleader discrimination (RD henceforth) can be beneficial since the ringleader is less willing to set up a cartel in the absence of leniency.

Chen et al. (2015) study the implications of denying leniency to cartel ringleaders under the assumption that firms have the opportunity to report after an investigation has been launched. It identifies the impact of such exclusion on the sustainability of the collusive agreement and concludes that, while the anticipated harsher treatment may reduce the ringleader's incentive to instigate a cartel, the incentive of other firms to come forward is also mitigated. Under RD cartel formation may be less frequent; but once a cartel is created, whistle blowing and evidence provision become less likely.

Clemens and Rau (2019) experimentally find that RD enhances trust among infringers. Cartels emerge less frequently under a non-discriminatory LP; this is a result that points against the use of RD.

Our contribution to the theoretical literature is twofold: First, we examine the impact of the discriminatory LP considering that firms can report not only while an investigation is underway, but also *before* any investigation has been launched. This highlights two countervailing effects of discriminatory policies: Excluding the ringleader from any leniency provision: a) creates an asymmetry that is destabilizing for the cartel; and b) reduces the ringleader's payoff from deviation.

Second, we propose an alternative leniency scheme: The ringleader's eligibility for leniency depends on whether the cartel is already under investigation: Leniency is available for the ringleader only in the event of pre-investigation reporting. Allowing the ringleader to benefit from pre-investigation leniency restores its payoff from deviation at the non-RD level, while excluding the ringleader from leniency when the AA already possesses incriminating evidence weakens the ringleader's incentive to adhere to collusion. We show that a partially discriminatory LP undermines collusion more efficiently compared to either a fully exclusionary LP, or a non-discriminatory LP.

The paper proceeds as follows: Sect. 2 contains the model specifications. Section 3 presents the analysis of the model. Section 4 includes an extension; and Sect. 5 concludes.

2 The Model

In a duopoly firms produce homogeneous goods and compete in prices for an infinite number of periods.[6] They maximize the expected sum of future discounted profits and use a common discount factor $\delta \in (\frac{1}{2}, 1)$.[7] During each period a competition-versus-collusion game takes place: If all firms set the collusive price, each one earns an amount of profit: π. When one firm unilaterally deviates by undercutting the

[6] Our findings are robust for $n > 2$, where n represents the number of firms in the market.

[7] For $\delta < 0.5$ collusion is not sustainable even in the absence of antitrust policy.

collusive price marginally, it receives 2π while the other firm gets zero. The competitive gross profits are zero.

A cartelized industry has a probability $a \in (0, 1)$ to be the object of an independently initiated investigation by the AA. We assume that a cartel that is already under scrutiny has a probability $1 - \rho$, with $\rho \in (0, 1)$, to escape conviction. This reflects the fact that usually the AA's actions (dawn-raids, etc.) uncover only a portion of the necessary evidence that would assure conviction. This fact is acknowledged by most AAs, which offer post-investigation leniency to those firms that are willing to provide additional evidence. While we consider it possible for guilty firms not to be convicted, false conviction of innocent firms is ruled out.

Fines The AA announces the fine for convicted firms.[8] The fine consists of: a) a fixed amount $f \geq 0$; and b) a variable component $\mu\Pi$, where Π denotes the current period profit (e.g., $\Pi = \pi$ when both firms collude) and $\mu \geq 0$.

The fine for an infringer that receives Π is $\lambda\mu\Pi + (1 - \lambda)f$; the parameter $\lambda \in [0, 1]$ measures the proportionality of the penalty.[9] The overall penalty for colluding firms that receive the profit π is a given amount φ, while the fine for a firm that earns $\Pi > (<)\pi$ increases (reduces) with λ. The penalty φ must be independent of λ; if we set $f = \mu\pi$, the fine equals $\varphi = \lambda\mu\pi + (1 - \lambda)f = \mu\pi$.

Profit-proportional fines imply that, if the cartel is convicted at the moment where a firm deviates, that firm will pay a higher fine due to its temporarily higher profit. The fine for a defecting firm that receives $\Pi = 2\pi$ becomes

$$\lambda\mu 2\pi + (1 - \lambda)f = (1 + \lambda)\mu\pi \geq \varphi = \mu\pi.$$

The fine for the non-defecting firm that receives zero profit is $\lambda\mu 0 + (1 - \lambda)f = (1 - \lambda)\mu\pi \leq \varphi$.[10]

The following assumption assures that the expected gain from collusion exceeds the competitive outcome:

Assumption : $\pi - a\varphi > 0 \Leftrightarrow \mu < \frac{1}{a}$.

The LP provides full immunity to a cartel member that reports the existence of the infringement and collaborates with the AA. This collaboration is possible at two different moments: a firm may: a) "spontaneously" report the existence of a cartel before any investigation is underway; and b) provide evidence in addition to what is already possessed by the AA for a cartel that is already under investigation.

A common feature among LP-related legislation in different countries is that it restricts leniency to only a limited number of applicants – usually on a first-come-first-served basis. Even in jurisdictions where multiple applicants are eligible, their treatment is asymmetric, with the "early birds" receiving substantially more

[8] The US fines are restricted to not more than twice the gross gain that is derived from the cartel; see Harrington (2014), Katsoulakos et al. (2015).

[9] Note that if the fine equals $\mu\Pi + f$, changes in μ or f affect both the fine's proportionality and its overall level.

[10] Observe that for $\lambda = 0$ the fine is fixed: Regardless of the profit convicted firms pay $f = \mu\pi$.

generous treatment.[11] Since the analyzed market is a duopoly, we assume that only one firm can benefit from the LP and receives a full-fine discount. Unless the ringleader is a priori excluded from the LP, if both firms decide simultaneously to provide evidence, we assume that each firm has a 50% chance to receive the discount.

