Colluding or Settling? The role of unilateral overlapping ownership

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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 study the effect of unilateral overlapping ownership on the individual incentives of two colluding asymmetric firms to settle with the Competition Authority. We show that, regardless of which firm increases its cross-holding level, both firms are provided with higher incentives to enter the settlement procedure. On the contrary, when the reference shareholder of either firm increases its minority shares in the other, the controlled firm faces higher incentives to settle, as opposed to the target firm which increases its preference for collusion. Therefore, the objective of CAs to induce all cartel firms to settle is more likely to arise in equilibrium under cross-shareholding than under common ownership. This theoretical finding is supported by empirical evidence revealing that the former overlapping ownership type is more closely related to non-hybrid settled cases, as opposed to the latter which is better linked to hybrid settled cases.

Keywords: Antitrust policy; Cartel fines; Competition policy; Partial overlapping 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%.

The goal of this paper is to study the effect of unilateral overlapping ownership on the individual incentives of two colluding asymmetric firms to settle with the CA. For this purpose, we assume a duopolistic market where one competitor may hold shares in its rival. We consider such horizontal agreements either to have or to have no significant influence on corporate strategy.

According to the definition of overlapping ownership (de Haas and Paha, 2021; Heim et al., 2022; Lopez & Vives, 2019), partial common ownership (CNO) exists when large shareholders not only have significant shares in rival firms but also influence their corporate strategy (Azar et al., 2018; Leonardos et al., 2021; Rosati et al., 2020; Schmalz, 2018). On the contrary, partial cross ownership (CRO) is present when firms acquire other firms' shares in the form of investments with no control rights, while acting in their largest (reference) shareholder's 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).

We compare the profit of each firm when deciding to enter into the settlement procedure with that obtained when they both agree to collude and act as a monopolist. The outcome of this comparison is found to be crucially affected by the form of overlapping ownership. In particular, we show that when reference shareholder of either firm increases its minority shares in the rival, the controlled firm faces higher incentives to settle, as opposed to the target firm which increases its preference for collusion. On the contrary, regardless of whether the efficient or the inefficient firm increases its cross-holding level, both firms are provided with higher incentives to enter the settlement procedure.

This theoretical finding is supported by empirical evidence stating that partial cross ownership is more probable to lead to non-hybrid settled cases, as opposed to partial common ownership which is found to be more closely related to hybrid settled cases. Therefore, the objective of CAs to induce all cartel firms to settle is more likely to arise in equilibrium under cross-shareholding than under common ownership.

The paper is organized as follows. Section 2 reviews the related literature, whereas Section 3 presents statistics of the most important cartel cases in the EU. Section 4 presents the basic theoretical modeling setup and compares the derived results when firms reach a collusive agreement with those derived when they settle with the CA. Section 5 analyzes the effect of unilateral overlapping ownership on the incentives of each firm to enter the settlement procedure. Section 6 provides some empirical evidence regarding both hybrid and non-hybrid settled cases in the EU. The last section 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]

Another literature strand studies the incentives of cartel participants to use overlapping ownership as a tool to stabilize collusion. de Haas and Paha (2020) state that overlapping ownership weakens the sustainability of collusion, especially in countries with an effective CA. However, Heim et al. (2020) argue that firms may use overlapping ownership 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 overlapping ownership 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 overlapping ownership. Ascione and Motta (2008) use data of all fines decided by EC[2] and

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[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.

all 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.

More recently, Huse et al. (2022) examine the evolution of overlapping ownership in the global automobile industry over the period 2007-2021. The authors state that that partial common ownerships amount to 31–40%, while partial cross ownerships amount to 5–9% of

automobile manufacturers' stock. The latter result in an underestimation of the average weight assigned by managers to the profit of competitors by between 41–105%, depending on the years and on the measure of corporate control used. Therefore, CA ought to account for cross ownership when calculating the traditional indicators used to screen unilateral anti-competitive effects.

Our paper contributes to the above-mentioned literature since it represents the first formal attempts to examine the effect of overlapping ownership on the success of SP. Contrary to the negative effect of LP on competition under the presence of overlapping ownership, we show that SP can contribute to uncovering a cartel by inducing all participants to settle, especially when the horizontal agreements take the form of cross ownership.

3   Statistics of most important cartel cases in the EU

3.1   Cartel cases with the highest fines in EU case law: 2001 - 2022

Table 1 shows that two out of six settled cartel cases with the highest fines in the EU have ended via a non-hybrid SP (i.e., all firms prefer to settle with CAs), while in the remaining four settled cartel cases some firms prefer not to settle with CAs (the hybrid SP).

Table 1 reveals that in all cartel cases with the highest fines in EU (ten cartel cases), at least two (i.e. "Car emissions - CE" cartel case) or more cartel firms (i.e. "Trucks, EIRD, Automotive Bearings, Car emissions and YIRD" cartel cases) have engaged in the LP. Particularly, 40% of these cases (4 out of 10 cartel cases) have ended via a hybrid settled procedure ("Trucks, EIRD, YIRD, FOREX" cartel cases), while 20% of these cases (2 out of 10 cartel cases) have ended via a non-hybrid settled procedure ("Automotive Bearings and Car emissions" cartel cases). More interestingly, regarding two cartel cases (TV and Computer Monitor Tubes - Airfreight (air cargo carriers), most of the firms engaged in the LP, but none of them engaged in the SP.

