On the effectiveness of Settlement Procedure in the presence of partial ownerships

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ABSTRACT According to the Settlement Procedure, a reduction on cartel fines is granted to firms admitting their participation in a cartel agreement. In this paper, we derive the required cartel fine reduction that fulfills the objective of competition authorities to induce all cartel firms to settle. We find that such an effective reduction is negatively correlated with the likelihood that the cartel would be detected. We also show that the presence of partial ownerships among rival firms may enhance the effectiveness of the Settlement Procedure, as opposed to their negative impact on competition under a Leniency Program.

Keywords: Antitrust policy; Cartel fines; Competition policy; Partial ownerships; Settlement Procedure.

JEL Classification: D43; K21; L13; L41

1 Introduction

In June 2008, the European Commission (EC) introduced the Settlement Procedure (SP) under the Commission Regulation 622/2008 (OJ L 171/3, 1.7.2008) to promote the procedural efficiency of cartel enforcement in the European Union (EU). The objective of this initiative is not to replace the standard enforcement procedure for cartel cases, but instead to establish a SP that makes Competition Authorities (CAs) handle faster and more efficiently cartel cases (OJ L 167/1, 2.7.2008). According to the Commission Regulation 622/2008, if the EC decides to reward cartel participants for their cooperation during the SP, the final amount of the cartel fine imposed to them is reduced by 10%.

We challenge the effectiveness of the above reduction to fulfill the goal of CAs to induce the participation of all cartel firms in the SP. For this purpose, we assume a duopolistic market where each competitor may hold partial ownerships (POs) in its rival. We consider POs either to have or to have no significant influence on corporate strategy. According to the definition of POs (de Haas and Paha, 2021; Heim et al., 2022; Lopez & Vives, 2019), partial common ownerships (*PcomOs*) exist when large shareholders not only have significant POs in rival firms but also influence their corporate strategy (Azar et al., 2018; Rosati et al., 2020; Schmalz, 2018). On the contrary, partial cross ownerships (*PcrOs*) are present when firms acquire other firms' shares in the form of investments with no control rights, while acting in their largest shareholders' financial interest by maximizing their own value and disregarding the impact of their actions on other firms' corporate strategy (Flath, 1991; Gilo, 2006; Salop & O'Brien, 2000; Zevgolis & Fotis, 2019).

The goal of this paper is to derive the required reduction on cartel fines that fulfills the goal of CAs to induce all cartel firms to participate in the SP. For this purpose, we use a theoretical modeling setup where two competitors form a cartel. By comparing each firm's profit with the one obtained when it decides to settle with CAs, we provide the conditions under which the reduction of the cartel fine is sufficient to incentivize all cartel firms to settle. We find a negative relationship between such reduction and the cartel detection probability, implying that when CAs decrease the attractiveness of SP, they should undertake the necessary measures to signal an increase in the probability of detecting the cartel, and vice versa.

We also challenge the robustness of this finding by allowing POs between the rival firms. We show that the firm increasing its *PcomOs* faces higher incentives to enter the SP, as opposed to the target firm which increases its preference for the cartel formation. Also, as firms become more asymmetric, the inefficient firm has more incentives to settle, as opposed to the efficient firm which prefers the cartel formation for more parameter values. However, under the existence of *PcrOs* between firms, an increase in the *PcrOs* of either firm, provides both firms with higher incentives to enter the settlement procedure.

The paper is organizing as follows. Section 2 reviews the related literature and presents empirical evidence of the SP in the EU. Section 3 presents the basic theoretical modeling setup and the discuss the derived results when firms reach a collusive agreement with those derived when they settle with the CA while possessing *PcomOs* to each other. Section 4 extents the basic theoretical set up by allowing firms to possess *PcrOs* to each other. Section 5 concludes and draws some policy implications.

2 Literature Review

Ascione and Motta (2008) indicate that deterrence may be diluted since a reduction of 10% of the cartel fine is guaranteed from the SP. However, deterrence may not be diluted if the probability of being detected is not constant or increases and free resources due to the initiation of SP are devoted to the detection of other cartel cases.[1]

A very recent literature strand studies the incentives of cartel participants to use POs as a tool to stabilize collusion. de Haas and Paha (2020) state that POs weaken the sustainability of collusion, especially in countries with an effective Competition Authority (CA). However, Heim et al. (2020) argue that firms may use POs to either stabilize collusive agreements or soften competition in the event of a Leniency Program (LP). In particular, the authors use the LP as a shock that destabilize collusive agreements and, after analyzing data from 63 countries, find a significant increase in domestic horizontal POs in the countries where the LP has been deemed to be effective.

A sizable literature empirically studies the implications of the fine reduction induced by POs. Ascione and Motta (2008) use data of all fines decided by EC[2] and all

[1] Harrington (2017) argues that a structural remedy may also be an effective deterrent distinct if collusion is unstable.
[2]Both infringements of articles 81 and 82, but as the authors mention, article 81 consists of most of the cases.

correspondent reductions from appeals the court from 1970 to 2007 to estimate that the average expected reduction of the fine, if the involved firms appealing the EC's decision, is 26%. Hence, after appealing, the involved firms in the infringement expect a reduction of almost a quarter of the fine imposed by the EC. Since this expectation may underestimate some important costs for the applicants of the appeal, such as legal and consultancy fees (litigation costs) and/or managerial distraction, the authors conclude that there is a need for a more accurate estimation of the optimal cartel fine reduction granted by the SP.