We name one firm the ringleader of the conspiracy: firm 1. With regard to the non-ringleader (firm 2), we use alternatively the term follower. Both firms possess "perfect evidence" in the sense that either firm's confession suffices to convict the cartel with certainty.[12]

After the AA has announced the policy parameters, firm 1 can act as the ringleader of the conspiracy and propose to set up a cartel. If the ringleader instigates, the follower decides whether to accept or not. If the follower refuses to collude, or the ringleader does not instigate, both firms receive a zero payoff for this period. If the ringleader instigates and the follower accepts, a subgame starts with the following timing:

Stage 1. In all subsequent periods firms choose whether to remain loyal to the cartel, or to defect by undercutting the agreed price. At the same time firms decide simultaneously whether to report the agreement to the AA. At this stage each firm has four available actions: remaining loyal or defecting; and, simultaneously, reporting or not reporting to the AA. A deviation from the collusive price – whether with or without reporting – implies the end of the cartel, with the market remaining competitive ever after (trigger strategies).

Stage 2. After firms have set their prices and made the current period profit and given that no firm has reported at stage 1, the AA randomly investigates the market, with probability a. In the event of no investigation, the probability of cartel conviction is zero, and the game ends for this period.

Stage 3. If the cartel is randomly investigated (no reporting at stage 1), both firms make the reporting decision simultaneously, knowing that the cartel is being investigated.[13]

If the cartel is reported, the firms compete forever. If no firm confesses or deviates, stages 1 to 3 are repeated.[14] We assume that in the event of a conviction the identity of the ringleader is uncovered. We also assume that if a firm is indifferent between reporting and remaining silent it chooses the former. Finally, if multiple equilibria arise, we allow firms to coordinate on the Pareto-superior outcome.

We consider three policy regimes: In the benchmark case, termed "no discrimination" – regime n – both firms are eligible for either pre- or post-investigation

[11] For instance, the US system grants leniency to a single applicant. The European LP grants leniency to additional applicants, being more generous for those that come forward early.

[12] One might consider that the evidence that is possessed by the follower, may be of lesser quantity and/or lower quality. Allowing the follower to possess "imperfect evidence" does not affect the quality of our results.

[13] Post-investigation leniency is available only when no firm reports in the pre-investigation stage. If only one firm reports in the pre-investigation stage the other firm's reporting has no added value and this firm has zero probability of receiving leniency.

[14] An assumption that the cartel ceases in the event that the AA successfully prosecutes its members without their assistance has no qualitative impact on our findings.

leniency. If one firm reports, this firm receives full leniency, and its partner pays the full fine. A similar outcome occurs if both firms report; but since only one firm is to receive lenient treatment, the identity of that firm is determined randomly with equal probability for each firm to be the winner.

In the *full discrimination* regime – regime *rd* – the ringleader has no right to lenient treatment no matter if it reports in the absence of an investigation or when an investigation is underway. If the follower reports, it receives leniency with certainty regardless of the ringleader's behavior.

Finally, in the *partial discrimination* regime – regime *pd* – we allow the ringleader to benefit from leniency only if its reporting takes place before the AA launches an investigation (stage 1); we exclude the ringleader from any post-investigation leniency.

3 Analysis

Starting from the point where an agreement has been reached, each firm must make two decisions at the same time, and make both decisions simultaneously with its rival: whether to remain loyal to, or to deviate from the agreement; and whether to report the existence of the agreement to the AA. The strategic form of stage 1 corresponds to a 4×4 matrix that consists of the following composite actions: D/R, D/NR, ND/R and ND/NR, where the D and ND indicate deviation and no deviation respectively, while R and NR indicate pre-investigation reporting and no reporting respectively.

If any combination but $C = (ND/NR, ND/NR)$ is played at stage 1, at least one firm deviates from the agreement and/or reports; and at the beginning of the next period the cartel has dissolved, and the two firms charge competitive prices from then on. If combination C is played, there is a positive probability that the cartel persists.

We focus our attention on the sustainability of the collusive agreement: The permanent interruption of the collusive activity is the consequence of either a deviation or reporting; collusion can be sustainable as long as C is the equilibrium outcome at stage 1. Otherwise, either the agreement has not been reached or, following agreement; the cartel collapses because at least one firm deviates and/or denounces the cartel at stage 1.

If C is the equilibrium at stage 1, there is a positive probability that an investigation opens at stage 2. In the event of an investigation, colluding firms must decide whether to confess or not. Thus, there are two "types" of collusion: Both firms collude and remain silent at stage 1 (combination C); and if a random investigation starts, all firms that are eligible for leniency either (i) report or (ii) remain silent at stage 3.

In each regime we consider first that no firm deviates or reports at stage 1 and that an investigation starts. We derive the conditions under which firms report or remain silent at stage 3; and we obtain each firm's payoffs that correspond to C. Then, we derive the conditions under which collusion is sustainable: the conditions

Table 1 Stage 3 when no firm defects or reports at stage 1

firm 1↓ / firm 2 →	Report (r)	Not report (nr)
Report (r)	$\pi - \frac{\varphi}{2}, \pi - \frac{\varphi}{2}$	$\pi, \pi - \varphi$
Not report (nr)	$\pi - \varphi, \pi$	B,B

under which C is the equilibrium at stage 1. Finally, we compare these conditions among the regimes.

3.1 No Discrimination (Regime *n*)

Consider that no firm has previously either defected from or reported the agreement, and an investigation is underway. Each firm faces the choice of collaborating with the AA by providing incriminating evidence, or not. If both firms decide not to report, each one expects with probability $1 - \rho$ that the investigation will be unsuccessful, and no fines will be paid.