Table 1. Highest cartel fines[*] per case, leniency program and settlement procedure: 2001 – 2022 (29.11.2022)

A/A	Year	Cases	Fine in €	Leniency Program	Settlement Procedure Hybrid	Settlement Procedure Not Hybrid
1	2016/2017	Trucks (**T**)	**3 807 022 000**	4 applicants	5 out of 6 firms	
2	2019/2019/ 2021	Forex[**] (*three-way Banana Split*) (**TWBS**) (*Essex Express*) (**EE**) (*Sterling Lands*) (**SL**)	1.329.980.000 **811.197.000** **257.682 000** **261 101 000**	5 applicants 3 applicants 4 applicants	5 firms 4 firms 4 out of 5 firms	
3	2012	TV and Computer Monitor Tubes (TVCMT)[***] **CPT** CARTEL **CDT** CARTEL	1.490.615.000 **328.187.000** **1.162.428.000**	3 (out of 4) applicants 5 (out of 8) applicants	-	-
4	2013/2016/ 2021[****]	Euro Interest Rates Derivatives (**EIRD**)	**1.308.172.000**	4 applicants	4 out of 7 firms	
5	2014	Automotive Bearings (**AB**)	**953 306 000**	5 applicants		All (6 firms)
6	2021	Car emissions (**CE**)	**875 189 000**	2 applicants		All (3 firms)
7	2007	Elevators and escalators (**E&E**)[*****] BELGIUM GERMANY LUXEMBOURG THE NETHERLANDS	**992 312 000** 185.620.050 617.091.750 49.361.400 140.239.000	4 (out of 4) applicants 4 (out of 4) applicants 4 (out of 4) applicants 3 (out of 5) applicants	-	-
8	2010/2017	Airfreight (air cargo carriers) (**ACC**)	**1.215.215.000**	10 (out of 13) applicants	-	-
9	2001	Vitamins (**V**)[*****]	**855.230.000**	9 (out of 13) applicants	-	-
10	2013/2015	Yen Interest Rate Derivatives (**YIRD**)	**689.859.000**	5 applicants	6 out of 7 firms	
		TOTAL IMPOSED FINES	**13.496.900.200**			

[*]Amounts adjusted for changes following judgments of the Courts (General Court and European Court of Justice) and/or amendment decisions.
[**]The Forex case consists of three Settlement cases/decisions and one ordinary decision.
[***] The TVCMT case consists of two ordinary cartel decisions: the CPT ordinary cartel decision in the sector of color display tubes used in computer monitors and the CDT ordinary cartel decision in the sector of color picture tubes used for color televisions.
[****] The EIRD case consists of two amendment cases in 2016 and 2021. For the ordinary prohibition cartel decision see https://ec.europa.eu/commission/presscorner/detail/en/mex_21_3283.
[*****]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:** Cartel cases (CASE AT.39258 – AIRFREIGHT, CASE COMP/39922 – AUTOMOTIVE BEARINGS, CASE AT.40178 – CAR EMISSIONS, Case COMP/E-1/38.823 - PO/ELEVATORS AND ESCALATORS, CASE AT.39914 - EURO INTEREST RATE DERIVATIVES, CASE AT.40135 FOREX (Sterling Lads), CASE AT.40135 FOREX (Essex Express), CASE AT.40135 FOREX (Three Way Banana Split), CASE AT.39824 -TRUCKS, CASE AT.39437 – TV AND COMPUTER MONITOR TUBES, Case COMP/E-1/37.512 VITAMINS, CASE AT.39861 – YEN INTEREST RATE DERIVATIVES); Laina & Bogdanov (2019); EC (2022).

3.2 EU cartel cases before and after the introduction of Settlement Procedure

Figure 1 shows the 10 cartel cases with the highest fines in the EU from 2001 to 29th of November 2022 before and after the introduction of the EC's SP (1.7.2008).

It is evident from Figure 1 that the adoption of EC's final decision in two cartel cases (V - E&E) was prior to the introduction of the SP, while the adoption of EC's final decision of the remaining eight cartel cases was after the introduction of the SP. Therefore, the combined data of Table 1 and Figure 1 reveals that only in two out of eight cartel cases (25%) after the establishment of the SP, the engaged firms in the cartel did not settle with the EC, while in the remaining 75% of the cartel cases the engaged firms in the cartel settled with the EC.

