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Abstract EC's Notice on the conduct of settlement procedures mentions that if the EC decides to reward a firm for settlement in the framework of its Notice, a reduction of 10% on cartel fine will be granted to that firm. In this paper, we compare the cartel profits with the ones derived when the cartel members decide to settle with competition authority so as to find the optimal reduction on cartel fines that fulfills EC's Notice goal of inducing all cartel firms to participate in the settlement procedure. We find 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.

Keywords: Antitrust policy; Competition policy; Cartel fines; Settlement Procedure

JEL Classification: D43; K21; L13; L41

1   Introduction

In June 2008, the European Commission («EC») introduced the Settlement Procedure («SP») with Commission Regulation 622/2008 (OJ L 167/1, 2.7.2008)[1] in order to promote the procedural efficiency of cartel enforcement in the European Union («EU») and not to replace the standard enforcement procedure for cartel cases (Laina & Laurinen, 2013). In July 2008, the EC introduced Commission Notice (OJ L 167/1, 2.7.2008) relating to the SP adopted with Commission Regulation 622/2008.

The main purpose of Commission Regulation 622/2008 is to establish a SP so as the EC to handle faster and more efficiently cartel cases (OJ L 171/3, par. 4).[2] This purpose is one of the benefits of Leniency Program («LP») (OJ C 298/7, 8.12.2006).[3] However, even though LP has been successful in causing the end of various cartels,[4] it has not reduced considerably the length of the cartel proceedings (Ascione and Motta, 2008; Huschelrath and Laitenberger, 2017).

Settlement decisions are prohibition decisions (OJ L 1/1, 4.1.2003, ar. 7 and 23).[5] Normally, they have to pass the same legal scrutiny as decisions in the standard enforcement procedure in accordance with article 230 of the Treaty on the Functioning of the European Union («TFEU»). As provided in article 229 of TFEU and article 31 of OJ L 1/1, 4.1.2003, the Court of Justice («CoJ») has the power to review EC's cartel decisions on fines. However, once settlement applicants anticipate that the reduction of cartel fine meets their prior beliefs about it, their incentive to litigate further and/or the scope of litigation may be very limited (Wils, 2006). Moreover, it will be more than difficult to persuade the CoJ to make invalid a decision that has been built in the terms agreed during the SP by the applicants (Maillo & Orus, 2017; Ascione and Motta, 2008). In the same sense, in many jurisdictions, there is discussion during the SP

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[1] Commission Regulation (EC) No 622/2008 amended Commission Regulation (EC) No 773/2004 (OJ L 123/18, 27.4.2004) and it entered into force on 1 July 2008.
[2] Therefore, the SP is not an investigation tool (OECD, 2019). For empirical evidences see section 3 below.
[3] See also the latest amendment OJ C 256/1, 5.8.2015.
[4] Wills (2016) estimates that the number of cartel decisions under the LP, as a percentage of total cartel decisions with fines, increased from 10% in period 1996–2000 to 91% in period 2011–2015, indicating the importance of LP in detecting and punishing cartels (see also Table 1 in Katsoulacos et al. 2019). Veljanovski (2007) reports that LP reduced fines in 26 from a sample of 39 considered cartels by EC during the period from 1999 to 2006. However, since 12 cartels had already been detected by authorities in the US and 5 of these were under parallel investigation, the author wonders whether LP played the central role for detecting cartel and securing successful prosecution.
[5] Council Regulation (EC) No 1/2003 of 16 December 2002 on the implementation of the rules on competition laid down in Articles 81 and 82 of the Treaty

about the possibility of settlement applicants to litigate to the CoJ and its effects on the final settlement decision (OECD, 2011).[6]

Following EC Notice (OJ L 167/1, 2.7.2008, par. 32), if EC decides to reward an undertaking or a group of undertakings for their cooperation during the administrative SP, the final amount of the cartel fine imposed to the undertakings will be reduced by 10%. The 10% reduction of fine adds to the fine reduction granted to an undertaking which has previously applied for immunity from fines under LP.