Since reporting and/or deviation result in the cartel's collapse, the only node of the stage game that contains reporting decisions and can be repeated over time is the one reached when combination C is played at stage 1 and the AA decides to investigate at stage 2.[15] When none of the firms report, each partner's expected payoff is:

$$B = \rho(\pi - \varphi) + (1 - \rho)\pi + \delta V_0 = \pi(1 - \rho\mu) + \delta V_0$$

where V_0 denotes the firm's cartel value when no investigated firm confesses: $V_0 = (1 - a)\big(\pi + \delta V_0\big) + \alpha B$, which simplifies to

$$V_0 = \frac{\pi(1 - \alpha\rho\mu)}{1 - \delta}. \tag{1}$$

Substituting (1) into the definition of B, we obtain each firm's payoff if none of the cartel partners reports:

$$B = \frac{\pi[1 - \rho\mu(1 - \delta(1 - a))]}{1 - \delta}. \tag{2}$$

In the event of single reporting the cartel is convicted with certainty and its activity is permanently interrupted. If one firm confesses while the other remains silent, the former receives the collusive profits and pays zero fine while the latter receives $\pi - \varphi$. When both firms report under investigation, the expected payoff of each firm is $\pi - \frac{\varphi}{2}$, since each one receives leniency with probability $\frac{1}{2}$. Table 1 summarizes the investigation subgame when the combination C has been played at stage 1 and the AA investigates at stage 2. The lowercase r and nr denote post-investigation reporting and non-reporting respectively.

The following lemma describes the equilibrium of the investigation subgame when no firm deviates or reports at stage 1:

[15] According to our assumption, a strategy that dictates non-reporting at this node in the first period also dictates non-reporting if the firm is at a similar node in any subsequent period, and each firm knows that the same holds for its partner's strategy.

Lemma 1 *Consider that firms collude and remain silent at stage 1 and an investigation opens at stage 2. When leniency is offered to all cartel participants on equal terms (no discrimination), there exist a critical value of* μ,

$$\tilde{\mu} = \frac{\delta}{\rho[1-\delta(1-a)]} \tag{3}$$

such that: i) for $\mu < \tilde{\mu}$, *the equilibrium of stage 3 is* (nr, nr); *ii) for* $\mu \geq \tilde{\mu}$ *the equilibrium of stage 3 is* (r, r).

Proof If $\pi \geq B$, r dominates nr for each firm. Rearranging $\pi \geq B$ gives $\mu \geq \tilde{\mu}$. When $\pi < B$, both (r, r) and (nr, nr) are equilibria. The latter Pareto dominates the former since $\pi - \frac{\varphi}{2} < \pi < B$. Thus, for $\mu < \tilde{\mu}$ (nr, nr) prevails.

We have shown that when firms adhere to collusion at stage 1 and an investigation starts, these firms cooperate with authorities by revealing information or evidence if leniency is sufficient. A random investigation is also possible in the event that at least one firm deviates and no firm reports the agreement at stage 1. Following an observed deviation at stage 1, no firm has any incentive to remain silent at stage 3 (the cartel will be dissolved). Both investigated firms reveal for any $\mu > 0$; otherwise, there is a positive probability of paying the fine.

If both firms select *ND*/*NR* (combination *C*), the game proceeds to stage 3 (investigation) with probability a, and the firms' behavior is described by Lemma 1. If no investigation takes place, the cartel avoids conviction with certainty, while in the event of an investigation the value of remaining loyal depends on the anticipated equilibrium of the investigation subgame. From Lemma 1, for $\mu \geq \tilde{\mu}$ if an investigation opens, then: both firms confess; the cartel collapses; both firms are convicted; and each firm has a 0.5 probability of being the leniency recipient. Hence, for each firm the value of remaining loyal $\left(v_n^1 = v_n^2\right)$ is

$$V_n = (1-a)\left(\pi + \delta V_n\right) + \alpha\left[\frac{1}{2}\pi + \frac{1}{2}(\pi - \varphi)\right] = \frac{\pi(2 - a\mu)}{2[1-\delta(1-a)]} \tag{4}$$

For $\mu < \tilde{\mu}$, no investigated firm reports, and each one's collusive value is $v_n^1 = v_n^2 = V_0$, as given by (1).

Collusion is the equilibrium if its value exceeds that of unilateral deviation for both firms. When a firm knows that its own behavior will result in the cartel's dissolution in the next period, it finds that reporting is optimal, since the LP shields that firm from any fines that would be due to a subsequent investigation. Thus, *C* is an equilibrium if $v_n^1 = v_n^2 \geq 2\pi$.[16] If *C* is the equilibrium, it dominates any other equilibrium.[17]

[16] Observe that $v_n^1 = v_n^2 < 2\pi$ implies the cartel's non-continuation. We do not deal with the cases where firms fail to honor the agreement; we focus on the conditions under which *C* prevails in each regime.

[17] This is straightforward since any other combination implies zero profits from the next period; thus no other combination entails a payoff that is equal to or greater than 2π for each firm.

Table 2 Stage 3 if no firm defects or reports at stage 1 under discrimination

firm 1↓ / firm 2 →	Report (r)	Not report (nr)
Report (r)	$\pi-\varphi, \pi$	$\pi-\varphi, \pi-\varphi$
Not report (nr)	$\pi-\varphi, \pi$	B,B

Lemma 2 *When the LP allows the ringleader to have full access to leniency, C is the Pareto dominant equilibrium at stage 1 if* $v_n^1 = v_n^2 \geq 2\pi$.

Note that if C is the equilibrium outcome of stage 1, the ringleader proposes and the follower accepts the establishment of the cartel, as collusion entails a positive payoff that exceeds the competitive outcome.

Lemma 3 determines the conditions under which collusion is sustainable in the benchmark (no discrimination) case:

Lemma 3 *For* $\mu \geq \tilde{\mu}$ *collusion is sustainable if* $\delta \geq \delta_n \equiv \frac{2+a\mu}{4(1-a)}$; *for* $\mu < \tilde{\mu}$ *collusion is sustainable if* $\delta \geq \delta_0 = \frac{1+a\mu\rho}{2}$.

