If the fine is not discriminatory at all ($\partial F / \partial k = 0$) it is evident from (6) that the cartels that are more harmful than the marginal one are not deterred even if the probability of detection approaches one. The reason is that the cartels most harmful to welfare are the most profitable ones, and as long as one cannot discriminate the fine it is not possible to deter those worst cartels from being formed.

Let us assume that the fine is discriminatory, so that it can capture at least some of the gain associated with a more profitable cartel. If the additional fine for a cartel with a larger negative impact is larger than the additional per period profits ($\frac{\partial F}{\partial k} > \frac{\partial \pi_C}{\partial k} = \frac{\partial \alpha}{\partial k} \pi$), we define this as an overproportional discriminatory fine.[6]

It follows straightforwardly from (3.1):

Corollary 1 *If $p < \frac{1}{2}$ and S is independent of k, and the cartel with over-charge k^{PC} is marginally deterred, the fine must be overproportional discriminatory ($\frac{\partial F}{\partial k} > \frac{\partial \pi_C}{\partial k}$) to deter cartels with overcharge above k^{PC} as well.*

Corollary 1 shows that if a discriminatory fine captures exactly the additional per period profit due to a larger cartel overcharge so that $\frac{\partial F(k)}{\partial k} = \frac{\partial \pi_C(k)}{\partial k}$ and a particular cartel is marginally deterred, the fine schedule will not be able to deter cartels with a larger harm if the probability of being detected is less than a half. In such a case an overproportional discriminatory fine is needed to deter the worst cartels.

We assume that the firms anticipate the probability of being detected if they form a cartel. This implies that the probability for being detected is of importance for the design of the fine schedule. If the probability of detection is low, then only a small fraction of the increase in the fine will be taken into account by the firms. In this case the increase in fine for a cartel with a larger negative impact on welfare must be larger than the increase in per period profits.

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[6]This is identical to the definition of proportionality in Smith et al. (1987).

To understand this, let us assume that the fine is set such that the cartel with the lowest negative impact on welfare is indifferent between forming a cartel and not. To ensure that a cartel that has a larger negative impact on welfare is indifferent as well, the fine must of course be higher than for the cartel with the lowest negative impact on welfare. What we have shown is that if the probability of being detected is sufficiently low, it is not sufficient to increase the fine by the difference in per period profits for the two potential cartels, but that the increase in the fine must overcompensate for the difference in per period profits. In the design of the fine schedule it is necessary to take into account the fact that cartels anticipates the low probability of being detected. A higher fine for cartels with a larger negative impact on welfare is needed to deter it, and in this case the additional fine is larger than the difference in per period profits for those two cartels.

3.1.2 Private litigation

Finally, let us consider the effect of private litigation on the participation constraint. It can easily be seen that F can be reduced due to the threat of private litigation, since $\partial F_{PC}/\partial S < 0$.

If we, instead of assuming that S is fixed assume that $S(k) = \sigma(\alpha(k) - 1)\pi$, i.e., that cartel members costs with private litigations is given by a fraction $0 \leq \sigma \leq 1$ of the cartel's profit increase from the collusive agreement.

The critical fine making cartel formation just unprofitable changes to

$$F_{PC}^S = \frac{1 - p(1 + \sigma)}{p}(\alpha(k) - 1)\pi$$

and we can confirm that $\partial F_{PC}/\partial \sigma < 0$.

Given that the question is whether it is profitable to form a cartel or not, private litigation that leads to payments to customers will make it less profitable to form a cartel. This is straight forward, since it simply adds to the fine imposed by CA. Then we have the following result:

Corollary 2 *(i) The fine that marginally deters a cartel with overcharge k decreases when private litigation cost increases, and (ii) the optimal fine is overproportional discriminatory if $p < \frac{1}{2+\sigma}$ when $S(k) = \sigma(\alpha - 1)\pi$.*

When we compare Corollary 2 part (ii) with Corollary 1, we see that it is less likely that the fine must be overproportional discriminatory when there is private litigation. As long as private litigation captures a fraction σ of the additional profits for a more harmful cartel, the fine can be correspondingly less discriminatory. However, as we will see, if the incentive constraint is binding both results in Corollary 2 are reversed.

3.2 Incentive constraint: Cartel desistence

Let us now consider the incentive constraint. If there is a leniency program, this implies that a firm may find it individually rational to defect and inform CA about the cartel. If a firm deviates, it increases the profit relative to the collusive profit $\pi_C = \alpha\pi$ by a factor $\beta > 1$, capturing $\beta\alpha\pi$ in the period it deviates. β can also be interpreted as a parameter capturing the number of firms, since a larger number of firms will imply that the gain from deviating is increased.

Every firm that reports the cartel to CA is eligible for leniency under which they pay a fine L, $0 \leq L < F(k)$.