In this paper we derive the optimal reduction on cartel fines that fulfills the EC's goal of inducing all cartel firms to participate in the settlement procedure. That is, we try to answer the following question: is the reduction of the cartel fine sufficient to generate the incentive for firms to settle? For this purpose, we use a theoretical model where two asymmetric Cournot competitors form a cartel and we compare the cartel profits with the ones derived when the firms in the cartel decide to settle with competition authority.

The paper is organizing in the following way: section 2 provides the literature review and section 3 presents empirical evidences of settlement procedure in the EC. Section 4 provides the theoretical model under scrutiny and section 5 offers the results. Section 6 concludes and provides some policy implications.

2   Literature Review

From a theoretical point of you, Rubinfeld (2015) states that settlement decisions in antitrust cases depend on the savings in litigation costs, the degree of risk aversion of the involved parties, the likelihood of success, or other reputational effects flowing from the case. The involved parties in a cartel case may often benefit from their participation in the SP through cost savings in legal fees, trial costs and/or the opportunity costs of time that are associated with the standard

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[6] Hellwig, Huschelrath and Laitenberger (2018) by using a data set of 575 firms that were convicted by the European Commission («EC») for being involved in cartel cases during the period from 2000 to 2015, investigate the impact of the SP on the probability to file the involved firms an appeal and estimate a settlement-induced reduction in the number of appeals of about 53%.

procedure of the case (Hellwig, Huschelrath and Laitenberger, 2018). Perloff and Rubinfeld (1988) state also that the incentives to settle can be influenced by the existing legal rules.[7]

Perloff, Rubinfeld, and Ruud (1996) investigate the role of risk aversion in explaining the settlement decision in the context of antitrust cases. The authors conclude that risk aversion, and not reputation effects, is found to have a decisive influence in the decision to settle. Moreover, plaintiff's success depends on various criteria such as the firm size, the product market of the case and whether or not a jury trial occurs.

Ascione and Motta (2008) indicate that since a reduction of 10% of the cartel fine is guaranteed from the settlement decision then the degree of deterrence may be diluted, that is, it would be detrimental for involved firms in a cartel case to complete evidence and facilitate the final decision of a cartel case. Some of the leniency applicants through LP may not be in favor to apply if the reduction of cartel fines during the SP is too large. Assuming that the probability of being detected is constant, as long as the cartel fine decreases due to the SP, the minimum amount of profits required to infringe the law reduces and a "diluted deterrence effect" occurs.[8] However, if the probability of being detected is not constant or increases, since free resources due to the initiation of SP are devoted to the detection of other cartel cases (Motta and Polo, 2003), deterrence may not be diluted. In this case the net effect of SP is ambiguous: the degree of deterrence decreases (stays constant or increases) if the probability of being detected does not (more than) compensate the reduction of the fine.

Ascione and Motta (2008) also point out that an involved firm in a cartel case decides whether to enter or not in the SP after comparing the fine it would receive if being a member of the SP, with the fine it would expect to receive if appealing the court. If the former is lower than the latter then the involved firm settles and gets the reward. The authors use data of all fines decided by EC[9] and all correspondent reductions from appeals the court from 1970 to 2007 and

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[7] In this paper we do not discuss general issues regarding legal disputes that are not examined and decided in courts, but reached a decision «in the shadow of law» through SP (Cooter and Ulen, 2000). For more details on these matters see, *inter alia*, Landes (1971), Posner (1973), Adelstein (1978), Priest and Klein (1984), Perloff and Rubinfeld (1988), Briggs et al. (1996), Rubinfeld (2015).

[8] When a firm decides to infring the law it compares the profits it gets from the infringement with the fine it would obtain oncw detected times the probability of detection.

[9] Both infringements of articles 81 and 82, but as the authors mention, article 81 consists of the vast majority of the cases.

estimate that the average expected reduction of the fine if the involved firms appealing the EC's decision is 26%. So, after appealing, the involved firms in the infringement are expected a reduction of almost a quarter of the fine imposed by the EC. Since this estimate 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 of a more accurate estimate of the optimal cartel fine reduction of settlement procedure.