Proof Setting V_n and V_0 equal or greater than the defecting payoff (twice the collusive profits) yields $\delta \geq \delta_n$ and $\delta \geq \delta_0$ respectively.

3.2 Ringleader Discrimination (Regime *rd*)

Consider that the ringleader is exempted from both pre- and post-investigation leniency and that no firm reports or deviates at stage 1. When the ringleader has no possibility to be rewarded for reporting, it has no incentive to reveal as long as the follower remains silent. If the follower reveals, conviction is certain and the ringleader is indifferent between reporting or not. With regard to the follower, r dominates nr when $\pi \geq B$. Table 2 summarizes the investigation subgame when no firm reports or defects at stage 1 and the ringleader is exempted from leniency.

When $\mu \geq \tilde{\mu}$ ($\pi \geq B$), then: both colluding firms earn the collusive profit; the non-ringleader pays no fine; and the ringleader pays $\varphi = \mu\pi$. For $\mu < \tilde{\mu}$ no post-investigation reporting takes place, and each firm receives B.[18]

If no firm defects or reports at stage 1 and $\mu \geq \tilde{\mu}$, which implies that the follower reveals and pays no fine if an investigation has opened, the ringleader's collusive payoff $\left(v_{rd}^1\right)$ is

$$V_{rd}^1 = (1-a)\left(\pi + \delta V_{rd}^1\right) + \alpha(\pi - \varphi) = \frac{\pi(1-a\mu)}{1-\delta(1-a)}. \tag{5}$$

[18] As in the no-discrimination case, an investigation is possible when one firm deviates and no firm reports the agreement at stage 1. Regardless of which firm undercuts the agreed price at stage 1, r dominates nr for the follower.

If no investigation starts, both firms earn the collusive profit and continue to collude in the next period. Otherwise: The follower pays no fine; the ringleader pays the full fine; and the cartel collapses. The follower's collusive value $\left(v_{rd}^2\right)$ is

$$V_{rd}^2 = (1-a)\left(\pi + \delta V_{rd}^2\right) + \alpha\pi = \frac{\pi}{1-\delta(1-a)} \tag{6}$$

For $\mu < \tilde{\mu}$, no firm reports under investigation, and each firm's collusive value is $v_{rd}^1 = v_{rd}^2 = V_0$, as given by (1).

Lemma 4 concerns stage 1 when both firms make their pricing and pre-investigation reporting decisions simultaneously:

Lemma 4 *When the LP excludes the ringleader from any access to leniency, C is the Pareto dominant equilibrium when* $v_{rd}^1 \geq 2\pi - a\mu\pi(1+\lambda)$ *and* $v_{rd}^2 \geq 2\pi$.

Lemma 4 implies that under full discrimination the satisfaction of the incentive constraint (ICC) for the ringleader requires its collusive payoff to exceed the payoff from unilateral deviation: $2\pi - a\mu\pi(1+\lambda)$. The latter is true since unilateral deviation by the ringleader is followed by the follower's reporting in the event of investigation. If the ringleader deviates, it remains silent at stage 1 (otherwise conviction is certain); and if an investigation starts, the follower reveals. Cartel sustainability also requires that the follower's collusive payoff exceeds the value from unilateral deviation: 2π.

Lemma 5 determines the conditions under which collusion is sustainable when the ringleader is fully exempted from leniency[19]:

Lemma 5 *Consider that the ringleader is excluded from both pre- and post-investigation leniency. For* $\mu \geq \tilde{\mu}$ *collusion is sustainable if* $\delta \geq \delta_{rd} \equiv \frac{1-\alpha\lambda\mu}{(1-a)[2-a\mu(1+\lambda)]}$; *for* $\mu < \tilde{\mu}$ *collusion is sustainable if* $\delta \geq \delta_0 = \frac{1+a\mu\rho}{2}$.

Proof See the Appendix.

Using Lemmata 3 and 5 we compare the effectiveness of the LP under no discrimination (regime n) to its effectiveness under ringleader discrimination:

Proposition 1 *For* $\mu \geq \tilde{\mu}$: *fully excluding the ringleader from LP facilitates (hinders) collusion if.*

$$\lambda > (<) \frac{a\mu}{2-a\mu}$$

For $\mu < \tilde{\mu}$: *the condition for cartel sustainability remains unaffected.*

[19] As in the no-discrimination regime, if no firm reports or deviates in the equilibrium of stage 1, the ringleader proposes the formation of the cartel and the follower agrees to collude. Otherwise they receive a zero payoff.

Proof Using Lemmata 3 and 5, $\delta_n > \delta_{rd} \Leftrightarrow \lambda > \frac{a\mu}{2-a\mu}$. For $\mu < \tilde{\mu}$ the critical discount factors are equal.

Proposition 1 states that the introduction of ringleader discrimination can produce perverse effects. When both investigated firms report under the non-discriminatory policy ($\mu \geq \tilde{\mu}$), their collusive payoffs are symmetric, since the investigated cartel is convicted with probability 1 and each firm has probability 0.5 of being the leniency receiver. The defecting payoffs are equal since both firms couple deviation with reporting. Excluding the ringleader from leniency creates an asymmetry in the collusive payoffs: The exclusion reduces the profitability of collusion for the ringleader and increases the collusive value for the non-ringleader. Also the payoff from deviation is reduced for the ringleader: The defecting ringleader earns the respective gain and expects to be punished with positive probability in the event of investigation.

Therefore, excluding the ringleader from leniency: i) reduces the ringleader's payoff from defecting; ii) reduces the ringleader's payoff from staying loyal; and iii) increases the collusive payoff of the follower. The latter clearly encourages collusion; and while the first two work in opposite directions, Proposition 1 states that the first dominates the second if the fine is mainly profit-proportional.