Figure 1: Cartel cases in the EU prior and after the introduction of the SP[*]
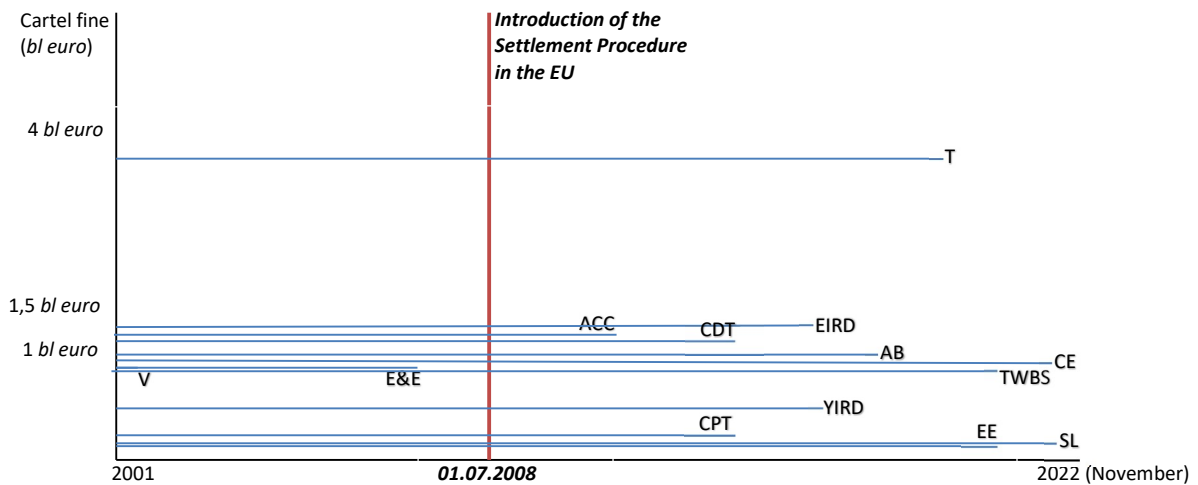
*FOREX case: TWBS – EE – SL; TV and Computer Monitor Tubes case: CDT – CPT.
Source: Data elaboration of Table 1.

4 Equilibrium analysis

Consider a setting in which two firms $i = 1,2$ face the inverse demand function $P = 1 - Q$, 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, firms may linked by overlapping ownership. Under unilateral overlapping ownership, one firm holds minority shares in its rival, but not vice versa. Let $\mu_i \in [0,0.5)$ denote the share of firm i in firm $j's$ equity capital, hence $\mu_j = 0$, 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.

4.1 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 overall 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:

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

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 regardless of whether the cartel is detected or not; and (ii) the cartel fine, which is defined as a percentage (κ) of its revenue and is realized once the cartel is detected.[3] In what follows, we adopt the EC's practice, according to which the cartel fine is limited to 10% of its overall revenue ($P_M Q_M$), thus $\kappa = 0.1$. The equilibrium quantity of the monopolist is thus given by:

$$Q_M = \frac{(1 - 0.1\rho)(1 + w)}{2(1 - 0.1\rho)(1 + w) + wc} \tag{2}$$

The profit function of each cartel firm writes:

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

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

$$q_{i,M}^* = \frac{w}{w_i} \cdot \frac{5(1 - 0.1\rho)}{(10 - \rho)(1 + w) + 5wc} \tag{4}$$

and

$$\pi_{i,M}^* = \frac{w}{w_i} \cdot \frac{(10 - \rho)^2}{40[(10 - \rho)(1 + w) + 5wc]} \tag{5}$$

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

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.

4.2 Settlement procedure with partial overlapping ownership

In this section, we study the case where each Cournot competitor settles with the CA. The firm posing an overlapping ownership in its rival pursues to maximize the following objective function:

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

(6)

On the contrary, the target firm, which does not hold any overlapping ownership in its rival, aims to maximize:

$$\pi_{j,S} = \left(P_S q_{j,S} - w_j \frac{c(q_{j,S})^2}{2}\right)\frac{(1 - \mu_i)}{DV} - (1 - \chi)\kappa\left(P_M q_{j,M}\right)$$

(7)

where DV is a dummy variable taking value 1 in the case of partial common ownership (CNO) and $(1 - \mu_i)$ in the case of partial cross ownership (CRO), hence $DV = \{1, (1 - \mu_i)\}$. In each type of overlapping ownership, the profit of each firm is modelled in a way following that of de Haas and Paha (2020). The main difference between the two types of ownerships is the absence of term $(1 - \mu_i)$ under CRO, meaning that, in this case, each firm profit is modeled as it appears in its income statement (de Haas and Paha, 2020). It is interesting to note that as $\mu_j = 0$, the objective function of the firm holding shares in its rival is the same under both CNO and CRO. The last part in Eqs. (6) and (7) represents the percentage reduction (χ) on the cartel fine due to settling, with $\chi \in [0,1]$.

Therefore, four cases are nested in the above expressions: (i) the inefficient firm $i = 1$ holds CNO shares in the efficient firm $j = 2$; (ii) the inefficient firm $i = 1$ holds CRO shares in the efficient firm $j = 2$; (iii) the efficient firm $i = 2$ holds CNO shares in the inefficient firm $j = 1$; (ii) the efficient firm $i = 2$ holds CRO shares in the inefficient firm $j = 1$.

Regardless of the type of overlapping ownership, the equilibrium quantity of each firm is given by:

$$q^*_{i,S} = \frac{(1 - \mu_i) + c\frac{w}{w_i}}{(3 - \mu_i) + [wc^2 + 2c(1 + w)]} \qquad (8)$$

and

$$q^*_{j,S} = \frac{1 + c\frac{w}{w_j}}{(3 - \mu_i) + [wc^2 + 2c(1 + w)]} \qquad (9)$$

Therefore, compared to the standard duopoly case: (i) the firm increasing its overlapping ownership shares partially internalizes the impact of its decision on the rival's profit, hence chooses to decrease its output, as opposed to the target firm which chooses to increase its output due to strategic substitutability; and (ii) total output is lower, thus overlapping ownership softens competition. These findings are consistent with the literature of horizontal shareholding as summarized in Li and Shuai (2022).