Veljanovski (2007) states that the reduction of cartel fines during the settlement procedure is low and should have been increased to at least a 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 settlement procedure.

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*»[10] the authors find insignificant results for the duration of the cartel and the mitigating circumstances. As the authors sate «*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) estimate the impact of the SP on the duration of EC cartel investigations. They use data from 84 cartels decided by the EC from 2000 to 2014. The empirical results indicate a statistically significant reduction in the duration of settled cases of about 8.7 months. However, as they point out, even though the overall duration of a cartel investigation has shown a significant reduction, especially in the years 2011 and 2014, still its value remains above the 2003 value, which has reached without the settlement procedure. The authors divide the overall duration of a cartel case into two stages, the first stage from the beginning of the investigation until the issuing of Statement of Objections («SO») to the involved firms and the second stage, which begins after the issuing of SO and ends with the EC's

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[10] Duration of cartel, aggravating circumstances, mitigating circumstances, key witness, leniency reduction and repeat offender.

decision on the case. They indicate that the reduction of overall duration of a cartel investigation is driven by the second stage, finding support of the effectiveness of SP. However, they show an increment of the duration of non-settled cases, especially the second stage of them, since SP was implemented by EC.

Katsoulacos et al. (2019) estimates that, during the period from 1992 to 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 the majority of annulled decisions are horizontal agreements or a combination of agreements and concerted practices.

3   Empirical evidence of the Settlement procedure in the EC

In recent years the EC has made considerable efforts to promote competitiveness by detecting and punishing cartels. For instance, while the Commission decided 19 cartel cases in the 1990 to 1999 period imposing fines of in sum about €0.8 billion, from the outset of 2000 until 2009 the EC experienced 62 decided cases with total fines of about €13 billion and during the period from 2010 until 2019 the EC experienced 57 decided cases with total fines of about €16 billion imposed by the EC.[11] Comparing the era prior and after the introduction of SP the decided cartel cases have shown a reduction of almost 42%. Table 1 shows the highest cartel fines per case since the SP came into force (2009 onwards) until September 2019.

Table 1 provides valuable insights on a quite interesting issue regarding the settled EC cartel cases: the probably most apparent finding from Table 1 is that the majority of settled cartel cases do not constitute EC cartel cases with the highest cartel fines. Only 4 out of 8 most significant cartel cases during the period from 2010 to 2019 have ended through the SP. Moreover, 3 out of 4 most significant cartel cases have ended through a hybrid settlement procedure, in which typically one of the firms decided to opt out of the settlement procedure, and only in one case

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[11]The data consist of cartel infringements under Article 101 TFEU and amounts as imposed by the Commission and not corrected for changes following judgments of the Courts. See European Commission (2019).

(Automotive Bearings, 39.922, 14 March 2014) the number of involved firms in the cartel coincided with the number of settled firms.

Table 1. Highest cartel fines[*] per case, leniency program and settlement procedure: 2009 – 2019

Year	Cases	Fine in €	Leniency Program	Settled Cases	
				Hybrid	Not Hybrid
2009	FORTEX	1 068 879 000	-	-	-
2010/2017	Airfreight (inc. re-adoption)	785 345 000	-	-	-
2012	TV and Computer Monitor Tubes	1 409 588 000	-	-	-
2013/2015	Yen Interest Rate Derivatives (YIRD)	669 719 000	5 applicants	6 out of 7 firms	-
2013/2016	Euro Interest Rates Derivatives (EIRD)	1 276 433 000	4 applicants	4 out of 7 firms	-
2014	Automotive Bearings	953 306 000	5 applicants		All (6 firms)
2016/2017	Trucks	3 807 022 000[**]	4 applicants	5 firms	
2019	Forex	1 068 879 000	-	-	-

Source: Laina & Bogdanov (2019), Annex; European Commission, (2019), Table 1.5.
[*]*Amounts adjusted for changes following judgments of the Courts (General Court and European Court of Justice) and/or amendment decisions*. [**]As it is in European Commission, (2019), Table 1.5. In Laina & Bogdanov (2019) the corresponding amount of fine is 2 926 499 000