Veljanovski (2007) states that the reduction of cartel fines during the SP is low and should have been increased to, at least, 20% or more. In support of his view, the author estimates that the average reduction in fines on appeal in 30 Commission's cartel decisions during the period from 1999 to 2006 was approximately 22,7%, and therefore the 10% reduction will not create sufficient incentives for firms to apply for settlement. Alike, OECD (2008) reports that the US jurisdiction imposes much more significant reductions of cartel fine during the SP.

Huschelrath and Laitenberger (2017) point out that further empirical analysis is needed for a comprehensive evaluation of the overall welfare implications of SP on the determination of fines. Particularly, with respect to the «*fine-related variables*», such as, *inter alia*, duration of cartel, key witness and leniency reduction, the authors find insignificant results for the duration of the cartel and the mitigating circumstances. As the authors state "*although cartel duration is a key factor in the determination of the fine, its mechanical calculation apparently has no significant influence on the duration of the investigation*". Huschelrath and Laitenberger (2017) use data from 84 cartels decided by the EC from 2000 to 2014 to find a statistically significant reduction in the duration of settled cases of about 8.7 months.

Katsoulacos et al. (2019) estimates that, during the period 1992-2016, the average reduction in fines on appeal in 29 Commission's cartel decisions under the standard enforcement procedure for cartel cases was approximately 21,64%. More interestingly, 54 out of 134 EC's cartel decisions (40,3%) have already been annulled during the same period. The authors also report that most annulled decisions are horizontal agreements or a combination of agreements and concerted practices.

Table 1 shows that four out of seven settled cartel cases with the highest fines in Europe have ended via a non-hybrid SP (i.e., all firms prefer to settle with CAs), while in the remaining three settled cartel cases some firms prefer not to settle with CAs (the hybrid SP). Notice that only in two cartel cases none of the engaged firms settled with CAs (*TV and Computer Monitor Tubes - Airfreight (air cargo carriers*), while the adoption of EC's final decision in two cartel cases was prior the establishment of the SP (*Vitamins - Elevators and escalators*).

Table 1. Highest cartel fines* per case, leniency program and settlement procedure: 2001 – 2022 (30.03.2022)

	Year	Cases	Fine in €	Leniency Program	Settled Cases	
A/A					Hybrid	Not Hybrid
1	2016/2017	Trucks	3 807 022 000**	4 applicants	5 firms	
2 3****	2019/2021	Forex (*three-way Banana Split*) (*Essex Express*)	1 413 274 000**	1 applicant	-	All (5 firms) All (4 firms)
4	2012	TV and Computer Monitor Tubes	1 409 588 000**	-	-	-
5	2013/2016/2021	Euro Interest Rates Derivatives (EIRD)	1 308 172 000**	4 applicants	4 out of 7 firms	-
6	2014	Automotive Bearings	953 306 000**	5 applicants		All (6 firms)
7	2021	Car emissions	875 179 000**	2 applicants		All (3 firms)
8	2007	Elevators and escalators*****	832 422 250**	-	-	-
9	2010/2017	Airfreight (air cargo carriers)	739 642 616**	-	-	-
10	2001	Vitamins*****	790 515 000**	-	-	-
11	2013/2015	Yen Interest Rate Derivatives (YIRD)	669 719 000	5 applicants	6 out of 7 firms	-

*Amounts adjusted for changes following judgments of the Courts (General Court and European Court of Justice) and/or amendment decisions.
**As it is in EC, (2022), Table 1.5. In Laina& Bogdanov (2019) the corresponding amount of fine is 2 926 499 000.
*** As it is in Laina & Bogdanov (2019).
****The Forex case consists of two Settlement cases/decisions.
*****The adoption of EC's final decision is prior the establishment of SP [Commission Regulation 622/2008 (OJ L 171/3, 1.7.2008)].
Source: Laina & Bogdanov (2019); EC (2022).

Our paper contributes to the above-mentioned literature since we assess the required reduction of cartel fine that makes SP reach its main goal. In other words, we estimate the minimum cartel detection probability required to induce all firms to settle for any given cartel fine reduction. We argue that the 10% fine reduction associated with settlement could be sufficient if the probability of cartel detection is sufficiently high. Also, our paper is the first to examine the implications of POs on the success of SP. Contrary to the negative effect of LP on competition under the presence of POs, we show that SP can contribute to uncovering a cartel by inducing all participants to settle.