Substituting $q^*_{i,S}$ in Eq. (6) and $q^*_{j,S}$ in Eq. (7) yields the equilibrium profit ($\pi^*_{i,S}$ and $\pi^*_{j,S}$) of each firm when it decides to settle with the CA.[4]

5   The effect of unilateral overlapping ownership

The goal of this section is to assess the impact of unilateral overlapping ownership on the incentives of each firm to enter the settlement procedure. To do so, we calculate the first derivative of the difference of each firm's profit under colluding and settling with respect to the CNO and CRO shares of firm i in firm j.

Let $\Delta\pi^{CNO}_i = \pi^{CNO*}_{i,S} - \pi^{CNO*}_{i,M}$ denote the difference of firm's i profit when choosing to settle and when choosing to collude under the CNO scenario, whereas the respective difference of firm j is given by $\Delta\pi^{CNO}_j = \pi^{CNO*}_{j,S} - \pi^{CNO*}_{j,M}$. In a similar way, $\Delta\pi^{CRO}_i = \pi^{CRO*}_{i,S} - \pi^{CRO*}_{i,M}$ and $\Delta\pi^{CRO}_j = \pi^{CRO*}_{j,S} - \pi^{CRO*}_{j,M}$ denote the respective profit difference of each firm when firm i holds CRO shares in firm j. The effect of overlapping ownership on each profit difference is presented in the following Lemma.

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[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.

Lemma 1.

(i) *Under unilateral common ownership, the impact of μ_i on $\Delta\pi_i^{CNO}$ and $\Delta\pi_j^{CNO}$ is given, respectively, by:*

$$\frac{\partial\Delta\pi_i^{CNO}}{\partial\mu_i} = \frac{\left(1 + c\frac{w}{w_j}\right)[(4 + c(2 + w + wc)(5 + 2c - \mu_i + wc(2 + c)]}{2[(3 - \mu_i) + [wc^2 + 2c(1 + w)]^3} > 0$$

and

$$\frac{\partial\Delta\pi_j^{CNO}}{\partial\mu_i} = -\frac{\left(1 + c\frac{w}{w_j}\right)^2\left(2 + c\frac{w}{w_i}\right)[(1 + 2c + \mu_i + wc(2 + c)]}{2[(3 - \mu_i) + [wc^2 + 2c(1 + w)]^3} < 0$$

(ii) *Under unilateral cross ownership, the impact of μ_i on $\partial\Delta\pi_i^{CRO}$ and $\Delta\pi_j^{CRO}$ is given, respectively, by:*

$$\frac{\partial\Delta\pi_i^{CRO}}{\partial\mu_i} = \frac{\partial\Delta\pi_i^{CNO}}{\partial\mu_i} > 0$$

and

$$\frac{\partial\Delta\pi_j^{CRO}}{\partial\mu_i} = \frac{\left(1 + c\frac{w}{w_j}\right)^2\left(2 + c\frac{w}{w_i}\right)}{[(3 - \mu_i) + [wc^2 + 2c(1 + w)]^3} > 0$$

From Lemma 1, we can deduce that the firm partially owning in its rival, either in the form of CNO or CRO, increases its preference for settling with the CA when increasing its minority shares. This finding implies that the gaining of this firm from softening competition due to settling outweighs any positive effects of cost asymmetry on its profit. Indeed, regardless of whether the efficient or the inefficient firm holds minority shares in its rival, the impact of overlapping ownership on its preference for settling instead of colluding is positive.

On the contrary, the effect of overlapping ownership on the incentives of the target firm to settle with the CA crucially depends on the form of such ownership. In particular, a higher CNO (respectively, CRO) share in the target firm increases its preference for colluding (respectively, settling). Obviously, the main reason for this result is the fact that the gross

profit of the target firm when settling is multiplied by $(1 - \mu_i)$ in the case of CNO, hence an increase in μ_i negatively affects its incentives to enter the settlement procedure.

The implications of Lemma 1 can be summarized in the following proposition:

Proposition 1.

(i) *Regardless of whether the efficient or the inefficient firm increases its cross-holding level, both firms are provided with higher incentives to enter the settlement procedure.*

(ii) *When the reference shareholder of either firm increases its minority shares in the other, the controlled firm faces higher incentives to settle, as opposed to the target firm which increases its preference for collusion.*

A direct implication of Proposition 1 is that the objective of CAs to induce all cartel firms to settle is more likely to arise in equilibrium under cross-shareholding than under common ownership. Recall that the objective function of the firm holding shares in its rival is the same under both CNO and CRO, hence its preference for settling or colluding is independent of the form of overlapping ownership. As far as the target firm is concerned, higher CRO (respectively, CNO) shares increases its preference for settlement (respectively, collusion).