If no investigated firm reports in the non-discriminatory case, the ringleader's exclusion loosens the ICC for this firm while the follower's ICC remains unaffected. The ringleader's full exclusion has no impact on the sustainability of the agreement, as the follower's condition is now stricter compared to that of the ringleader and similar to that of no discrimination.

Discussion and Comparison with Chen et al. (2015) In Chen et al. (2015) (hereafter, CGR) it is found that while discrimination produces the pro-collusive effect of making cartel reporting less frequent, it can also hinder collusion by tightening the incentive constraint for cartel sustainability. The use of *strategic riskiness* as an equilibrium selection criterion in CGR implies that removing the possibility of reporting for the ringleader makes non-reporting less risky and consequently more likely for the non-ringleader. In our model where Pareto dominance is used, the condition for post-investigation reporting ($\pi \geq B$) is not affected by discrimination, while the collusion-sustainability condition loosens or tightens.

Focusing on collusion-sustainability in cases where the non-ringleader reports under discrimination, our result (Proposition 1) differs with that of CGR. Both papers rely on the balance of two effects that work in opposite directions: Harsher punishment due to discrimination: (i) implies a lower collusive payoff for the ringleader; and (ii) makes the ringleader less willing to deviate, and therefore a more credible partner. The divergence between the two papers' results lies on two differences in assumptions: a) whether (as in CGR) fines are fixed; and b) whether (as in CGR) the firms' unique opportunity to report comes only after an investigation has been launched.

First, with fixed fines a unilaterally defecting firm that is caught pays a *ceteris paribus* lower fine than under proportional fines. Recall that in our case a firm that deviates pays $\varphi(1 + \lambda) \geq \varphi$. Leniency under proportional fines creates stronger deviation incentives because the fine that is waived for a defecting firm is greater than

that of a colluding firm. Therefore, excluding the ringleader from leniency under proportional fines means eliminating a stronger deviation incentive.

The other difference in the assumptions is that CGR rules out the possibility that firms reveal as they defect before investigation, whereas we allow for both pre- and post-investigation collaboration and leniency. Compared to post-investigation leniency, pre-investigation leniency gives a greater incentive to deviate: Pre-investigation leniency affects the deviation payoff without affecting the collusive payoffs.

Allowing firms to report before *or* during an investigation provides the possibility to consider an alternative discriminatory scheme.

3.3 Partial Discrimination (Regime *pd*)

Consider now that the ringleader is excluded from leniency in the post-investigation stage, while still being eligible for leniency in the event of pre-investigation reporting, at stage 1. When firms collude and remain silent at stage 1 while the ringleader is exempted from post-investigation leniency, r dominates nr for the non-ringleader if $\mu \geq \tilde{\mu}$, as in the fully discriminatory regime. When no firm deviates or reports at stage 1 and an investigation starts, the ringleader earns $\pi - \varphi$ while the follower receives π when $\mu \geq \tilde{\mu}$. Otherwise, each firm receives B, as is given by (2) (see Table 2).

If no firm defects or reports at stage 1 and the follower confesses under investigation ($\mu \geq \tilde{\mu}$), the ringleader's collusive value is given by (5): $v^1_{pd} = V^1_{rd} = V^1_{pd} = \frac{\pi(1-a\mu)}{1-\delta(1-a)}$. Since there is no possibility for post-investigation leniency for the ringleader, its collusive payoff when there is full discrimination and when there is partial discrimination coincide. The cartel value for the follower – which pays a zero fine in the event of a successful investigation – is similarly

$$v^2_{pd} = V^2_{rd} = V^2_{pd} = \frac{\pi}{1-\delta(1-a)} \geq V^1_{pd}.$$

If both firms collude, remain silent at stage 1, and $\mu < \tilde{\mu}$, then no firm reports under investigation, and $v^1_{pd} = v^2_{pd} = V_0$.

Since both firms are eligible for leniency at stage 1, the optimal deviation for each firm involves pre-investigation reporting. Following deviation, the cartel will be dissolved; thus, firms reveal in an attempt to avoid penalties:

Lemma 6 *When the ringleader is exempted only from post-investigation leniency, collusion is sustainable when* $v^1_{pd} \geq 2\pi$ *and* $v^2_{pd} \geq 2\pi$.

Lemma 7 determines the conditions under which collusion is sustainable when the ringleader is partially exempted from leniency:

Lemma 7 *For* $\mu \geq \tilde{\mu}$ *collusion is sustainable if* $\delta \geq \delta_{pd} \equiv \frac{1+a\mu}{2(1-a)}$*; for* $\mu < \tilde{\mu}$ *collusion is sustainable if* $\delta \geq \delta_0$.

The following proposition compares the sustainability of collusion under the partially-discriminatory LP to that under full and non-discrimination:

Proposition 2 *Consider that $\mu \geq \tilde{\mu}$. Partially excluding the ringleader from LP undermines collusion compared to both full exclusion and no discrimination; for $\mu < \tilde{\mu}$ all systems have similar effects.*

Proof See the Appendix.

A discriminatory program is effective in destabilizing cartels when it allows the ringleader to report before the investigation, which reduces its willingness to adhere to collusion. Excluding ringleaders from post-investigation leniency maintains the asymmetry of the collusive payoffs, which is destabilizing for the agreement. A discriminatory policy that allows the ringleader to benefit in case of pre-investigation reporting has no impact on firms' payoff from deviation. Therefore, a partially discriminatory LP makes collusion harder to be sustained as it tightens the incentive compatibility constraint for the ringleader.

4 Asymmetric Shares

Cartel agreements may split the market in various ways, which will reflect the relative influence and/or power of their partners. However, it is well-known that as the agreed market shares become more asymmetric, the cartel becomes less stable. In all of the previous analysis we assumed that the firms split total profits equally when they collude.