3 Equilibrium analysis

Consider a setting in which two firms $i = 1,2$ face the inverse demand function $P = A - bQ$, where $Q = q_1 + q_2$, and produce a homogenous final good at a cost $w_i \frac{c(q_i)^2}{2}$. For expositional reasons, we assume that $w_1 = 1$ and $w_2 \equiv w \in [0,1]$. Therefore, the two firms are cost symmetric when $w = 1$; otherwise, firm 2 is the efficient firm and firm 1 is the inefficient one. In addition, each firm may hold a POs in its rival. Let $\mu_i \in [0,0.5)$ denote the POs of firm i in firm $j's$ equity capital, with $i, j = 1,2$ and $i \neq j$. In the rest of this section, we discuss the equilibrium outcomes when firms: (i) reach a collusive agreement, thus acting as a cartel monopolist; and (ii) settle with the CA to benefit from the percentage reduction on the cartel fine due to settling.

3.1 Cartel formation

The assumed quadratic cost function implies that the analysis for collusion is not trivial given that linear cost functions result in constant marginal costs, hence the entire collusive output is produced by the firm with the lowest marginal cost (Ciarreta and Gutiérrez-Hita, 2012; Escrihuela-Villar and Gutiérrez-Hita, 2018). In our case, however, the marginal costs of both cartel firms should be equal in equilibrium, meaning that firms may produce different output quotas depending on the level of the efficiency parameter w.

In fact, cartel firms allocate output quotas like a multiplant monopolist allocating outputs between two plants (Patinkin, 1947). Therefore, the marginal cost of the monopolist is $MC = (Q_M wc)/(1 + w)$, meaning that its total cost is $TC = \frac{wc}{2(1+w)}(Q_M)^2$, while its total revenue is $TR = P_M Q_M$. The goal of the monopolist is to maximize the following profit function:

$$\Pi_M = (TR - TC)(1 - \rho) - \rho(\kappa P_M Q_M) \tag{1}$$

where $\rho \in [0,1]$ denotes the probability that the cartel would be detected. The monopolist's profit concerns: (i) its gross profit margin, which is realized if the cartel is not detected; and (ii) the cartel fine, which is defined as a percentage (κ) of its revenue ($P_M Q_M$) and is realized once the cartel is detected.[3] The equilibrium quantity of the monopolist is thus given by:

$$Q_M = \frac{A[1-\rho(1+k)](1+w)}{2b[1-\rho(1+k)](1+w)+c(1-\rho)} \tag{2}$$

The profit function of each cartel firm writes:

$$\Pi_{i,M} = \left(P_M q_{i,M} - w_i \frac{\mathrm{c}(q_{i,M})^2}{2}\right)(1-\rho) - \rho\left(\kappa P_M q_{i,M}\right) \tag{3}$$

Given that each cartel firm produces $q_{i,M} = MC/(w_i c)$, its equilibrium output and profit is given, respectively, by:

$$q_{i,M}^{*} = \frac{w}{w_i} \cdot \frac{A[1-\rho(1+k)]}{2b[1-\rho(1+k)](1+w)+c(1-\rho)} \tag{4}$$

and

$$\Pi_{i,M}^{*} = \frac{w}{w_i} \cdot \frac{(A[1-\rho(1+k)])^2}{4b[1-\rho(1+k)](1+w)+2c(1-\rho)} \tag{5}$$

First note that since $MC_i = q_{i,M} w_i c$, the marginal cost of each cartel firm is the same in equilibrium. Second, the inefficient firm produces less output and earns less profit than the efficient one. In particular, its output and its profit is $100\ (1-w)\%$ less than those of the efficient firm.

3.2 Settlement procedure with partial common ownership

When settling with the CA, each Cournot competitor earns:

$$\begin{aligned}\Pi_{i,S} = &\left(P_S q_{i,S} - w_i \frac{\mathrm{c}(q_{i,S})^2}{2}\right)(1-\mu_j) + \mu_i\left(P_S q_{j,S} - w_j \frac{\mathrm{c}(q_{j,S})^2}{2}\right) \\ &- (1-\chi)\left(\kappa P_M q_{i,M}\right)\end{aligned} \tag{6}$$

[3] To keep the analysis as simple as possible, throughout the paper we assume that neither firm appeals the cartel decision to the court.

According to Eq. (6), each firm draws revenue from its direct sales and its *PcomOs* to the rival firm in a way following that of de Haas and Paha (2020). The last part represents the percentage reduction (χ) on the cartel fine ($\kappa P_M q_{i,M}$) due to settling, with $\chi \in [0,1]$. The equilibrium quantity of each firm is:

$$q_{i,S}^{*} = \frac{\mathrm{A}(1-\mu_i)[b(1-\mu_i-\mu_j)+c(1-\mu_j)\frac{w}{w_i}]}{b^2(3-\mu_i-\mu_j)(1-\mu_i-\mu_j)+[c^2 w+2bc(1+w)](1-\mu_i)(1-\mu_j)} \tag{7}$$

Substituting $q_{i,S}^{*}$ in Eq. (6) yields the equilibrium profit ($\pi_{i,S}^{*}$) of each firm when it decides to settle with the CA.[4]

3.3 Comparison

We compare the profitability of staying in the cartel ($\Pi_{i,M}$) and settling with the CA ($\Pi_{i,S}$) to discuss the required reduction on cartel fines that induces all cartel firms to enter the SP. Although this comparison leads to closed-form solutions, the derived level of χ is a complex function of $A, w, c, \kappa, \rho, \mu_1$ and μ_2. Therefore, the presentation and the subsequent analysis are mainly based on numerical simulations. In particular, we assume that: (i) $A = 5$ and $b = 1$; (ii) $c = 0.5$; and (iii) $\kappa = 0.1$, which reflects the current EC's practice regarding cartel fines.