Table 1 also reveals that the introduction of the SP hasn't undermined so far the important role of LP in detecting and ending the cartels. It is obviously that in all settled cartel cases of Table 1 the majority of the involved firms in the cartel were immunity applicants under LP. Moreover, cartel settlements have been used for 114 out of 288 involved firms (39,6%) in 28 out of 57 cartel cases (49,1%) and 94 of them (80%) have previously applied for immunity from fines under LP during the period from 2010 to 2018 (Laina & Bogdanov, 2019). Table 2 shows the cumulative distribution of settled cartel cases per fines.

Table 2. No of settled cartel cases per fines: 2009 – 2019

| Amount of fine (in €)[*]	No. of Cases	No. of Settled Cases	
		Hybrid	Not Hybrid
< 30 000 000	4		4
< 50 000 000	9	2	7
< 75 000 000	11		9
< 100 000 000	13		11
< 150 000 000	17		15
< 200 000 000	21	3	18
< 400 000 000	24		21
Highest Cartel Fines (> 660 000 000[**])	28	6	22

Source: Laina & Bogdanov (2019), Annex.
[*]Total amount of fines: 8 122 219 800 [**] Yen Interest Rate Derivatives Case (YIRD, 39.861, 4 December 2013) – see Table 1.

An interesting further observation has to do with the degree of significance, in terms of fines, of the settled cartel cases within EU. From Table 2 we see that in 17 out of 28 settled cases (60.7%) the total amount imposed per settled firm is below 150 million euro, while in almost a half of the settled cases the total amount imposed per settled firm is below 100 million euro (13 out of 28 settled cases). Moreover, 21,5% of the settled cases have ended through a hybrid settlement procedure (6 out of 28 settled cases), but half of them (hybrid settled cases) are settled cases among the ones with the highest cartel fine (see Table 1).

Figure 1 depicts the percentage of settled cartel cases per imposed fines during the period from 2009 to 2019. It is evident from figure 1 that 86% of the imposed fines per settled cartel cases lies below 400 million euro (cases with low significant role), while only the 14% of the corresponding fines lies above 660 million euro (cases with high significant role). Indeed, only the latter group of settled cartel cases are among the cases with the highest imposed fines by the EC (see Table 1).

Figure 1. % of settled cartel cases per fines: 2009 – 2019
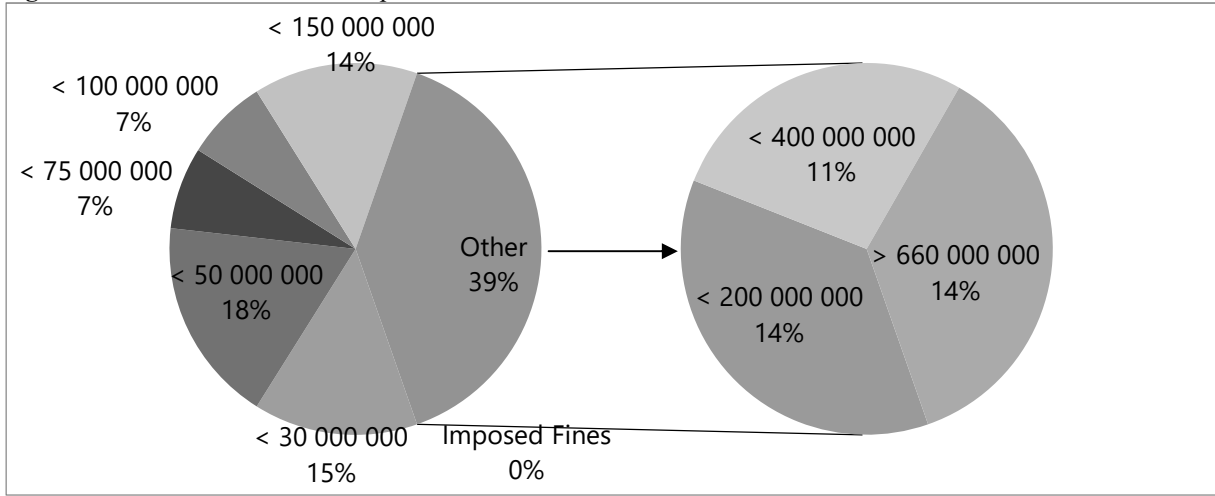
In a nutshell, we may therefore conclude from the above mentioned empirical evidence of EC's settled cartel cases, that, in the first place, even though the decided cartel cases have shown a reduction of almost 42% since the introduction of settlement procedure, the latter impacts, in terms of imposed fines, more cartel cases with low significant role than cartel cases with high significant role. Moreover, the average reduction of EC's fines of decided cartel cases due to appeals to the court is more than 21%, while the majority of the settled cases among the cases with the highest cartel fines follow a hybrid settlement procedure. All these findings together