When discriminating against the ringleader, the AA's policy introduces a new element of asymmetry between firms. If the initial arrangement allocates a smaller market share to the ringleader, the leniency-discrimination policy amplifies asymmetries and reduces cartel stability. However, if cartels allocate a higher market share to the ringleader, the discriminating aspect of antitrust policy reduces initial asymmetries and may even become counter-productive if the cartel agreement reserves to the ringleader the lion's share of the total market's sales and profits.

Here, we assume that for any given leniency policy, the market-share agreement is shaped so as to maximize the cartel's survival. We show that partial discrimination is still the form of policy that destabilizes the cartel for the largest range of possible values of the discount factor.

The collusive agreement allows the ringleader to obtain a share $\sigma \in (0, 1)$ of the total cartel profit, which is still equal to 2π. The other firm earns $(1 - \sigma)2\pi$, and the partner that undercuts the common price earns the entire profit 2π, as was true earlier.

In order to keep the analysis simple and focused we compare partial to no discrimination, and we assume $\lambda = 1$. We consider that firms agree on the level of σ that equates their expected payoff from collusion. This is equivalent to sharing market profits in an attempt to stabilize collusion, or more precisely to maximize

the scope of collusion.[20] The analysis of this section is presented formally in the Appendix.

We proceed by showing first that discrimination does not affect the non-ringleader's incentive to come forward; hence, with or without discrimination, reporting occurs for $\mu \geq \tilde{\mu}$. Then we show that allowing firms to determine the collusive shares does not affect the ranking between partial and no discrimination. For brevity, we restrict our attention to cases where firms report when under investigation: $\mu \geq \tilde{\mu}$.

Under non-discrimination both firms receive symmetric treatment by the AA; thus, if they agree to set $\sigma = \frac{1}{2}$, their collusive payoffs and ICCs are symmetric: The former is given by (4), while the latter is as described in Lemma 3: $\delta \geq \delta_n = \frac{2+a\mu}{4(1-a)}$.

When the ringleader is excluded from post-investigation leniency, firms receive asymmetric payoffs if they split the collusive profits equally. In order to improve the scope of collusion they must bring their payoffs closer to being symmetric by compensating the ringleader for the harsher punishment that it faces:

Lemma 8 *Under partial discrimination, the firms' collusive payoffs are symmetric iff the ringleader receives* $\sigma_1 2\pi$ *where,* $\sigma_1 \equiv \frac{1}{2-a\mu} > \frac{1}{2}$.

Proof See the Appendix.

Lemma 8 implies that when the AA applies partial discrimination, the critical discount factor above which collusion is sustainable takes its lowest value when the cartel agreement allows the ringleader to obtain a market share $\sigma = \sigma_1 > \frac{1}{2}$. This way of sharing the market equalizes the two firms' critical discount factor and maximizes the cartel's viability. In the Appendix we show that this (common) critical discount factor is $\delta'_{pd}(\sigma_1) = \frac{1}{(1-a)(2-a\mu)}$ and that each firm's expected collusive payoffs are equal to $V'_{pd}(\sigma_1) = \frac{2\pi(1-a\mu)}{[1-\delta(1-a)](2-a\mu)}$. The following proposition compares the sustainability of collusion between non- and partial discrimination when the firms are allowed to agree on shares that make their expected collusive payoffs equal:

Proposition 3 *Leniency programs that include partial discrimination against the ringleader make collusion less likely to be sustainable, compared to programs that make no discrimination between the ringleader and the other firm:* $\delta'_{pd}(\sigma_1) > \delta_n$.

Proof See the Appendix.

Thus, the superiority of the partially discriminatory regime remains true even if we allow firms to agree on asymmetric market-shares. When the AA excludes the ringleader only from post-investigation leniency, the cartel may try to eliminate the destabilizing effect of the asymmetric treatment by securing a higher market share for the ringleader. Proposition 3 states that rearranging market shares cannot effectively eliminate the entire pro-competitive effect that partial discrimination exerts; collusion is still less likely to arise under partial discrimination.

[20] Since the defecting payoff is the same for both firms under either regime (total market profits and zero fine), equal collusive payoffs imply that firms face the same ICC.

5 Concluding Remarks

Discrimination with respect to the leniency treatment of cartel ringleaders is an important feature of leniency policies; discrimination has been adopted by some major jurisdictions and ignored by others. The present paper aims to examine how introducing such discrimination in leniency policies affects their effectiveness to hinder collusive arrangements.

First, we find that fully excluding ringleaders from the benefits of LP loosens the incentive compatibility constraint (ICC) for the non-ringleader: The payoff from staying loyal is increased, since the ringleader is induced to remain silent in the event of an investigation. For the ringleader, such discrimination reduces its payoff from collusion (no possibility for the fine's reduction when there is an investigation); but discriminating also reduces the *deviator's effect* of leniency, since it eliminates the defect-and-simultaneously-report option. Our analysis shows that the ringleader's incentive to deviate can be lower when this firm is excluded from leniency. Recent experimental evidence in Clemens and Rau (2019) supports the idea that the introduction of discriminatory policy fosters cartel sustainability.

Second, we show that compared to both, full- and non-exclusion, excluding the ringleader only from post-investigation leniency while still waving its fines if it reports the cartel before the cartel becomes the object of an antitrust investigation constitutes a more efficient LP design. The partially discriminatory LP scheme properly balances the costs and benefits of discriminatory leniency policies, since deviation remains as profitable as it is under no discrimination while the collusive payoff lessens. This way, a cartel is less likely to be sustainable.

The superiority of excluding the ringleader only from post-investigation leniency is robust for a large range of market sharing agreements. Even if one assumes that market shares are determined so as to mitigate the leniency policy and maximize cartel sustainability, partial discrimination is still the superior policy to follow.