The comparison of $\Pi_{i,M}^{*}$ and $\Pi_{i,S}^{*}$ gives a critical value of χ (as a function of ρ) denoting by $\hat{x}_i$ that makes firm i indifferent between staying in the cartel and settling with the CA (i.e., $\Pi_{i,M}^{*} = \Pi_{i,S}^{*}$).

To better understand the impact of POs on the effectiveness of SP to induce all cartel firms settling, consider first the following benchmark case without *PcomOs* ($w = 0.8$, $\mu_1 = 0,\ \mu_2 = 0$) as depicted in Figure 1. It illustrates each firm's indifference curve $\hat{x}_i$, with the red (black) line denoting the combinations of χ and ρ that make $\Pi_{1,M}^{*} = \Pi_{1,S}^{*}$ ($\Pi_{2,M}^{*} = \Pi_{2,S}^{*}$).

[4] The equilibrium profit functions of the firms are quite long without providing any useful intuition. Hence, they are not presented here for simplicity. However, they are available upon request.

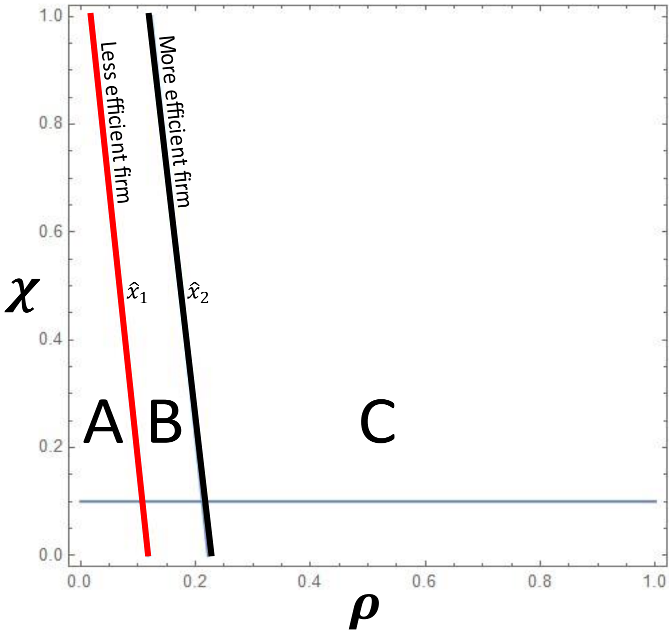

Figure 1: Indifference curve for each cartel firm

Figure 1 reveals a negative relationship between χ and ρ (the indifference curves are downward slopping).[5] Therefore, for any given level $\chi = \bar{\chi}$, there is a critical value of ρ (denoted by $\rho_i^{\bar{\chi}}$) that leads to $\Pi_{i,M}^{*} = \Pi_{i,S}^{*}$. When $\rho < \rho_i^{\bar{\chi}}$ ($\rho > \rho_i^{\bar{\chi}}$), then $\Pi_{i,M}^{*} > \Pi_{i,S}^{*}$ ($\Pi_{i,M}^{*} < \Pi_{i,S}^{*}$). We thus separate Figure 1 in three areas. In area A, both firms are better off by staying in the cartel ($\Pi_{i,M}^{*} > \Pi_{i,S}^{*}$); in area B, the more efficient firm prefers the SP ($\Pi_{2,S}^{*} > \Pi_{2,M}^{*}$), whereas the less efficient firm prefers to stay in the cartel ($\Pi_{1,M}^{*} > \Pi_{1,S}^{*}$), thus giving rise to the hybrid settled case; in area C, both firms are better off when settling with the CA ($\Pi_{i,S}^{*} > \Pi_{i,M}^{*}$), thus inducing the non-hybrid settled case. Since SP is regarded as effective in the latter case, the binding indifference curve is the one lying on the right.

Proposition 1. *The effective cartel fine reduction is negatively correlated with the likelihood that the cartel would be detected.*

Consider, for instance, the current European practice according to which the reduction on the cartel fine is $\chi = 10\%$ (blue line in Figure 1). In this representative example, this reduction is effective only when $\rho \geq 0.211$, since this is the lowest probability of detecting the cartel inducing both firms to enter the SP. Therefore, CA should ensure that their evidence signifies the right signal to cartel firms to form the required perception of being caught.

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[5]This result does not qualitatively change since a change in a parameter value only moves $\hat{x}_i$ to the left or right.