If a firm deviates and does not report, the drop in prices can lead to an investigation by the antitrust authorities. If so, a deviation followed by no report will result in a higher probability of detection than before the deviation. Let us define γ as the increase in the probability of cartel detection that follows if one or more firms deviates from the collusive price setting, *i.e.*, $0 \leq \gamma < 1$, and $p + \gamma < 1$. Given that a firm deviates, the strategy of deviating and reporting will dominate the strategy of deviating and not reporting if

$$\beta\alpha(k)\pi - L - S + \frac{\delta}{1-\delta}\pi \;>\; \beta\alpha(k)\pi - (p+\gamma)(F(k) + S) + \frac{\delta}{1-\delta}\pi$$

$$L \;<\; (p+\gamma)F(k) - (1 - p - \gamma)S \tag{7}$$

From condition (7) above it is immediate that self-reporting to the CA is more likely the more generous the leniency program is, and the larger the probability of CA detecting the cartel without any member providing information about it's existence. Further, if the fine is discriminatory, *i.e.*, when $\partial F/\partial k > 0$, the worst cartels are the ones that are most likely to self-report, and every firm that deviates will also report under full leniency ($L = 0$) if it does not risk private litigation costs. Private litigation, on the other hand, may destroy the members' incentives to self-report. To see this, notice that if a member of a cartel with overcharge $\tilde{k}$ is indifferent between reporting and not under full leniency (7) is just met for the cartel $\tilde{k}$:

$$(p + \gamma)F(\tilde{k}) - (1 - p - \gamma)S(\tilde{k}) = 0 \qquad (8)$$

The cartel $\tilde{k} + \varepsilon$ will report only if $\partial S/\partial k \leq \frac{p+\gamma}{1-p-\gamma}\partial F/\partial k$. If $p + \gamma < \frac{1}{2}$ then $F(k)$ must steeper than $S(k)$ for this condition to be met. Hence, discriminatory private enforcement may destroy the incentive to report for the worst cartels.

Deviate and report is the most profitable strategy if the firm deviates given that L is sufficiently low and/or γ is sufficiently high. We will assume that this is the case throughout the analysis. The strategy "deviate and report" will of course always dominate the strategy "collude and report". Hence, given that the restriction in (7) is met, the two strategies we are comparing are "always collude" and "deviate and report". The incentive constraint gives the following restriction on the fine

$$\frac{(1-p)\alpha(k)\pi + p\left(\frac{\pi}{1-\delta} - F - S\right)}{1 - \delta\left(1-p\right)} < \beta\alpha(k)\pi - L - S + \frac{\delta}{1-\delta}\pi \qquad (9)$$

Let us assume that there exists a marginal cartel, *i.e.*, a cartel that is indifferent between collusion and deviation. We define this marginal cartel by $k^{IC} \in (0, \bar{k})$. Knowing that the incentive constraint is binding for k^{IC} the fine that just desists this cartel is

$$F_{IC} = \frac{((1-p)(1+\delta\beta) - \beta)\alpha + (p - \delta(1-p))}{p}\pi$$
$$+ \frac{1 - \delta(1-p)}{p}L + \frac{(1-\delta)(1-p)}{p}S \quad (10)$$

Let us now return to the case where the cartel overcharge can influence the probability of detection, *i.e.*, $p(k)$. We assume for the moment that $L = S = 0$. A marginal change in the overcharge has then the following effect:

$$\frac{\partial F_{IC}}{\partial k} = \frac{(1-p)(1+\delta\beta) - \beta}{p}\frac{\partial \alpha}{\partial k}\pi - \frac{(1 - \beta(\delta - 1))\alpha - \delta}{p^2}\frac{\partial p}{\partial k}\pi$$

As is the case with the participation constraint, an increase in k will trigger two opposing forces. We have the following result:

Proposition 3 *Let us assume that the participation constraint for each cartel member is met and non-binding. If*

$$\frac{[(1-p)(1-\delta\beta) - \beta]p}{[1 - \beta(\delta - 1)]\alpha - \delta} > \frac{\frac{\partial p}{\partial k}}{\frac{\partial \alpha}{\partial k}}$$

then

$$\frac{\partial F^{IC}}{\partial k} > 0.$$

We see that the probability of detection and the profit increase per period from cartelizing have the same qualitative effects as when the participation constraint is binding (see Proposition 1). In addition, we see that the parameters β and δ also influence the relationship between the cartel overcharge and the minimum fine.

As argued earlier, it can be difficult for the competition authorities to detect which cartels have the highest price-cost margin. Let us therefore from now on unless otherwise stated assume that the overcharge has no effect on the probability of detection. We then have the following result:

Proposition 4 *Let us assume that the participation constraint is strictly non-binding for all $k \in [k^{IC}, \bar{k})$, that L and S are independent of k, and that the cartel with overcharge k^{IC} is indifferent between deviating and not. If*

$$\frac{\partial F}{\partial k} > \frac{(1-p)(1+\delta\beta) - \beta}{p}\left(\frac{\partial \alpha}{\partial k}\right)\pi \qquad \forall k \in (0, \bar{k}) \qquad (11)$$

then all cartels $k \in [k^{IC}, \bar{k})$ are desisted while all cartels $k \in (0, k^{IC})$ are sustained.

Not surprisingly, we see from Proposition 4 that the worst cartel can be deterred if the increase in fine is everywhere sufficient large for cartels with infinitesimal larger overcharge ($\partial F/\partial k$ is sufficiently large). This is similar to what we found when we checked the participation constraint (see Proposition 2). However, as we will show later the fine schedule differs from the fine schedule we derived when the participation constraint was binding.

3.2.1 Full leniency

Let us for the moment assume that $L = S = 0$. From Proposition 4 it can easily be verified that:

Corollary 3 *Let us assume full leniency ($L = 0$) and no private litigation ($S = 0$).*

(i) An overproportional discriminatory fine is needed if

$$p < 1 - \frac{1+\beta}{2+\delta\beta} \equiv p^{FL} \qquad (12)$$

(ii) The scope for an overproportional discriminatory fine is

   – increasing in the discount factor $\left(\frac{\partial p^{FL}}{\partial \delta} > 0\right)$

   – decreasing in the gain from deviating $\left(\frac{\partial p^{FL}}{\partial \beta} < 0\right)$.