suggest, on the one hand, that the majority of the involved firms (60,1%) do not settle because the incentive to settle, that is, the cartel fine reduction, is not optimal to motivate them to settle, and on the other hand, EC may not be able to devote resources from the settled cases to the detection of other cartel cases, since in the non-settled cases firms follow the standard cartel investigation procedure.

4   The theoretical model

In this section we derive the conditions under which each cartel firm settles with the competition authority in order to reduce the cartel fine. For this purpose, consider a setting in which: (i) two firms $i = 1,2$ face the inverse demand function $P = A - bQ$, where $Q = q_1 + q_2$; and (ii) the production of the final good incurs a marginal cost c_i.

At the beginning of the game, the two firms form a cartel in order to maximize their joint profits. It is assumed that cost savings are realized due to the joint production of the final good. Therefore, the marginal cost of the monopolist is c, with $c \leq (c_1 + c_2)/2$. Under these assumptions, the profit function of the monopolist is given by

$$\Pi_M = (P_M - c)Q_M(1 - \rho) - \rho(\kappa P_M Q_M) \quad (1)$$

where $\rho \in [0,1]$ denotes the probability that the cartel would be detected (Motta and Polo, 2003). It should be noted that the monopolist's profit is shaped by two parts: the former one concerns its gross profit margin, which is realized if the cartel is not detected; the latter one refers to the cartel fine, which is defined as a percentage (κ) of its revenues ($P_M Q_M$) and is realized once the cartel is detected.[12] Taking the first order condition of Eq. (1) with respect to Q_M, gives the equilibrium quantity of the monopolist:

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

It is assumed that each cartel firm produces according to its market share under Cournot competition. It is well-known that the Cournot-Nash equilibrium quantities are $q_i = (A - 2c_i + c_j)/(3b)$, where $i, j = 1,2$ and $i \neq j$. As a result, each Cournot competitor produces q_i/Q of the

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[12] In this paper we derive the optimal reduction on cartel fines by EC that induces all cartel firms to participate in the SP. Since the reduction of cartel fine is optimal we assume that firms do not have an incentive to appeal the settlement decision to the court.

total quantity. Therefore, each cartel firm produces $q_{i,M} = (q_i/Q)Q_M$, whereas its profit is given by:

$$\Pi_{i,M} = (P_M - c)q_{i,M}(1 - \rho) - \rho(\kappa P_M q_{i,M}) \qquad (3)$$

Now consider that each firm can settle with the competition authority in order to reduce its cartel fine. If the settlement occurs the two firms act as Cournot competitors. In this case, each firm's profit function is given by

$$\Pi_{i,S} = (P_S - c_i)q_{i,S} - (1 - \chi)(\kappa P_M q_{i,M}) \qquad (4)$$

The above function is also shaped by two parts. The former part represents each firm's gross profit margin with equilibrium quantities $q_{i,S} = (A - 2c_i + c_j)/(3b)$, where $i, j = 1,2$ and $i \neq j$, whereas the latter denotes the percentage reduction (χ) on the cartel fine $\kappa P_M q_{i,M}$, with $\chi \in [0,1]$.