To challenge the robustness of the above finding under the presence of POs, we first consider cost symmetric firms (i.e., $w = 1$). Figure 2 shows each firm's "indifferent" cartel detection probability ($\rho_i^{\bar{\chi}}$) as a function of the inefficient firm's *PcomOs* (μ_1) for several POs of the efficient firm (μ_2) when $\bar{\chi} = 10\%$.[6]

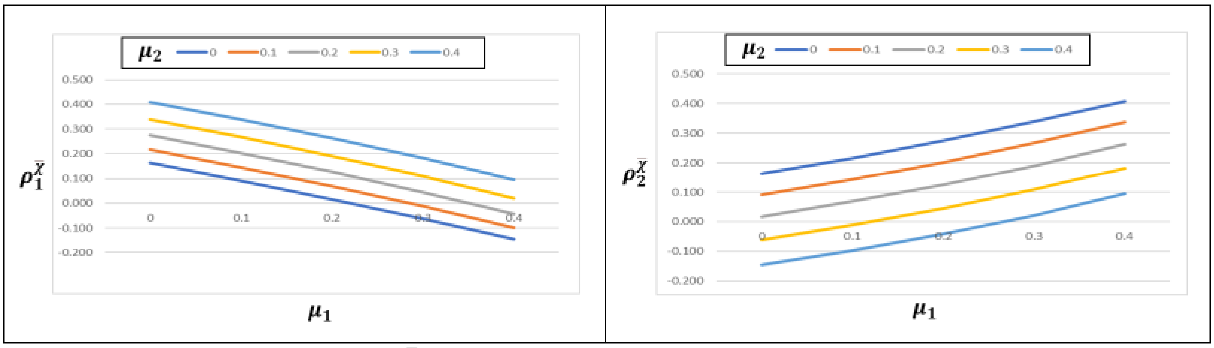

Figure 2. The levels of $\rho_i^{\bar{\chi}}$ as a function of μ_1 for $\mu_2 = \{0.0, 0.1, 0.2, 0.3, 0.4\}$ and $\chi = \bar{\chi} = 0.1$

An increase in μ_i affects $\rho_i^{\bar{\chi}}$ negatively and $\rho_j^{\bar{\chi}}$ positively regardless of the particular value of μ_j. Therefore, the following proposition can be stated:

Proposition 2. *The firm increasing its PcomOs faces higher incentives to enter the settlement procedure, as opposed to the target firm which increases its preference for the cartel formation.*

A direct implication of Proposition 2 is that as μ_i increases, the likelihood of both firms settling strictly reduces since $\rho_j^{\bar{\chi}}$ increases. Therefore, the hybrid cases are more probable. In addition, if the more efficient firm increases its *PcomOs*, then $\hat{x}_1$ and $\hat{x}_2$ diverge, whereas if the less efficient firm increases its *PcomOs*, the convergence of $\hat{x}_1$ and $\hat{x}_2$ may be followed by a subsequent divergence since $\hat{x}_1$ afterwards could lie on the left of $\hat{x}_2$.

Note that qualitatively similar results to those presented in Figure 2 would be obtained if considering alternative values of χ and/or w (see Tables 2 and 3 in the Appendix). However, increasing the cost asymmetry between firms distorts their preference for settling with the CA.

[6] Without loss of generality, we focus on the more realistic cases where $\mu_i \in [0,0.4]$. Indeed, in many markets, such as airlines and supermarkets, each top shareholder holds less than 15% in a rival firm's capital (Schmalz, 2018). Figure 2 is a graphical representation of Table 1 presented in the Appendix.

Proposition 3. *As firms become more asymmetric, the inefficient firm has more incentives to settle, as opposed to the efficient firm which prefers the cartel formation for more parameter values.*[7]

The intuition behind Proposition 3 is as follows. The efficient firm has more incentives to stay in the cartel than to settle since it produces more output and earns more profit than the inefficient one. The higher the cost asymmetry, the higher the output and profit of the efficient firm compared to those of the less efficient cartel member. On the contrary, the latter firm has more incentives to settle since it benefits from the percentage reduction on the cartel fine. Of course, whether POs eventually result in both firms settling depends heavily on the particular values of μ_1 and μ_2.

4 Extension: Partial cross ownership

This case is similar to that of *PcomOs*, with the exception that the profit of each competitor now writes:

$$\Pi_{i,S} = \left(P_S q_{i,S} - w_i \frac{c(q_{i,S})^2}{2}\right) + \mu_i \left(P_S q_{j,S} - w_j \frac{c(q_{j,S})^2}{2}\right) - (1-\chi)\left(\kappa P_M q_{i,M}\right) \tag{8}$$

The main difference between Eqs. (6) and (8) is the absence of term $\left(1-\mu_j\right)$ in Eq. (8), meaning that each firm profit is now modeled as it appears in its income statement (de Haas and Paha, 2020). As we have already mentioned in the introduction, under the existence of *PcrOs* between firms, each firm acquires other firms' shares in the form of investments with no control rights, while acting in their largest shareholders' financial interest by maximizing their own value and disregarding the impact of their actions on other firms' corporate strategy.

Therefore, the equilibrium quantity of each firm is:

$$q_{i,S}^{(*)} = \frac{A(b - b\mu_i + c\frac{w}{w_i})}{b^2\left(3 - \mu_i - \mu_j - \mu_i\mu_j\right) + c^2 w + 2bc(1+w)} \tag{9}$$

Substituting $q_{i,S}^{(*)}$ in Eq. (8) yields the equilibrium profit of each firm ($\Pi_{i,S}^{(*)}$) when it decides to settle with the CA.[8]

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[7] See Tables 4 and 5 in the Appendix.