The discrimination against cartel ringleaders is present in several countries' LPs. The present paper indicates that AAs should consider limiting the discriminatory treatment to cartels that are already under scrutiny. In addition, authorities that do not apply discrimination for cartel ringleaders can improve the efficiency of their LPs by introducing partial discrimination.

Appendix

Proof of *Lemma 5*

The first part of Lemma 5 is derived by setting both $V^1_{rd} \geq 2\pi - a\mu\pi(1+\lambda)$, and solving for δ. For the follower $V^2_{rd} \geq 2\pi \Leftrightarrow \delta \geq \frac{1}{2(1-a)}$ and $\delta_{rd} \geq \frac{1}{2(1-a)}$.

When $\mu < \tilde{\mu}$, firms have symmetric collusive values since none confesses under investigation, but their defecting values are asymmetric: The follower deviates and reports, while the ringleader has no benefits from reporting. Collusion

sustainability requires both constraints to hold; therefore, we need to compare the common collusive value V_0 to the follower's defecting value, which yields the same critical discount factor as in the benchmark case.

Proof of *Proposition 2*

Full versus partial discrimination when $\mu \geq \tilde{\mu}$

Under full discrimination, collusion is sustainable for $\delta \geq \delta_{rd} \equiv \frac{1-\alpha\lambda\mu}{(1-a)[2-a\mu(1+\lambda)]}$; see Lemma 5. Under partial discrimination collusion is sustainable for $\delta \geq \delta_{pd} = \frac{1+a\mu}{2(1-a)}$; see Lemma 7. $\delta_{pd} > \delta_{rd}$ holds for $\mu < \frac{1}{a}$. Therefore, partial discrimination produces better results compared to full discrimination.

No versus partial discrimination when $\mu < \tilde{\mu}$

For $\mu < \tilde{\mu}$, all systems allow collusion for $\delta \geq \delta_0$; see Lemmata 3, 5 and 7.

No versus partial discrimination when $\mu \geq \tilde{\mu}$

Under no discrimination collusion is sustainable for $\delta \geq \delta_n \equiv \frac{2+a\mu}{4(1-a)}$; see Lemma 3. It can be easily verified that $\delta_{pd} > \delta_n$.

Profit-shares

No discrimination

Both firms collude; and if the AA launches an inspection, both firms must make a reporting decision. When neither firm reports, the ringleader's expected payoff is $B^{'} = \rho\sigma 2\pi(1-\mu) + (1-\rho)\sigma 2\pi + \delta V_0^{'}$ where.

$$V_0^{'} = (1-a)\left(\sigma 2\pi + \delta V_0^{'}\right) + aB^{'} \Leftrightarrow V_0^{'}(\sigma) = \frac{\sigma 2\pi(1-a\rho\mu)}{1-\delta}.$$

If the ringleader unilaterally reports, it earns $\sigma 2\pi$; thus it reports for $\sigma 2\pi \geq B^{'} \Leftrightarrow \mu \geq \tilde{\mu}$, where $\tilde{\mu}$ is given by (3). The other firm's expected payoff from universal non-reporting is $B'' = \rho(1-\sigma)2\pi(1-\mu) + (1-\rho)(1-\sigma)2\pi + \delta V_0''$, where.

$$V_0^{''}(\sigma) = \frac{(1-\sigma)2\pi(1-a\rho\mu)}{1-\delta}.$$

The non-ringleader unilaterally reports for $(1-\sigma)2\pi \geq B'' \Leftrightarrow \mu \geq \tilde{\mu}$. Therefore, for $\mu \geq \tilde{\mu}$ reporting dominates for each firm, while for $\mu < \tilde{\mu}$ universal no-reporting is the payoff-dominant equilibrium.

Consider that the colluding firms report under investigation. The ringleader's expected payoff is.

$$V_n^{'} = (1-a)\left(\sigma 2\pi + \delta V_n^{'}\right) + \alpha\left[\frac{1}{2}\sigma 2\pi + \frac{1}{2}\sigma 2\pi(1-\mu)\right] \Leftrightarrow V_n^{'}(\sigma) = \frac{\sigma\pi(2-a\mu)}{1-\delta(1-a)}.$$

Similarly, the non-ringleader's collusive payoff is $V_n^{''}(\sigma) = \frac{(1-\sigma)\pi(2-a\mu)}{1-\delta(1-a)}$. Collusion is sustainable if the value from collusion exceeds that from unilateral deviation for both firms. If a firm unilaterally deviates, it reports in order to be protected from fines. Thus, for the ringleader

$$V_n^{'}(\sigma) \geq 2\pi \Leftrightarrow \delta \geq \delta_n^{'}(\sigma) = \frac{2(1-\sigma)+a\sigma\mu}{2(1-a)};$$

for the non-ringleader

$$V_n^{''}(\sigma) \geq 2\pi \Leftrightarrow \delta \geq \delta_n^{''}(\sigma) = \frac{2\sigma + a\mu(1-\sigma)}{2(1-a)},$$

where $\delta_n^{''} > \delta_n^{'}$ holds for $\sigma > \frac{1}{2}$. For $\sigma > (<)\frac{1}{2}$ collusion is sustainable without discrimination for $\delta \geq \delta_n^{''}(\delta_n^{'})$.

Partial discrimination

When both firms collude under partial discrimination and the AA launches an inspection, the non-ringleader reports when $(1-\sigma)2\pi \geq B^{''} \Leftrightarrow \mu \geq \tilde{\mu}$.