In fact, there is a critical value of χ that makes each firm indifferent between settling and colluding under each overlapping ownership case. This critical value is a complex function of c, w, ρ and μ_i, meaning that does not provide any useful intuition. For the firm holding minority shares in its rival, this critical level is the same under both CNO and CRO.

On the contrary, for the target firm, the critical levels between the two cases would differ for positive values of μ_i. However, a mathematical software package (such as *Wolfram Mathematica*) is unable to find the combination of two parameters that makes the critical values in each case equal after giving any set of values to the remaining two parameters. This implies that the critical value of χ under CNO is always higher than the respective value of χ under CRO, hence the target firm enters the settlement procedure for more values of χ under CRO than under CNO.

Therefore, the following proposition can be stated:

Proposition 2. *Partial cross ownership is more probable to lead to non-hybrid settled cases, as opposed to partial common ownership which is found to be more closely related to hybrid settled cases.*

6   Empirical Evidence

In this section, we examine some empirical evidence to challenge the effectiveness of Proposition 2 in practice. The sample is based on the eight settled cartel cases with the highest fines in the EU during the period from 2001 until 29th of November 2022 as presented in Table 1 and Figure 1.

6.1   Evidence from the hybrid settled cartel cases

Tables 2 and 3 present the top shareholders of the largest banks institutions and largest trucks manufacturers, respectively. It is evident that the top shareholders across the major players in each market are very similar.

The ownership structures of the largest banks, such as those reported in Table 2, reveal that Black Rock Group is the largest shareholder of BARCLAYS and UBS bank institutions, The Vanguard Group, Inc. is the largest shareholder of JP MORGAN and CITIGROUP bank institutions, whereas Credit Agricole is by far the largest shareholder of SOCIETE GENERALE (via Amundi Asset Management SA). The top shareholders across the major players in the banking system are very similar (Schmalz 2018). These mutual funds (Black Rock Group and The Vanguard Group, Inc.) are among the major holders of most of the largest bank institutions as well. Indeed, Black Rock Group is also the second lager shareholder of HSBC and MUFG INC, while The Vanguard Group, Inc. is also the third larger shareholder of SOCIETE GENERALE and HSBC banking systems and the fourth larger shareholder of MUFG INC, RBS and DEUTSCHE banking systems. These firms do not act in their largest shareholders' financial interest and neither maximize their own value, nor disregard the potential impact of their actions on their competitor's profits, since their top shareholders not only have significant shares in rival firms but also influence their corporate strategy. Hence, the top shareholders have economic interests in their competitors' capital stock, and they prefer to maximize their portfolio value rather than their own value.

Table 2. The largest (institutional and non-institutional) beneficial owners and corresponding capital for largest banks[*]

BARCLAYS *Shareholders (Capital %)*	RBS *Shareholders (Capital %)*
Qatar Investment Authority (6,54)	HM Treasury (38,5)
Credit Suisse Asset Management (5,52)	Norges Bank Investment Management (3,38)
Dodge & Cox (3,98)	MFS International (UK) Ltd. (1,95)
Black Rock Investment Management (3,64)	The Vanguard Group, Inc. (1,77)
The Vanquard Group (3,13)	Massachusetts Financial Services Co. (1,69)
Black Rock Fund Advisors (2,74)	Black Rock Investment Management (UK) Ltd. (1,51)
Black Rock Advisors (UK) Ltd. (1,43)	

UBS *Shareholders (Capital %)*	CITIGROUP *Shareholders (Capital %)*
Black Rock Inc. (4,97)	The Vanguard Group, Inc. (8,29)
Massachusetts Financial Services Co. (3,17)	SSgA Funds Management, Inc. (4,25)
Artisan Partners Limited Partnership (3,03)	Berkshire Hathaway, Inc. (2,84)
Dodge & Cox International Stock Fund (3,02)	BlackRock Fund Advisors (2,30)
Norges Bank (3,01)	Geode Capital Management LLC (1,81)
The Vanguard Group, Inc. (2,08)	Capital Research & Management Co. (1,19)
Credit Suisse Asset Management (Schweiz) AG (2,06)	Massachusetts Financial Services Co. (1,17)

JP MORGAN *Shareholders (Capital %)*	HSBC *Shareholders (Capital %)*
The Vanguard Group, Inc. (8,93)	Ping An Asset Management Co., Ltd. (8,29)
SsgA Funds Management, Inc. (4,23)	Black Rock Investment Management (3,86)
BlackRock Fund Advisors (2,16)	The Vanguard Group, Inc. (3,38)
Geode Capital Management LLC (1,78)	Norges Bank Investment Management (2,99)
Capital Research & Management Co (1,39)	BlackRock Fund Advisors (2,63)
Capital Research & Management Co. (1,38)	BlackRock Advisors (UK) Ltd. (1,35)

DEUTSCHE BANK *Shareholders (Capital %)*	SOCIETE GENERALE *Shareholders (Capital %)*
Capital Research & Management Co. (5,74)	Amundi Asset Management SA (4,41)[**]
Hamad Al-Thani (4,59)	Société Générale Société anonyme (2,75)
Hudson Executive Capital LC (3,3)	The Vanguard Group, Inc. (2,5)
The Vanguard Group, Inc. (2,6)	Caisse Des Dépôts & Consignations (2,31)
Norges Bank Investment Management (2,23)	BNP Paribas Asset Management France SAS (2,05)
Amundi Asset Management US, Inc. (2,2)[**]	Capital Research & Management Co. (1,85)
Goldman Sachs International (1,72)	UBS Fund Management (Ireland) Ltd. (1,77)
	Black Rock Investment Management (UK) (1,59)