As previously, we compare $\Pi_{i,M}^{*}$ and $\Pi_{i,S}^{(*)}$ for the same parameter values to derive the critical values of $\rho_i^{\overline{\chi}}$. Proposition 1 still holds; hence the effective cartel fine reduction is negatively correlated with the likelihood that the cartel would be detected. However, Proposition 2 does not hold anymore since:

Proposition 4. *An increase in the PcrOs of either firm, provides both firms with higher incentives to enter the settlement procedure.*

Proposition 4 is derived by inspecting the following figure, which is a graphical illustration of Table 6 given in the Appendix.

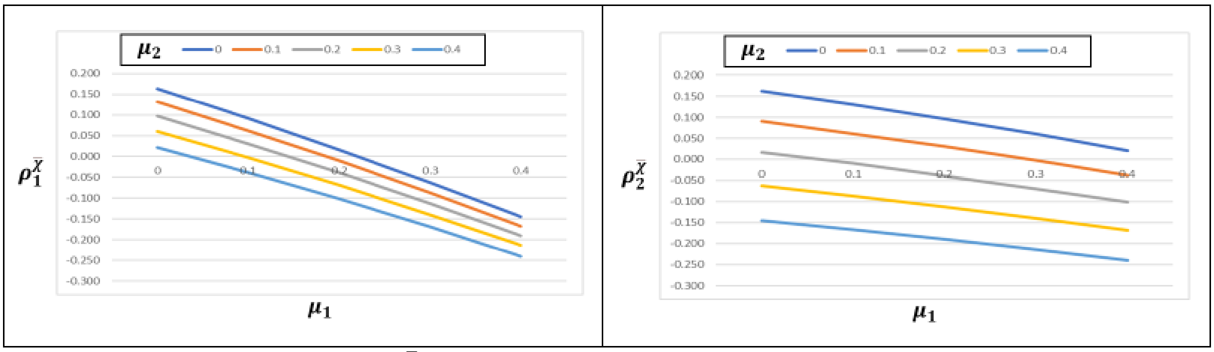

Figure 3. The levels of $\rho_i^{\overline{\chi}}$ as a function of μ_1 for $\mu_2 = \{0.0, 0.1, 0.2, 0.3, 0.4\}$ and $\chi = \overline{\chi} = 0.1$

The intuition behind Proposition 4 is that since each firm maximizes its own value, it does have more incentives to prefer the settlement choice rather than to be caught and pay the cartel fine. In fact, the existence of *PcrOs* instead of *PcomOs* induce firms to play a *Prisoner Dilemma* game.

It should be noted that qualitatively similar results to those presented in Figure 3 would be obtained if considering alternative values of χ and/or w (see Tables 7 and 8 in the Appendix). In addition, Proposition 3 still holds, hence as cost asymmetry increases, the inefficient firm has more incentives to settle, as opposed to the efficient firm which prefers the cartel formation for more parameter values.[9]

A direct implication of Proposition 4 is summarized in the following corollary:

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[8] Like the case with *PcomOs* between firms, the profit functions are not presented here for simplicity. However, they are available upon request.

[9] See Tables 9 and 10 in the Appendix.

Corollary 1. *Under the same levels of the cost efficient parameter (w) and the POs parameter (μ_i), settlement is more likely to arise in equilibrium under PcrOs than under PcomOs.*

Corollary 1 can be proven by inspecting Tables 11, 12 and 13 given in the Appendix.

5 Conclusions

According to the settlement procedure, cartel participants which decide to settle with Competition Authorities are rewarded with a reduced cartel fine. In this paper, we present the conditions under which a given reduction on cartel fines is effective in fulfilling the goal of inducing all cartel firms to participate in the settlement procedure.

Our results reveal that for any given cartel reduction fine, there is a particular level of cartel detection probability that makes each firm indifferent between staying in the cartel and settling with the competition authority. We show that such reduction is negatively correlated with the likelihood that the cartel would be detected, meaning that a higher probability of cartel detection is required for a lower reduction to be effective.

However, we should bear in mind that the probability of detecting the cartel is determined by firms' perception about the CA's evidence. Competition Authorities should convey the right signal to cartel firms that, given the existed evidence of the case under scrutiny, the reduction of cartel fine by entering the SP is effective. To put it differently, they should ensure that their evidence signifies the right signal to cartel firms so as to form the required perception of being caught. The necessary measures to signal an increase in the probability of detecting the cartel compromise the existence of solid evidence concerning: (a) the establishment and the function of the cartel; (b) its impact on consumers' welfare; and (c) the distinct role of its member. All of them play a crucial role to induce all cartel firms to settle and to eliminate their incentives to appeal to the court. By doing so, the SP has accomplished its main scope, that is, to promote the procedural efficiency of cartel enforcement in the EU.