The ringleader has no possibility to be the eligible for leniency; thus, its collusive payoff is

$$V_{pd}^{'} = (1-a)\left(\sigma 2\pi + \delta V_{pd}^{'}\right) + \alpha\sigma 2\pi(1-\mu) \Leftrightarrow V_{pd}^{'}(\sigma) = \frac{\sigma 2\pi(1-a\mu)}{1-\delta(1-a)}.$$

The non-ringleader's collusive value is

$$V_{pd}^{''} = (1-a)\left[(1-\sigma)2\pi + \delta V_{pd}^{''}\right] + \alpha(1-\sigma)2\pi \Leftrightarrow V_{pd}^{''}(\sigma) = \frac{(1-\sigma)2\pi}{1-\delta(1-a)}.$$

The ringleader's ICC is

$$V_{pd}^{'} \geq 2\pi \Leftrightarrow \delta \geq \delta_{pd}^{'}(\sigma) = \frac{1-\sigma+a\sigma\mu}{1-a}.$$

For the follower the collusive payoff exceeds that of deviation when

$$V_{pd}^{''} \geq 2\pi \Leftrightarrow \delta \geq \delta_{pd}^{''}(\sigma) = \frac{\sigma}{1-a},$$

where $\delta_{pd}^{''} > \delta_{pd}^{'}$ for $\sigma > \sigma_1 \equiv \frac{1}{2-a\mu} > \frac{1}{2}$. For $\sigma > (<)\sigma_1$ collusion is sustainable for $\delta \geq \delta_{pd}^{''}(\delta_{pd}^{'})$.

Proof of *Lemma 8* and *Proposition 3*

Recall that the critical discount factors for the ringleader and the follower are

$$\delta_n^{'}(\sigma) = \frac{2(1-\sigma)+a\sigma\mu}{2(1-a)} \text{ and } \delta_n^{''}(\sigma) = \frac{2\sigma+a\mu(1-\sigma)}{2(1-a)},$$

respectively when both report under non-discrimination. Observe that $\frac{\partial\delta_n^{'}}{\partial\sigma} < 0$ and $\frac{\partial\delta_n^{''}}{\partial\sigma} > 0$; the ringleader's (follower's) ICC loosens (tightens) with σ.

For $\sigma = \frac{1}{2}$, $\delta_n^{'}\left(\frac{1}{2}\right) = \delta_n^{''}\left(\frac{1}{2}\right) = \delta_n = \frac{2+a\mu}{4(1-a)}$; $max\left\{\delta_n^{'}, \delta_n^{''}\right\}$ is minimized; and the firms' expected collusive payoffs are also equal: $V_n^{'}\left(\frac{1}{2}\right) = V_n^{''}\left(\frac{1}{2}\right) = \frac{\pi(2-a\mu)}{2[1-\delta(1-a)]}$.

Recall also that the critical discount factors for the ringleader and the follower are $\delta_{pd}^{'}(\sigma) = \frac{1-\sigma+a\sigma\mu}{1-a}$ and $\delta_{pd}^{''}(\sigma) = \frac{\sigma}{1-a}$, respectively, given that the investigated follower reports under partial discrimination. Observe that $\frac{\partial\delta_{pd}^{'}}{\partial\sigma} < 0$ and $\frac{\partial\delta_{pd}^{''}}{\partial\sigma} > 0$; the ringleader's (follower's) ICC loosens (tightens) with σ.

For $\sigma = \sigma_1 \equiv \frac{1}{2-a\mu}$, $\delta_{pd}^{'}(\sigma_1) = \delta_{pd}^{''}(\sigma_1) = \frac{1}{(1-a)(2-a\mu)}$. For $\sigma = \sigma_1$ the firms' expected collusive payoffs are also equal: $V_{pd}^{'}(\sigma_1) = V_{pd}^{''}(\sigma_1)$. It is easy to verify that

$$\delta_{pd}^{'}(\sigma_1) = \frac{1}{(1-a)(2-a\mu)} > \delta_n = \frac{2+a\mu}{4(1-a)}.$$

Acknowledgements The author would like to thank Christos Constantatos, Patrick Rey, Thomas Ross, the Editor, Lawrence J. White and two anonymous Referees as well as the participants the 18th Conference on Research on Economic Theory and Econometrics (CRETE 2019) for their helpful comments and suggestions. The usual disclaimer applies.

Funding This research is co-financed by Greece and the European Union (European Social Fund- ESF) through the Operational Programme «Human Resources Development, Education and Lifelong Learning» in the context of the project "Reinforcement of Postdoctoral Researchers—2nd Cycle" (MIS-5033021), implemented by the State Scholarships Foundation (IKY).

Data Availability We do not analyze or generate any datasets, because our work proceeds within a theoretical and mathematical approach.

Declarations

Conflict of Interest The authors have no competing interests to declare that are relevant to the content of this article.

References

Blatter, M., Emons, W., & Sticher, S. (2018). Optimal leniency programs when firms have cumulative and asymmetric evidence. *Review of Industrial Organization, 52*, 403–427.

Chen, Z., Ghosh, S., & Ross, T. (2015). Denying leniency to cartel instigators: Costs and benefits. *International Journal of Industrial Organization, 41*, 19–29.

Chen, Z., & Rey, P. (2013). On the design of leniency programs. *Journal of Law and Economics, 56*, 917–957.
Clemens, G., & Rau, H. (2019). Do discriminatory leniency policies fight hard-core cartels? *Journal of Economics and Management Strategy, 28*(2), 336–354.
Harrington, J. E. (2008). Optimal corporate leniency programs. *Journal of Industrial Economics, 56*(2), 215–246.
Harrington, J. E. (2014). Penalties and the deterrence of unlawful collusion. *Economics Letters, 124*, 33–36.
Katsoulakos, Y., Motchenkova, E., & Ulph, D. (2015). Penalizing cartels: The case for basing penalties on price overcharges. *International Journal of Industrial Organization, 42*, 70–80.
Motta, M., & Polo, M. (2003). Leniency programs and cartel prosecution. *International Journal of Industrial Organization, 21*, 347–379.
Spagnolo, G. (2004). Divide and impera: optimal leniency programs. CERP Discussion Paper No. 4840
Wils, W. (2016). The use of leniency in EU cartel enforcement: An assessment after twenty years. *World Competition, 39*, 327–388.