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We see from Corollary 3, in line with the results from Proposition 4, that an overproportional discriminatory fine is necessary for deterring the worst cartels if the probability of being detected is sufficiently low. Furthermore, it can be shown that overproportionality is more likely for larger values of the discount factor (δ) and the smaller the gain is from deviating (β). None of these two parameters had any influence on the fine when the participation constraint determined the fine schedule.

As we explained above, a low probability for detection will imply that the expected value of a fine associated with detection is low as well. In this case overcompensation is needed to deter the most harmful cartels. The higher the discount factor (measured by δ), the more likely is the firm to continue with cartel behavior rather than reporting, and the need for an overproportional discriminatory fine is larger the higher the discount factor.

We also see that the lower the gain from deviating (measured by β), the larger is the need for overcompensation. The reason is that a smaller β will scale down the gain from deviating and everything else equal make it less tempting to deviate. To ensure that firms decides to deviate from the cartel the increase in the fine must be correspondingly larger. Note that one interpretation of a high β is that the number of firms is large. All else equal, a larger number of firms will make it less likely that an overproportional discriminatory fine is needed.

3.2.2 Partial leniency

Let us keep holding onto the assumption that $S = 0$, but assume that firms are eligible only to some leniency. In particular, assume that firms reporting the cartel to the competition authorities instead of paying F pay a reduced fine $L = \lambda F$. Obviously, this tends to make it less likely that the members of the worst cartels deviates and reports to CA. This time, given that a firm deviates, the strategy of deviating and reporting will dominate the strategy

of deviating and not reporting if

$$\lambda < p + \gamma$$

Assume that the incentive constraint is binding for some interior value $k_{IC}^L \in (0, \bar{k})$. By substituting for $L = \lambda F$ into (10) we find the fine that just desist this cartel is

$$F_{IC}^L = \frac{((1-p)(1+\delta\beta) - \beta)\,\alpha\,(k) + (p - \delta(1-p))}{p - \lambda(1 - \delta(1-p))}\pi \qquad (13)$$

In order to (weakly) desist all cartels above k_{IC}^L as well, the fine must change with the cartel overcharge, *i.e.*,

$$\frac{\partial F}{\partial k} \geq \frac{(1-p)(1+\delta\beta) - \beta}{p - \lambda(1 - \delta(1-p))}\left(\frac{\partial \alpha(k)}{\partial k}\right)\pi \qquad (14)$$

It is now easy to derive the following result:

Corollary 4 *If (i) $L < F$, an increase in the leniency fine must be more than compensated by an increase in the fine F. If (ii) $L = \lambda F$ and $0 < \lambda < 1$,*

- *an overproportional discriminatory fine is needed if*

$$p < 1 - \frac{1 + \beta - \lambda}{2 + \delta(\beta - \lambda)} \equiv p^{PL}, \text{ and} \qquad (15)$$

- *a higher leniency fine relative to the fine F (an increase in λ) will lead to a larger scope for an overproportional discriminatory fine $\left(\frac{\partial p^{PL}}{\partial \lambda} > 0\right)$.*

Part (i) can easily be verified by observing that $\partial F_{IC}/\partial L > 1$ in (10) since $[1 - \delta(1-p)]/p > 1$. It implies that if the leniency fine is increased with an amount X, then the ordinary fine must increase with more than X to ensure that a member of cartel that is at the outset indifferent between deviating

and not is indifferent also after the increase in L and F. The reason is that the leniency fine must be paid with certainty if they deviate and report, while there is a probability less than one that the cartel will be detected and fined if it continues to operate. A low discount factor means that a cartel member places less weight on future profit and is more tempted to deviate in any case. Hence, the lower is δ the lower is the likelihood that the fine has to be overproportional. Similarly, a higher β scales up the one-period gain from deviating and a cartel member is more tempted to deviate in any case. Moreover, we see from (ii) that the larger the leniency fine relative to the ordinary fine the larger is the scope for an overproportional discriminatory fine F.

The result in Corollary 4 is a strong argument against using a discriminatory leniency fine, but instead set a fixed leniency fine for all firms that report. In theory one should use a negative discriminatory leniency fine, where member of cartels with a large negative impact on welfare should pay a lower leniency fine than firms with a more modest negative impact on welfare.

3.2.3 Private litigation

Finally, let us consider the case where a cartel that is detected or a firm that apply for leniency risks private litigation, amounting to $S(k)$. Given this risk, private litigation would be an expected cost for the firm both if it sticks to the cartel agreement and if it reports. To simplify, let us assume that $L = 0$ but that a detected cartel, either detected by the competition authority or by one or more members that self-report, risks private litigation.

Assume that the incentive constraint is binding for some interior value $k_{IC}^S \in (\underline{k}, \overline{k})$. By substituting for $S = \sigma(\alpha - 1)\pi$ into (10) we find the fine that just desist this cartel as

$$F_{IC}^S = \frac{((1-p)(1 + \delta\beta + \sigma(1-\delta)) - \beta)\,\alpha\,(k) + (p - (\delta + \sigma(1-\delta))(1-p))}{p}\pi$$

In order to weakly desist all cartels above k_{IC}^S as well, the fine must increase with the cartel overcharge

$$\frac{\partial F}{\partial k} \geq \frac{((1-p)(1+\delta\beta+\sigma(1-\delta))-\beta)}{p}\left(\frac{\partial \alpha}{\partial k}\right)\pi$$

The following can easily be verified:

Corollary 5 *(i)* $\frac{\partial F_{IC}^S}{\partial \sigma} > 0$. *And if (ii)* $p < \frac{1-\delta}{2-\delta}$, *then an increase in the private litigation as a fraction of the damage (increase in σ) must be compensated by an increase in the fine F that exceeds the per period increase in profit from colluding $((\alpha-1)\pi)$.*

Proof: Concerning (i), it can easily be verified that $\partial F_{IC}/\partial \sigma > 0$ in (10) when $\partial S/\partial \sigma = (\alpha-1)\pi$ since $(1-\delta)(1-p)/p > 0$. Concerning (ii), it is easy to verify that $\partial F_{IC}^S/\partial \sigma > (\alpha-1)\pi$ if $p < \frac{1-\delta}{2-\delta}$.