Substituting the equilibrium quantities derived under monopoly ($q_{i,M}$) and under settlement ($q_{i,S}$) in Eq (1) and Eq (4) respectively yields the profit of each firm when it chooses to stay in the cartel and when it decides to settle with the competition authority.[13]

5   Discussion of the Results

In this section, we discuss the results by comparing the profitability of staying in the cartel and of settling with the competition authority in order to discuss the optimal reduction on cartel fines required for inducing all cartel firms to enter the SP. Such optimal reduction of cartel fines can be assessed by comparing $\Pi_{i,M}$ and $\Pi_{i,S}$. Although this comparison leads to closed-form solutions, the derived levels of χ are complex functions of A, c_1, c_2, c, κ and ρ. For this reason, the analysis of such comparisons is based on numerical simulations. In particular, when setting a particular value to A, c_1, c_2, c and κ, the comparison of $\Pi_{i,M}$ and $\Pi_{i,S}$ gives a critical value of χ (as a function of ρ) that makes firm i indifferent between staying in the cartel and settling with the competition authority (i.e., $\Pi_{i,M} = \Pi_{i,S}$). Therefore, for any given probability of detecting the cartel, there would be a cartel reduction fine level such that $\Pi_{i,M} = \Pi_{i,S}$.

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[13] The profit functions derived after substituting the equilibrium quantities are not presented here for simplicity since $\Pi_{i,S}$ does not provide any useful intuition due to its complexity. However, they are available from the authors upon request.

Figure 2 shows the combinations of χ and ρ that make each cartel firm be indifferent between staying in the cartel and settling with the competition authority. This figure has been drawn by assuming that: (i) $A = 5$ and $b = 1$; (ii) $c_1 = 0.5$ and $c_2 = 2c_1$, meaning that firm 1 is more efficient than firm 2; (iii) $c = 0.5(c_1 + c_2)/2$, meaning that there are significant cost savings arising from cartel formation; and (iv) $\kappa = 0.1$, which reflects the current European practice according to which the total cartel fine (cap) shall not exceed of 10% of each cartel firm's revenues (OJ L 1/1, 4.1.2003, article 23(2)(a)).[14]

Figure 2. Indifference curve for each cartel firm
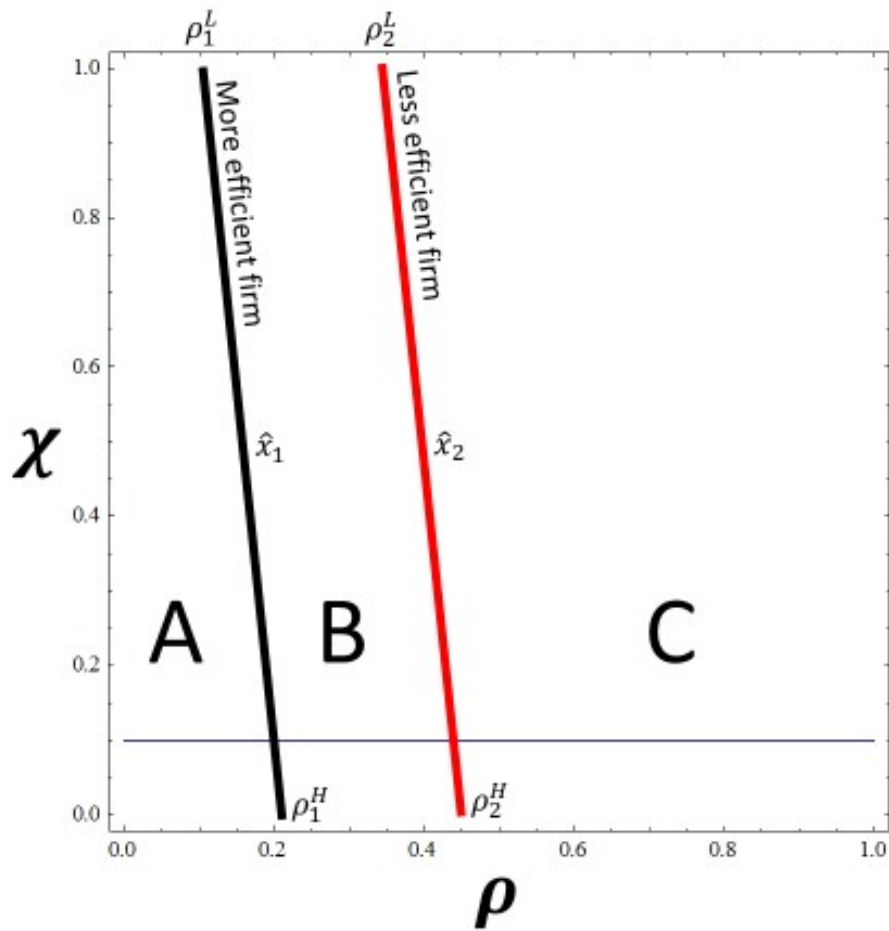
[14] Par. 2 of article 23 of Regulation (EC) No 1/2003 mentions, inter alia,
«For each undertaking and association of undertakings participating in the infringement, the fine shall not exceed 10 % of its total turnover in the preceding business year. Where the infringement of an association relates to the activities of its members, the fine shall not exceed 10 % of the sum of the total turnover of each member active on the market affected by the infringement of the association». See also par. 2 of OJ C 210/2, 1.9.2006.