We also challenge the robustness of our main finding by allowing partial ownerships (either *PcomOs* or *PcrOs*) between the rival firms. We argue that under the existence of *PcomOs* between firms, the firm increasing its *PcomOs* faces higher incentives to enter the settlement procedure, as opposed to the target firm which increases its preference for the cartel formation. Also, as firms become more asymmetric, the inefficient firm has more incentives to settle, as opposed to the efficient firm which prefers the cartel formation for more parameter values. However, under the existence of *PcrOs* between the firms, an increase in the *PcrOs* of either firm, provides both firms with higher incentives to enter the settlement procedure.

Therefore, the presence of partial ownerships among rival firms may enhance the effectiveness of the settlement procedure, as opposed to their negative impact on competition under a Leniency Program (Heim et al. 2020).

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Appendix

In the following tables, we provide the main estimations, as well as the main comparisons. Each combination of μ_1 and μ_2 results in a cell formed by two lines, with the upper denoting $\rho_1^{\overline{\chi}}$ and the lower $\rho_2^{\overline{\chi}}$ for $\chi = 10\%$.

Table 1. Results for $w = 1$ under *PcomOs*

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.163 0.163	0.091 0.216	0.016 0.275	-0.062 0.339	-0.145 0.408
	0.1	0.216 0.091	0.144 0.144	0.068 0.202	-0.013 0.267	-0.098 0.338
	0.2	0.275 0.016	0.202 0.068	0.126 0.126	0.044 0.190	-0.042 0.263
	0.3	0.339 -0.062	0.267 -0.012	0.190 0.044	0.109 0.109	0.021 0.182
	0.4	0.408 -0.145	0.338 -0.098	0.263 -0.042	0.182 0.021	0.095 0.095

Table 2. Results for $w = 0.8$ under *PcomOs*

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.107 0.211	0.022 0.260	-0.065 0.314	-0.158 0.373	-0.257 0.438
	0.1	0.162 0.151	0.077 0.199	-0.011 0.253	-0.106 0.312	-0.207 0.379
	0.2	0.223 0.088	0.139 0.135	0.049 0.188	-0.046 0.248	-0.149 0.315
	0.3	0.290 0.022	0.206 0.067	0.117 0.119	0.021 0.178	-0.081 0.247
	0.4	0.364 -0.048	0.282 -0.005	0.194 0.045	0.099 0.104	-0.002 0.173

Table 3. Results for $w = 0.6$ under *PcomOs*

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.004	-0.099	-0.209	-0.325	-0.448
		0.266	0.310	0.358	0.412	0.472
	0.1	0.064	-0.039	-0.150	-0.268	-0.394
		0.217	0.260	0.308	0.362	0.423
	0.2	0.131	0.026	-0.084	-0.202	-0.329
		0.165	0.207	0.255	0.309	0.370
	0.3	0.204	0.101	-0.008	-0.127	-0.254
		0.110	0.150	0.197	0.251	0.314
	0.4	0.285	0.184	0.076	-0.040	-0.167
		0.053	0.090	0.135	0.189	0.252

Table 4. Comparisons of Tables 2 and 1 where each cell of Table 1 has been subtracted from the corresponding cell of Table 2

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	-0.056	-0.069	-0.081	-0.096	-0.112
		0.048	0.044	0.039	0.034	0.030
	0.1	-0.054	-0.067	-0.079	-0.094	-0.109
		0.060	0.055	0.051	0.045	0.041
	0.2	-0.052	-0.063	-0.077	-0.090	-0.107
		0.072	0.067	0.062	0.058	0.052
	0.3	-0.049	-0.061	-0.073	-0.088	-0.102
		0.084	0.079	0.075	0.069	0.065
	0.4	-0.044	-0.056	-0.069	-0.083	-0.097
		0.097	0.093	0.087	0.083	0.078

Table 5. Comparisons of Tables 3 and 2 where each cell of Table 2 has been subtracted from the corresponding cell of Table 3

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	-0.103	-0.121	-0.144	-0.167	-0.191
		0.055	0.050	0.044	0.039	0.034
	0.1	-0.098	-0.116	-0.139	-0.162	-0.187
		0.066	0.061	0.055	0.050	0.044
	0.2	-0.092	-0.113	-0.133	-0.156	-0.180
		0.077	0.072	0.067	0.061	0.055
	0.3	-0.086	-0.105	-0.125	-0.148	-0.173
		0.088	0.083	0.078	0.073	0.067
	0.4	-0.079	-0.098	-0.118	-0.139	-0.165
		0.101	0.095	0.090	0.085	0.079

Table 6. Results for $w = 1$ under *PcrOs*

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.163	0.091	0.016	-0.062	-0.145
		0.163	0.131	0.096	0.060	0.021
	0.1	0.131	0.061	-0.010	-0.087	-0.167
		0.091	0.061	0.030	-0.003	-0.038
	0.2	0.097	0.030	-0.039	-0.113	-0.190
		0.016	-0.010	-0.039	-0.069	-0.101
	0.3	0.060	-0.003	-0.069	-0.140	-0.214
		-0.062	-0.087	-0.113	-0.140	-0.169
	0.4	0.021	-0.038	-0.102	-0.169	-0.240
		-0.145	-0.167	-0.190	-0.214	-0.240