While deviation will with certainty lead to a private litigation, there is a probability less than one for detection and subsequent private litigation if the cartes continue to operate. This implies that the larger the expected payment due to private litigation, the higher is the fine that is needed in order to destabilize the cartel. If the probability of detection is sufficiently low, the increase in the fine for a more harmful cartel must exceed the increase in the private litigation costs.

3.3 Participation versus incentive constraint

Let us now assume that the fine schedule enforced has the characteristics as described above. All cartels are marginally deterred, and in each industry either the incentive constraint or the participation constraint binds. Let us check carefully the interaction between those two constraints. We define the following:

V^C = Present value of a cartel

V^N = Present value of competition

V^D = Present value of deviation from cartel and competition in all future periods

We know from the analysis that:

- $V^C > V^N$: Participation constraint binds

- $V^C > V^D$: Incentive constraint binds

In the previous sections we have solved for the lowest fine that will ensure that the participation constraint and the incentive constraint is binding, respectively. Since $\partial V^C/\partial F < 0$ and $\partial V^N/\partial F = \partial V^D/\partial F = 0$, the fine F should be increased until either $V^C < V^N$ or $V^C < V^D$. This implies that the participation constraint (incentive constraint) is the binding constraint if $V^N > V^D$ (if $V^N < V^D$). We can use the expressions for V^N and V^D as defined in the previous sections. However, let us assume that there are some non-pecuniary costs C associated with being caught for involvement in cartel activities. For example, there might be some norms saying that price fixing is an unlawful action and thereby an action that is detrimental to the welfare for the persons making those decisions. Then we have that $V^N > V^D$ if

$$\frac{\pi_N}{1-\delta} > \beta\pi_C - L - S - C + \left(\frac{\pi_N}{1-\delta}\right)\delta$$

We see that if L, S or C are sufficiently high, the participation constraint is the binding constraint. In such a case an existing cartel will be punished quite fiercely by reporting and thus the fine must be rather high to give the existing cartel members incentives to deviate and report.

Furthermore, let us check the slopes of the fine schedule when the incentive and the participation constraints, respectively, are binding. In Propositions 1 and 3 we have defined the slopes of those minimum fine schedules, and we can from that information define the following parameters

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$$A = \frac{1-p}{p}$$

$$B = \frac{(\alpha - 1)}{p^2}$$

$$C = \frac{(1-p)(1+\delta\beta) - \beta}{p}$$

$$D = \frac{(1 - \beta(\delta - 1))\alpha - \delta}{p^2}$$

The following condition tell us whether the minimum fine schedule as determined by the incentive constraint has a lower slope than the fine schedule as determined by the participation constraint:

$$\frac{dF_{IC}}{dk} \equiv A\frac{\partial\alpha}{\partial k} - B\frac{\partial p}{\partial k} < C\frac{\partial\alpha}{\partial k} - D\frac{\partial p}{\partial k} \equiv \frac{dF_{PC}}{dk}$$

Rearranging, we have that the F_{IC} fine schedule is flatter than the F_{PC} fine schedule if:

$$\frac{p\beta[\delta(p-1) + 1]}{(\delta - 1)(\alpha\beta + 1)} < \frac{p'_k}{\alpha'_k}$$

We see that the lefthand side is negative, while $p'_k \gtreqqless 0$ and $\alpha'_k \gtreqqless 0$. It implies that the F_{IC} fine schedule is always flatter than the F_{PC}, irrespective of whether the overcharge influences the probability of detection or not.

Let us consider the case where $p'_k = 0$ (k has no effect on p). Then the fine must be discriminatory no matter which constraint is binding. By comparing the two constraints we see, in line with what we have already shown, that the participation constraint leads to a more discriminatory fine than the incentive constraint does. This can easily be seen from the following:

$$\frac{dF_{IC}}{dk} \equiv \frac{(1-p)(1+\beta\delta) - \beta}{p} < \frac{1-p}{p} \equiv \frac{dF_{PC}}{dk}, \tag{16}$$
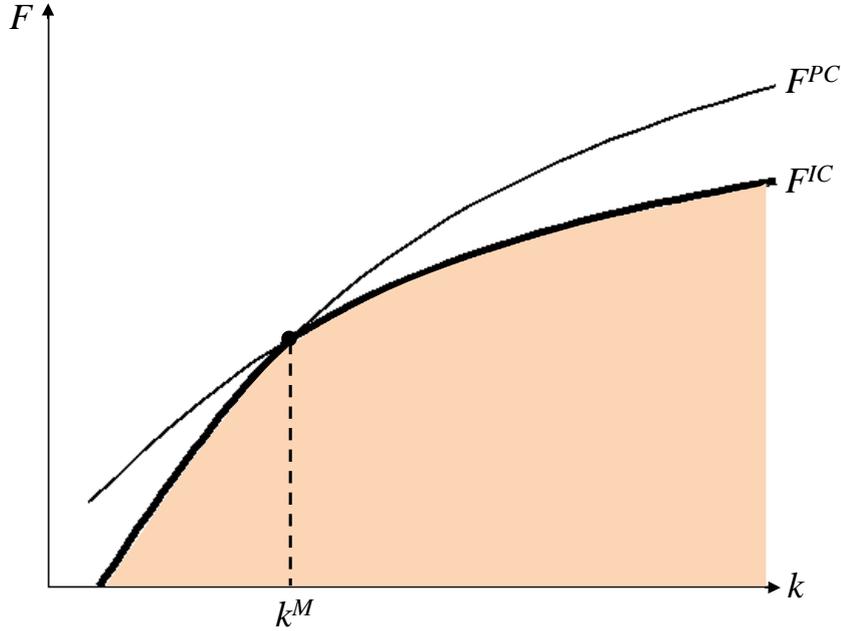
Figure 1: The optimal fines given incentive and participation constraints.

The optimal fine schedule is illustrated in Figure 1, which is everywhere the lowest as determined by the participation constraint and the incentive constraint, respectively. When we assume that the non-pecuniary cost C has an identical effect on all cartels the incentive constraint line F_{IC} is shifted upwards by C.

The solid piece-wise line shows the binding constraint. If any part of the schedule $F(k)$ lies within the shaded area these cartels are neither deterred nor desisted, thus they are formed and stable. We then have the following result:

Proposition 5 *Assume that there exist some level of k such that $F_{IC} = F_{PC}$ for the cartel with overcharge $k^M \in (\underline{k}, \overline{k})$, where k^M is defined by*

$$\alpha(k^M) = \frac{\pi + C + L + S}{\beta\pi}$$

If $F = \min[F_{PC}, F_{IC}] \equiv F^*(k)$, then all cartels $k \in [0, k^M\rangle$ are deterred while

all cartels $k \in [k^M, \bar{k}]$ are desisted.

As shown in Proposition 2 and illustrated in Figure 1, the participation constraint stops cartels with a low potential harm to consumers from forming and the incentive constraint stops cartels with a large potential harm to consumers from sustaining collusion. In both cases the firms' best choice is not to form cartels. Since both constraints bind, although for various industries, a change in the cartel policy can have very different effects in different industries. As shown in the previous sections, private litigation as such will make cartels more sustainable (incentive constraint) but at the same time make cartels less profitable (participation constraint). Table 1 summarizes the comparative statics with respect to changes in the leniency policy and in the private litigation costs under all possible enforcement regimes, i.e., combinations of private litigation and leniency.

Before we proceed it is necessary to set up some criteria for how we can assess the efficiency with respect to policy enforcement in our setting. Since we are not considering policy changes that has any direct costs for the competition authorities, e.g., an increase in p across all industries, or in targeted industries, it is in principle desireable and feasible to fight all potential cartels by designing the rules on how cartels should be fined together with appropriate leniency and private litigation. That is, to apply the policy $F^*(k)$ as defined in Proposition 5. However, due to fear of overdeterrence and the adverse effects of firm failure, policy rules with high fines may be difficult to implement in practice. Hence, searching for efficient enforcement policy amounts to design the mix of the available policy instruments in order to minimize the level of fines and the steepness of $F(k)$. The remaining part of this section discusses the trade-offs in such a policy design.

First, let us consider how a change in S affects the optimal schedule $F^*(k)$. If there is no leniency program at all in the CA's enforcement policy, an increase in S will lead to a reduction in F^* by the same amount, i.e., $dF^*/dS = -1$. If private litigation costs depends on cartel overcharge, i.e., $S = \sigma(\alpha - 1)\pi$, the slope of $F^*(k)$ is decreased as well. k^M remains unchanged in both cases. If
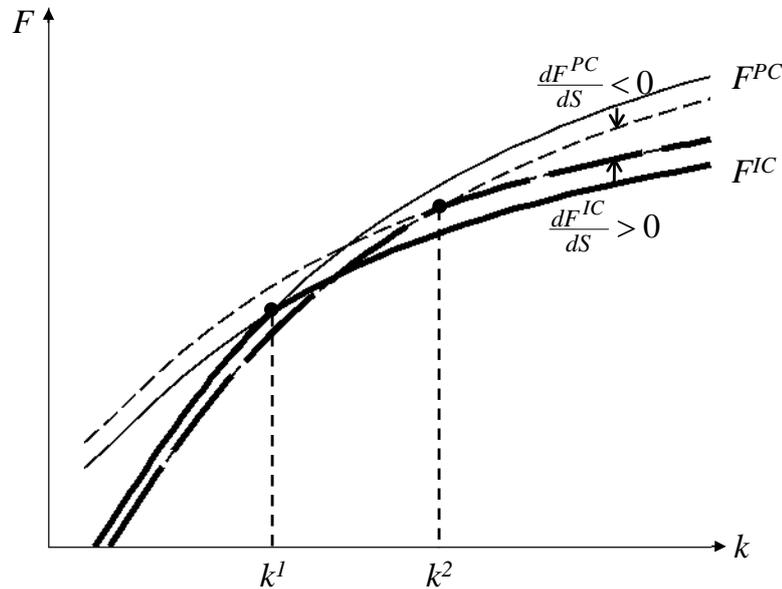
Figure 2: The effects of an increase in S.

there is a leniency program in place, the effects of increased private litigation costs are different. Then F_{PC} is shifted downwards, while F_{IC} is shifted upwards, and both $dk^M/dS > 0$ and $dk^M/d\sigma > 0$. Hence, more widespread use of private litigation makes it easier to deter cartels with relatively small overcharge, but more difficult to desist cartels with larger overcharges. The effects of increased private litigation under leniency is illustrated in Figure 2.