In Figure 2, the black (respectively, red) line depicts the combinations of χ and ρ that make $\Pi_{1,M} = \Pi_{1,S}$ (respectively, $\Pi_{2,M} = \Pi_{2,S}$). Therefore, each line denotes the level of χ (as a function of ρ) that leads to $\Pi_{i,M} = \Pi_{i,S}$. Let us denote these indifferent curves as $\hat{x}_1$ and $\hat{x}_2$, where the former corresponds to the black line (more efficient firm 1) and the latter to the red line (less efficient firm 2).

One of the main findings of this paper is that the indifference curve of each cartel firm is downward slopping, meaning that there is a negative relationship between χ and ρ. According to Figure 2, when ρ is significantly low ($\rho < \rho_i^L$), even a 100% reduction on the cartel fine is not sufficient to incentivize firms to enter the settlement procedure. Obviously, the low probability that the cartel would be detected makes firms prefer staying in the cartel. On the other hand, when ρ is significantly high ($\rho > \rho_i^H$), firms have an incentive to enter the SP, even without the reward of par. 32 of EC's Notice (OJ L 167/1, 2.7.2008) on cartel fine. Obviously, the high probability of detecting the cartel stimulates firms to settle with the competition authority. For intermediate values of ρ, where $\rho_i^L < \rho < \rho_i^H$, higher levels of ρ reduces the required reduction of χ for inducing $\Pi_{i,M} = \Pi_{i,S}$.

To put it differently, for any given level $\chi = \bar{\chi}$, there is a critical value of ρ (denoted by $\rho_i^{\bar{\chi}}$) that leads to $\Pi_{i,M} = \Pi_{i,S}$, thus when $\rho < \rho_i^{\bar{\chi}}$ (respectively, $\rho > \rho_i^{\bar{\chi}}$), then $\Pi_{i,M} > \Pi_{i,S}$ (respectively, $\Pi_{i,M} < \Pi_{i,S}$). Based on the above analysis, we separate Figure 2 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 (firm 1 in this case) prefers the settlement procedure ($\Pi_{1,S} > \Pi_{1,M}$), whereas the less efficient firm (firm 2 in this case) prefers to stay in the cartel ($\Pi_{2,M} > \Pi_{2,S}$); in area C, both firms are better off when settling with the competition authority ($\Pi_{i,S} > \Pi_{i,M}$).