Table 7. Results for $w = 0.8$ under *PcrOs*

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.107 0.211	0.022 0.179	-0.065 0.145	-0.158 0.109	-0.257 0.070
	0.1	0.070 0.151	-0.010 0.122	-0.095 0.090	-0.185 0.057	-0.281 0.021
	0.2	0.032 0.088	-0.045 0.061	-0.127 0.032	-0.214 0.002	-0.306 -0.030
	0.3	-0.009 0.022	-0.083 -0.002	-0.161 -0.028	-0.244 -0.056	-0.332 -0.085
	0.4	-0.053 -0.048	-0.123 -0.070	-0.197 -0.093	-0.276 -0.117	-0.360 -0.143

Table 8. Results for $w = 0.6$ under *PcrOs*

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.004 0.266	-0.099 0.234	-0.209 0.200	-0.325 0.165	-0.448 0.126
	0.1	-0.037 0.217	-0.138 0.187	-0.244 0.156	-0.356 0.123	-0.475 0.088
	0.2	-0.083 0.165	-0.179 0.138	-0.281 0.110	-0.389 0.079	-0.503 0.047
	0.3	-0.132 0.110	-0.223 0.086	-0.320 0.060	-0.423 0.032	-0.533 0.003
	0.4	-0.184 0.053	-0.270 0.031	-0.362 0.007	-0.460 -0.016	-0.565 -0.043

Table 9. Comparisons of Tables 6 and 7 where each cell of Table 6 has been subtracted from the corresponding cell of Table 7

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	-0.056	-0.069	-0.081	-0.096	-0.112
		0.048	0.048	0.049	0.049	0.049
	0.1	-0.061	-0.071	-0.085	-0.098	-0.114
		0.060	0.061	0.060	0.060	0.059
	0.2	-0.065	-0.075	-0.088	-0.101	-0.116
		0.072	0.071	0.071	0.071	0.071
	0.3	-0.069	-0.080	-0.092	-0.104	-0.118
		0.084	0.085	0.085	0.084	0.084
	0.4	-0.074	-0.085	-0.095	-0.107	-0.120
		0.097	0.097	0.097	0.097	0.097

Table 10. Comparisons of Tables 7 and 8 where each cell of Table 7 has been subtracted from the corresponding cell of Table 8

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	-0.103	-0.121	-0.144	-0.167	-0.191
		0.055	0.055	0.055	0.056	0.056
	0.1	-0.107	-0.128	-0.149	-0.171	-0.194
		0.066	0.065	0.066	0.066	0.067
	0.2	-0.115	-0.134	-0.154	-0.175	-0.197
		0.077	0.077	0.078	0.077	0.077
	0.3	-0.123	-0.140	-0.159	-0.179	-0.201
		0.088	0.088	0.088	0.088	0.088
	0.4	-0.131	-0.147	-0.165	-0.184	-0.205
		0.101	0.101	0.100	0.101	0.100

Table 11. Comparisons of Tables 1 and 6 (*PcomOs vs PcrOs* for $w = 1$) where each cell of Table 6 has been subtracted from the corresponding cell of Table 1

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.000	0.000	0.000	0.000	0.000
		0.000	0.085	0.179	0.279	0.387
	0.1	0.085	0.083	0.078	0.075	0.069
		0.000	0.083	0.172	0.270	0.376
	0.2	0.178	0.172	0.165	0.157	0.148
		0.000	0.078	0.165	0.259	0.364
	0.3	0.279	0.270	0.259	0.249	0.235
		0.000	0.075	0.157	0.249	0.351
	0.4	0.387	0.376	0.365	0.351	0.335
		0.000	0.069	0.148	0.235	0.335

Table 12. Comparisons of Tables 2 and 7 (*PcomOs vs PcrOs* for $w = 0.8$) where each cell of Table 7 has been subtracted from the corresponding cell of Table 2

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.000	0.000	0.000	0.000	0.000
		0.000	0.081	0.169	0.264	0.368
	0.1	0.092	0.087	0.084	0.079	0.074
		0.000	0.077	0.163	0.255	0.358
	0.2	0.191	0.184	0.176	0.168	0.157
		0.000	0.074	0.156	0.246	0.345
	0.3	0.299	0.289	0.278	0.265	0.251
		0.000	0.069	0.147	0.234	0.332
	0.4	0.417	0.405	0.391	0.375	0.358
		0.000	0.065	0.138	0.221	0.316

Table 13. Comparisons of Tables 3 and 8 (*PcomOs vs PcrOs* for $w = 0.6$) where each cell of Table 8 has been subtracted from the corresponding cell of Table 3

		μ_1				
		0	0.1	0.2	0.3	0.4
μ_2	0	0.000	0.000	0.000	0.000	0.000
		0.000	0.076	0.158	0.247	0.346
	0.1	0.101	0.099	0.094	0.088	0.081
		0.000	0.073	0.152	0.239	0.335
	0.2	0.214	0.205	0.197	0.187	0.174
		0.000	0.069	0.145	0.230	0.323
	0.3	0.336	0.324	0.312	0.296	0.279
		0.000	0.064	0.137	0.219	0.311
	0.4	0.469	0.454	0.438	0.420	0.398
		0.000	0.059	0.128	0.205	0.295