We see that if the fines F are not changed, the cartels with a limited damage will still be deterred but the fine will now be excessively high for each of them. For cartels with a large damage, no change in the fines following an increase in the private litigation will imply that more cartels are formed and sustainable.

Corollary 6 *An increase in private litigation, all else equal, would make it less likely that cartels with limited harm to consumers are formed and more likely that cartels with large harm to consumers are formed.*
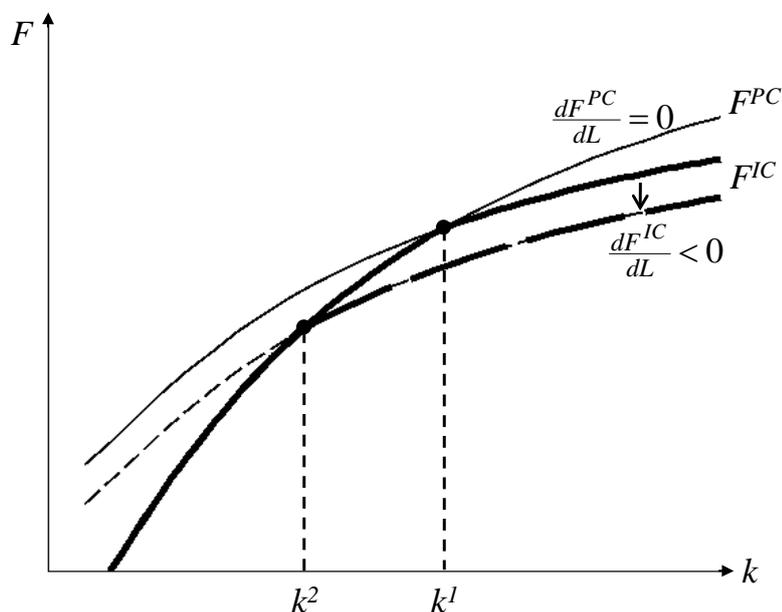
Figure 3: The effects of a reduction in L.

Next, let us consider how the introduction of or a change in the leniency program affects F^* and k^M. First, notice that leniency has no effect on the participation constraint. Hence, a change in the leniency fine will affect cartels with cartel overcharge $k \in [k^M, \overline{k}]$. The effects are simply that when leniency fines are decreased, F_{IC} is shifted downwards, and the slope of F_{IC} is reduced as well if λ is decreased under partial leniency. The effects of a reduction in L is illustrated in Figure 3.

Corollary 7 *An decrease in the leniency fine, all else equal, will make it less likely that cartels with large harm to consumers are formed while the likelihood that cartels with limited harm to consumers are formed is unaffected.*

Finally, taking as a starting point an initial enforcement policy that deter cartels $k \in [\underline{k}, k^M)$ and desist cartels $k \in (k^M, \overline{k}]$, we ask whether this deterrence/desistence ratio can be sustained at lower levels of $F^*(k)$ by shifting the policy towards a regime with more generous leniency and
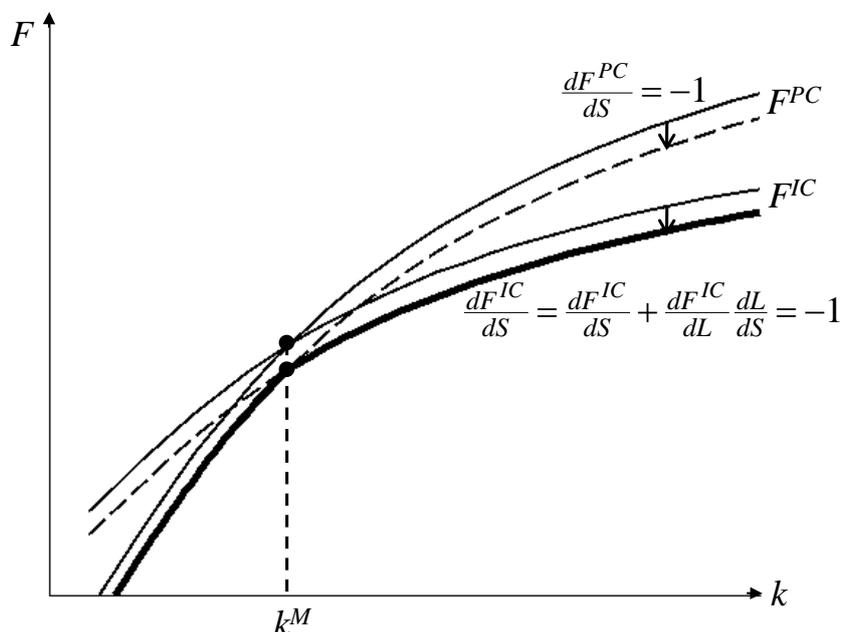
Figure 4: The effects of a k-neutral change $dL = -dS$.

more widespread use of private litigation? If S and L are changed simultaneously, the policy change has a neutral effect on k^M if the change has the form $dL = -dS$. That is, if $dL = -dS$, then dk^M as defined in Proposition 5 is preserved. Differentiating (5) and (10) with respect to L and S, using the above defined k-neutral policy change we find that $dF_{PC}/dS = -1$ and $dF_{IC}/dS = \partial F_{IC}/\partial S + (\partial F_{IC}/\partial L)(dL/dS) = -1$. The effects of the policy change is illustrated in Figure 4.