CREDIT AGRICOLE *Shareholders (Capital %)*	CREDIT SUISSE GROUP *Shareholders (Capital %)*
SAS Rue la Boétie (57,1)	Saudi National Bank (9,88)
Crédit Agricole SA Employee Stock Ownership Plan (6	Qatar Holding LLC (5,03)
BNP Paribas Asset Management France SAS (1,13)	Olayan Group (4,93)
The Vanguard Group, Inc. (1,1)	Black Rock, Inc. (2,82)
Dodge & Cox (0,97)	

MUFG INC *Shareholders (Capital %)*	
Mitsubishi UFJ Financial Group, Inc. (4,94)	
Nomura Asset Management Co., Ltd. (3,5)	
Black Rock Fund Advisors (3)	

The Vanguard Group, Inc (2,49)

Black Rock Japan Co., Ltd. (1,76)

Norges Bank Investment Management (1,71)

Daiwa Asset Management Co. Ltd. (1,57)

Nikko Asset Management Co., Ltd. (1,49)

Meiji Yasuda Life Insurance Co Pension Fund (

Toyota Motor Corporation (1,18)

*The bank institutions have been engaged in the three hybrid cartel cases in the EU during the period from 2001 until the 29th of November 2022 (see also Table 1) ** Amudi's major shareholder is Credit Agricole (69,2%).
In parentheses shareholder's stake in firm's capital equity.
Source: Cartel cases (CASE AT.39914 – EURO INTEREST RATE DERIVATIVES, CASE AT.40135 FOREX (Sterling Lads), CASE AT.40135 FOREX (Essex Express), CASE AT.40135 FOREX (Three Way Banana Split), CASE AT.39824 -TRUCKS, CASE AT.39861 – YEN INTEREST RATE DERIVATIVES); Marketscreener.com.

Table 3. The largest (institutional and noninstitutional) beneficial owners and corresponding capital for largest Truck manufacturers*

MAN *Shareholders (Capital %)*	SCANIA *Shareholders (Capital %)*
VW (TRATON) (100)	VW (TRATON) (100)

VOLVO *Shareholders (Capital %)*	DAMLER *Shareholders (Capital %)*
Swedbank Robur Fonder AB (5,44)	Mercendes – Benz Group AG** (30,01)
Shu Fu Li (4,96)	BAIC Group*** (6,49)
Alecta Pension Insurance Mutual (3,07)	Mercendes Benz Pension Trust e.V (4,99)
SEB Investment Management AB (2,99)	Kuwait Investment Authority (4,98)
Handelsbanken Fonder AB (2,85)	Institutional Investors (38,36)
Norges Bank Investment Manage (2,67)	Retail Investors (15,17)
The Vanguard Group, Inc. (1,81)	

DAF *Shareholders (Capital %)*	IVECO *Shareholders (Capital %)*
The Vanguard Group, Inc. (11,4)	Exor NV (Private Equity) (27,1)
SsgA Funds Management, Inc. (4,09)	Norges Bank Investment Manage (8,18)
Capital Research & Management Co. (3,43)	Harris Associates LP (6,43)
Geode Capital Management LLC (2,25)	Southpoint Capital Advisors LP (4,22)
Black Rock Fund Advisors (2,13)	Acadian Asset Management LLC (3,99)
Massachusetts Financial Services Co. (1,66)	The Vanguard Group, Inc. (2,2)

*The Truck manufacturers have been engaged in the hybrid cartel case AT.39824 -TRUCKS in the EU during the period from 2001 until the 29th of November 2022 (see also Table 1). ** The major shareholders of Mercendes – Benz Group AG are Beijing State-Owned Assets Supervision & Administration (9,98%), Shu Fu Li (9,69%), Kuwait Investment Authority (Investment Management) (5,57%), Deka Investment GmbH (2,32%), BlackRock Advisors (UK) Ltd. (1,68%), Amundi Asset Management SA (Investment Management) (1,62%) and Harris Associates LP (1,6%); *** The major shareholders of BAIC Group are Mercendes – Benz Group (30,4%), The Vanguard Group, Inc. (2,75%) and Norges Bank Investment Management (1,75%).
In parentheses shareholder's stake in firm's capital equity.
Source: CASE AT.39824 -TRUCKS; Marketscreener.com.

The empirical evidence of Tables 2 & 3 indicates that in the markets of banking system and truck manufacturers, passive common ownerships are present. In fact, the major shareholders not only have significant shares in rival firms but also influence their corporate strategy, while taking into account the impact of their actions on other firms' corporate strategy. It is interesting to point out that the firms reported in Tables 2 & 3 have engaged in 4 hybrid settled cartel cases (Case AT.39914 - Euro Interest Rate Derivatives, Case AT.40135 Forex (Sterling Lads), Case AT.40135 Forex (Essex Express), Case AT.40135

Forex (Three Way Banana Split), Case AT.39824 -Trucks, Case AT.39861 – Yen Interest Rate Derivatives; see also Table 1).Therefore, the theoretical findings of Proposition 2 are supported by empirical evidence revealing that CNO is more closely linked to hybrid settled cases.