Given that the goal of competition authorities is to induce all cartel firms to participate in the SP, the optimal reduction on cartel fine is determined by the binding constraint of the less efficient firm to enter the SP, that is, $\Pi_{2,S} > \Pi_{2,M}$ in this numerical example. In other words, the minimum probability of detecting the cartel should be ρ_2^L, otherwise the less efficient firm would never choose to settle with competition authority. For any given $\rho \in (\rho_2^L, \rho_2^H)$, the optimal reduction on cartel fine is $\hat{x}_2$ since a higher reduction would also motivate both firms to enter the procedure, but it would generate less revenues for the authorities (not optimal reduction of cartel

fine). And for $\rho \in [\rho_2^H, 1]$, the imposition of no reward of par. 32 of EC's Notice on cartel fine is sufficient for both firms to settle with competition authority.

However, in most cases, the probability of detecting the cartel is determined by firms' perception about the EC's evidence. This means that competition authorities set the reduction on the cartel fine and then strive to give the right signal to cartel firms. For this reason, Figure 2 also illustrates the current European practice according to which the reduction on the cartel fine is $\chi = 10\%$ (blue line). Interestingly enough, the current 10% reduction of cartel fine is effective only when $\rho \geq 0.436$ (the area right to the point in Figure 2, where the red line of less efficient firm intersects the blue line), since this is the lowest probability of detecting the cartel inducing both firms to enter the settlement procedure. Therefore, competition authorities should ensure that their evidence signifies the right signal to cartel firms so as to form the required perception of being caught.

Last, it is important to point out that the above results do not qualitatively change when there is a change in a parameter value. When A increases firms prefer to capture their higher willingness to pay with the highest possible probability. This happens when firms enter the SP, thus both $\hat{x}_1$ and $\hat{x}_2$ are moving to the left (area C expands). The same changes arise when c increases since the cost savings of forming the cartel are lower, meaning that firms prefer the settlement alternative for more combinations of χ and ρ. On the contrary, when κ increases firms tend to stay in the cartel since the increased cartel fine is paid only if the cartel is detected, whereas this fine is paid with certainty, given the reduction χ, once firms settle with competition authority. As a result, both $\hat{x}_1$ and $\hat{x}_2$ are moving to the right (area C shrinks). As expected, when c_1 increases and/or c_2 decreases, $\hat{x}_1$ is moving to the right and $\hat{x}_2$ is moving to the left, hence the two curves converge and coincide when $c_1 = c_2$.

6 Conclusions and policy implications

In this paper we derive the optimal reduction on cartel fines that fulfills the EC's goal of inducing all cartel firms to participate in the settlement procedure. We consider a theoretical model where two asymmetric competitors form a cartel and we compare the profit of each firm when it chooses to stay in the cartel with the one derived when it decides to settle with the competition authority.

The theoretical results show that for any given probability of detecting the cartel, there would be a cartel reduction fine level 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 (i.e., inducing both firms to enter the settlement procedure).

In most cases, the probability of detecting the cartel is determined by firms' perception about the EC's evidence. Considering specific but reasonable cost assumptions, we show that the current 10% reduction of cartel fine when a firm settles with competition authority is effective only when the probability of detecting the cartel is $\rho \geq 0.436$. This is the lowest probability of detecting the cartel required for inducing both firms to enter the settlement procedure.

Therefore, competition authorities should ensure that their evidence signifies the right signal to cartel firms so as to form the required perception of being caught. Competition authorities should give the right signal to cartel firms that the loss by staying in the cartel is higher than the loss by settling with them. However, since the higher the cartel fine, the lower the probability of settling by firms, competition authorities should be aware that by imposing high cartel fine will induce firms to take the risk and stay in the cartel, even though the probability of being caught is quite high. In this case, both competition authorities and firms are worse off.

On the one hand, competition authorities are worse off because, deterrence may be diluted, since no free resources due to the initiation of SP are devoted to the detection of other cartel cases and, therefore, may not be able to handle faster and more efficiently them. On the other hand, firms are worse off because although the probability of detecting the cartel is high, they prefer to take a chance and get the total monopoly profits.

Competition authorities should also 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 optimal. By doing so, cartel firms do not have the incentive to appeal to the court and the SP has accomplished its main scope, that is, to promote the procedural efficiency of cartel enforcement in the EU.

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