Corollary 8 *A policy change towards more generous leniency and more widespread use of private enforcement, all else equal, will make it less likely that cartels are formed. When the policy change has reached a point with full leniency to reporting firms, further increase in private litigation costs would make it less likely that cartels with limited harm to consumers are formed and more likely that cartels with large harm to consumers are formed.*

4 Are actual cartel fines discriminatory?

Commentators have criticized the cartel fine policy in both EU and the US, arguing that fines have been too low.[7] These studies consider the gains from a typical cartel, and compare that with the expected fine they have to pay. They point out, as is clearly present in our model too, that since the probability of detection is rather low the fines should be substantially more than the damages they cause. However, they also point out that the new guidelines in the EU for setting fines will imply that fines will be higher in the future and thereby closer to the fines that deter cartels.[8]

However, our main concern is whether fines are sufficiently discriminatory to deter the worst cartels. We find that for sufficiently low probability of detection the discriminatory fines should even be overproportional to the additional damage of a more harmful cartel. There are not many detailed empirical studies of the probability of detection. Bryant and Eckard (1991) found that the probability for a cartel being detected in one year cannot be higher than 13 - 17%.[9] If this is true, it suggests that the differences in fines between cartels should be overproportional to the difference in damage they cause. Unfortunately, the present policy in both the US and EU is such that it is an open question whether fines are discriminatory at all.

According to the US guidelines for fines it should be set a base fine level at 20% of affected commerce.[10] This is clearly based on an average cartel overcharge consideration.[11] It seems to be a deliberate choice not to try to

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[7]See for example Connor and Lande (2006) concerning both EU and the US, and Schinkel (2006), Veljanovski (2007) and OFT (2009) concerning EU.

[8]See, for example, Motta (2007). He makes some simple calculations of whether fines that are set according to the new rules are high enough. Although his calculations suggests that they will still be too low, he points out that his simple calculation cannot capture all relevant factors and therefore he cannot reject the hypothesis that fines will be high enough.

[9]See also Combe, Monnier and Legal (2008). They use data for the EU, and find that the probability for being caught cannot be higher than 13.3% each year.

[10]See U.S. Sentencing Guidelines Manual § 2R1.1 (2005).

[11]It has been a presumption that the average gain from price-fixing is 10% of the selling price. The guidelines doubled that amount to account for harm to consumers that could not buy the product at the higher price. See Connor and Lande (2006) for a discussion of

calculate the actual damage from each cartel:

> *The purpose of specifying a percent of the volume of commerce is*
> *to avoid the time and expense that would be required for the court*
> *to determine actual gain or loss.*

The base fine level should be adjusted by a number of factors, such as adjusted upwards if bid rigging or other aggravating factors are involved or downward if the firm cooperates with antitrust authority. However, it is hard to see that such adjustments introduce anything that would imply that the fine should depend on the actual damage. This suggests that the fine is not discriminatory at all.

In the EU guidelines for fines, the starting point is that the basic amount will be set at a level up to 30% of the relevant sales the last business year.[12] This amount should be multiplied with the number of years of infringement, and added a fixed component which equals 15-25% of annual sales. Note that it is argued that fines should have a deterrence effect:

> *Fines should have a sufficiently deterrent effect, not only in order*
> *to sanction the undertaking concerned (specific deterrence) but*
> *also in order to deter other undertakings from engaging in, or*
> *continuing, behavior that is contrary to Articles 81 and 82 of the*
> *EC treaty (general deterrence) (see paragraph 4).*

One interpretation of this is that the fine should be set such that the probability of detection is taken into account.

In the EU guidelines it is stated that factors such as the nature of the infringement, the combined market shares of the involved firms and the geographic

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the guidelines.

[12]See Guidelines on the method of setting fines imposed pursuant to Article 23(2)(a) of Regulation No 1/2003. For a critical review of the guideline, see Van Cayseele, Camesasca and Hugmark (2008).

scope for the infringement should influence the decision whether the basic amount should be in the lower or upper end of the scale. Except for the combined market shares, which can be decisive for how much they are able to raise the price, none of these factors are discriminatory the way we have interpreted it. This basic amount of the fine should be increased or reduced in each particular case taking into account all relevant circumstances. It leaves a large discretion for the Commission to impose discriminatory fines. However, none of the moments mentioned that could lead to an increase or a reduction in the basic amount is directly related to the differences in profits between various cartels. Nevertheless, there is scope for a discriminatory fine:

> *The Commission will also take into account the need to increase the fine in order to exceed the amount of gain improperly made as a result of the infringement where it is possible to estimate that amount (paragraph 31).*

Finally, the fine cannot exceed 10% of the previous business year's total turnover for the firm.

It is then an open question how discriminatory the fine is in the EU. In any case, there is no indication that it can be overproportional discriminatory. In Figure 5 we have illustrated two possible outcomes, assuming that the fines in EU are discriminatory within a lower and an upper bound.

The solid line F illustrates the optimal fine. It is an upward sloping piece-wise line, in accordance with Figure 1. The dashed piece-wise line illustrates the actual fine. Since there is a lower limit on the actual fine, even the cartel with the lowest negative (or even positive) effect on welfare will incur a fine. This explains why the actual fine does start at a positive level. There is also an upper limit on the fine, shown with the flat part of the dashed piece-wise line.