6.2 Evidence from the non-hybrid settled cartel cases

Tables 4 and 5 present the top shareholders of the largest manufacturers of SCR systems for diesel passenger cars and the largest manufacturers of bearings for automotive applications, respectively. It is evident that the top shareholders across the major players in all these markets are not similar.

Table 4. The largest (institutional and noninstitutional) beneficial owners and corresponding capital for largest manufacturers of SCR systems for diesel passenger cars[*]

VW GROUP *Shareholders (Capital %)*	BMW *Shareholders (Capital %)*
Amundi Asset Management SA[**] (3,17)	Stefan Quand (25,8)
The Vanguard Group, Inc. (2,64)	Susanne Klatten (20,9)
Porsche Automobil Holding SE (1,27)	Bayerische Motoren Werke (3)
Free Floating (42,3)	Flossbach von Storch AG (1,66)
Qatar Investment Authority (Investment Company) (1,2)	The Vanguard Group, Inc. (1,45)
Capital Research & Management Co. (1,19)	Amundi Asset Management SA[**] (0,97)
DAMLER *Shareholders (Capital %)*	
Mercendes - Benz Group AG[***] (30,01)	
BAIC Group[****] (6,49)	
Mercendes Benz Pension Trust e.V (4,99)	
Kuwait Investment Authority (4,98)	
Institutional Investors (38,36)	
Retail Investors (15,17)	
Mercendes - Benz Group AG[**] (30,01)	

[*]The manufacturers of SCR systems for diesel passenger cars have been engaged in the hybrid cartel case AT.40178 – CAR EMISSIONS in the EU during the period from 2001 until the 29th of November 2022 (see also Table 1). [**] Amudi's major shareholder is Credit Agricole (69,2%) [***] The major shareholders of Mercedes - Benz Group AG are Beijing State-Owned Assets Supervision & Administration (9,98%), Shu Fu Li (9,69%), Kuwait Investment Authority (Investment Management) (5,57%), Deka Investment GmbH (2,32%), BlackRock Advisors (UK) Ltd. (1,68%), Amundi Asset Management SA (Investment Management) (1,62%) and Harris Associates LP (1,6%); [****] The major shareholders of BAIC Group are Mercedes - Benz Group (30,4%), The Vanguard Group, Inc. (2,75%) and Norges Bank Investment Management (1,75%).
In parentheses shareholder's stake in firm's capital equity.
Source: CASE AT.40178 – CAR EMISSIONS; Marketscreener.com.

The ownership structures of the largest manufacturers of SCR systems for diesel passenger cars, such as those reported in Table 4, reveal that Amundi Asset Management SA, that is, Credit Agricole, is the largest shareholder of VW Group, two physical persons are the largest shareholders of BMW, whereas Mercedes - Benz Group AG is by far the largest shareholder of DAMLER. These firms act in their largest shareholders' financial interest, maximize their own value and disregard the impact their actions may have on their competitor's bottom lines. The basis for this intuition is that the largest shareholders don't

also have significant holdings in other firms (e.g., the Amundi Asset Management SA in BMW and Mercendes - Benz Group AG), and that holdings in other firms by diversified minority shareholders (e.g., the Vanguard Group Inc. in BMW and Mercendes - Benz Group AG) have no significant influence on corporate strategy.

Table 5. The largest (institutional and noninstitutional) beneficial owners and corresponding capital for largest manufacturers of bearings for automotive applications[*]

JTEKT GROUP *Shareholders (Capital %)*	NSK GROUP *Shareholders (Capital %)*
Toyota Motor Corporation[**] (22,5)	NSK Ltd. (5,44)
Nomura Asset Management (6,85)	Meiji Yasuda Life Insurance Co. (5,01)
DENSO Corporation (5,35)	Fukoku Mutual Life Insurance Co (4,06)
Nippon Life Insurance Co. (3,24)	Nippon Life Insurance Co. (4)
Toyota Industries Corporation (2,28)	Nomura Asset Management Co., Ltd. (3,89)
Sumitomo Mitsui Trust Holdings, Inc. (2,22)	Mizuho Financial Group, Inc. (3,29)
Nikko Asset Management Co., Ltd. (2,15)	Nikko Asset Management Co., Ltd. (3,25)
Daiwa Asset Management Co. Ltd. (2,07)	Sumitomo Mitsui Trust (2,8)
	The Vanguard Group, Inc. (2,1)
	Toyota Motor Corp. Pension Fund (1,94)
NFC GROUP *Shareholders (Capital %)*	**SKF GROUP** *Shareholders (Capital %)*
Nachi Wanei Stockholding (9,98)	FAM AB (15)
Nachi-Fujikoshi Employee Stock Ownership Plan (5,91)	Cevian Capital (7,9)
Nachi-Fujikoshi Corp. (5,87)	Harris Associates (5,2)
Mitsubishi UFJ Financial Group, Inc. (3,71)	Vanguard (3,1)
Nachi Torihikiten Business Association (3,62)	Livförsäkringsbolaget Skandia (0,7)
Hokuhoku Financial Group, Inc. (3,47)	Black Rock (2,8)
Nippon Life Insurance Co. (3,18)	SEB-Stiftelsen (0,4)
NTN GROUP *Shareholders (Capital %)*	**SCHAEFFLER GROUP** *Shareholders (Capital %)*
Nomura Asset Management Co., Ltd. (5,06)	BDT & MSD Partners (25)
Mitsubishi UFJ Financial Group, Inc. (4,41)	Union Investment Privatfonds GmbH (8,28)
Meiji Yasuda Life Insurance Co. (4,22)	Schroder Investment Management Ltd (4,52)
Dimensional Fund Advisors LP (3,32)	Norges Bank Investment Management (2,74)
NTN Kyoeikai Business Association (3,12)	JPMorgan Asset Management (UK) Ltd. (2,17)
Dai-ichi Life Holdings, Inc. (3,06)	The Vanguard Group, Inc. (1,29)

[*]The manufacturers of bearings for automotive applications have been engaged in the hybrid cartel case COMP/39922 – AUTOMOTIVE BEARINGS in the EU during the period from 2001 until the 29th of November 2022 (see also Table 1) [**] The two highest shareholders are Toyota Motor Corporation (16,9%) and Toyota Industries Corporation (7,31%).
In parentheses shareholder's stake in firm's capital equity.
Source: CASE COMP/39922 – AUTOMOTIVE BEARINGS; Marketscreener.com.

The ownership structures of the largest manufacturers of bearings for automotive applications, such as those reported in Table 5, reveal that Toyota Motor Corporation is by far the largest shareholder of JTEKT GROUP, NSK Ltd. is the largest shareholder of NSK GROUP, Nachi Wanei Stockholding is the largest shareholder of NFC GROUP, FAM AB. is the largest shareholder of SKF GROUP, Nomura Asset Management Co., Ltd. is the largest shareholder of NTN GROUP and BDT & MSD Partners is by far the largest shareholder of

SCHAEFFLER GROUP. These firms act in their largest shareholders' financial interest, maximize their own value and disregard the impact their actions may have on their competitor's profits. The basis for this intuition is that the largest shareholders do not also have significant holdings in other firms (e.g., Nomura Asset Management Co. in JTEKT GROUP[5]), and that holdings in other firms by diversified minority shareholders (e.g., Nippon Life Insurance Co. in JTEKT GROUP, NSK GROUP and NFC GROUP, Mitsubishi UFJ Financial Group, Inc. in NTN GROUP and NFC GROUP[6]) have no significant influence on corporate strategy.

The empirical evidence of Tables 4 and 5 indicate that in both markets of bearings for automotive applications and of SCR systems for diesel passenger cars, partial cross ownerships are present. In fact, the major shareholders act in their largest financial interest by maximizing their own value and disregarding the impact of their actions on other firms' corporate strategy. It should be highlighted that the firms reported in Tables 4 and 5 have engaged in two non-hybrid settled cartel cases (Case COMP/39922 – Automotive Bearings, Case AT.40178 – Car Emissions; see also Table 1). Therefore, empirical evidence supports the theoretical findings of Proposition 2, concluding that CRO is more likely to lead to non-hybrid settled cases.

7 Conclusions

According to the settlement procedure, cartel participants which decide to settle with Competition Authorities are rewarded with a reduced cartel fine. However, the incentive of each firm to enter the settlement procedure instead of colluding depends on several factors, such as the degree of cost asymmetry and the probability that the cartel will be caught. The objective of this paper is to answer whether the existence of horizontal shareholding in the form of unilateral common or cross overlapping ownership affects firms' decisions between settling or colluding.

We argue that under regardless of which firm increases its cross-holding level, both firms are provided with higher incentives to enter the settlement procedure. On the contrary,

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[5] Even though Nomura Asset Management Co., the major shareholder of NTN GROUP possesses the second larger stake in JTEKT GROUP, Toyota Motor Corporation is by far the largest shareholder of the Group, indicating that the former has no significant influence on Group's corporate strategy.

[6] Mitsubishi UFJ Financial Group possesses the second larger stake in NTN GROUP and the fourth larger stake in NFC GROUP. However, in the latter Group, the major shareholder, that is, the Nachi Group, is by far the largest shareholder of the Group (25,38%).

when the reference shareholder of either firm increases its minority shares in the other, the controlled firm faces higher incentives to settle, as opposed to the target firm which increases its preference for collusion.

Therefore, partial cross ownership is more likely to lead to non-hybrid settled cases, whereas partial common ownership is more closely related to hybrid settled cases. Empirical evidence from the most important settled cases in the EU verifies the above-mentioned theoretical result. This means that the objective of Competition Authorities to induce all cartel firms to settle, hence leading to non-hybrid settled cases, is more likely to arise in equilibrium under cross-shareholding, as opposed to common ownership which sharpens the firms' incentives to settle, hence is more closely related to hybrid settled cases.

In summary, the presence of partial overlapping ownership could enhance the effectiveness of the settlement procedure, as opposed to its negative impact on competition under a Leniency Program (Heim et al. 2020).

Acknowledgement

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