Obviously, there are many possible outcomes. In the left part of the figure we have shown a case where only the cartels with a medium negative impact
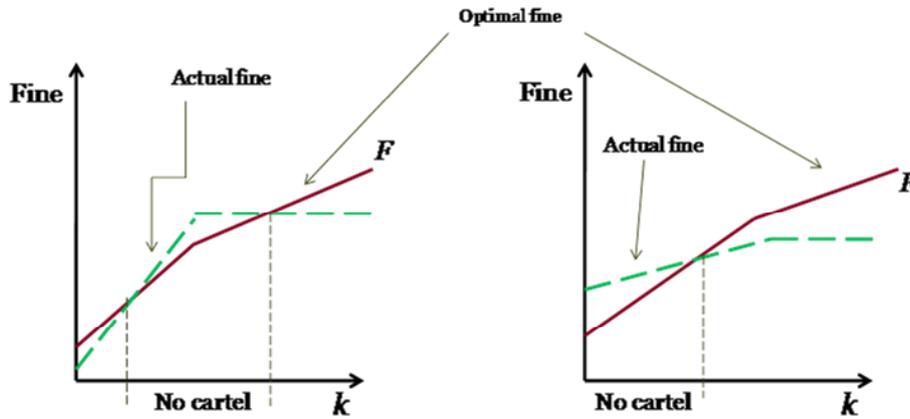
32

Figure 5: An example: Actual versus optimal fines.

on welfare are deterred, while in the right part of the figure we have shown a case where only the cartels with the lowest negative impact on welfare are deterred. The worst cartels are not deterred in any of these cases, and the obvious reason is that there is an upper limit on the fine. If we take the guidelines from the US for face value, a similar pattern as the right part of the figure would emerge. The dashed line should then be flat, since fines are not discriminatory at all.

Apparently, private litigation can help to mitigate this problem. Motta (2007) claims the following:

> *..if civil actions were likely and led to significant damages being recognized to clients and/or consumers hurt by cartels, the effect would be to substantially add to the fines that firms have to pay, thereby increasing deterrence.*

As we have shown, private litigation can stop the formation of cartels if the participation constraint is binding. However, if the incentive constraint is binding this is no longer true. On the contrary, we have shown that private action where payments to consumers are related to the damage they cause
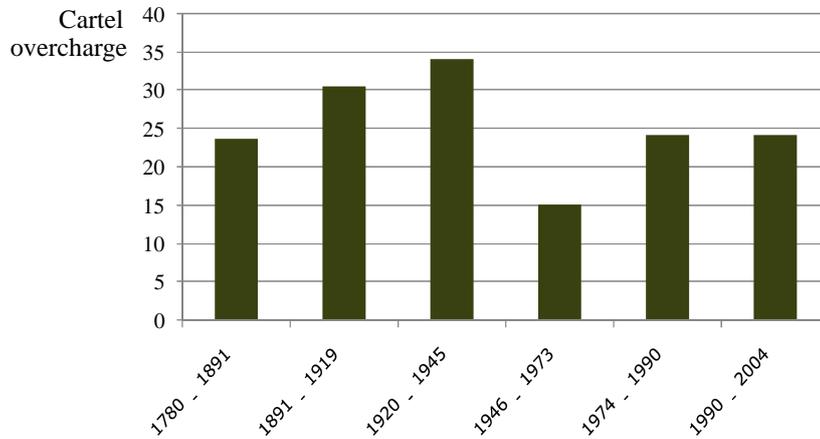
Figure 6: Cartel overcharge - the percentage price increase.

can undermine attempts to use discriminatory fines if the incentive constraint is the binding constraint.

Recently, EU commission has taken an initiative to spur more private litigation.[13] As argued above, if more private litigation and at the same time no change in the fine policy the worst cartels can become more sustainable. Unfortunately, the measures proposed by EU Commission will not prevent such a detrimental effect. It is proposed that the scope for damage to be paid by immunity recipients should be more limited when a leniency program is in place. The problem is that such a measure is not discriminatory, since it does not distinguish between cartels with a large harm and cartels with a more limited harm.

The large number of leniency cases in both the US and EU the last decade indicates that the violation of the incentive constraint, at least for those firm, is decisive for the fight against cartels. If the incentive constraint is binding, though, there is a risk that a discriminatory private litigation would deter the wrong cartels from deviating and reporting.

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[13]See white paper on damages actions for breach of the EC antitrust rules that was issued by DG Competition 2.4.2008.

In Figure 6 we have shown some figures for cartel overcharges for cartels in different time periods. Active cartel policy has been present only during the last century, and especially during the last couple of decades. If the worst cartels are deterred due to an active cartel policy, we would expect that detected cartels in the later periods have a lower average overcharge. From the figure we see that there is no such tendency according to these data.

5   Some concluding remarks

When firms agree to fix prices, it leads with very few exceptions to higher prices. In that respect it is natural with a per se ban on price fixing. Since price fixing in almost all instances will result in higher prices, there is no need to show that it has led to higher prices to conclude that the ban is violated. This is the present policy in most jurisdictions. We have argued that unless fines are very high, and thereby excessively high in most cases, it is a risk that the most harmful cartels are formed while the not so harmful cartels are deterred.

The obvious response to such a problem is to make fines discriminatory, in line what we have seen in other areas concerning crime and punishment. We show that it is non-trivial to design the optimal fines for cartel activities. First, for plausible parameter values we find that an overproportional discriminatory fine is needed. Second, the response to changes as, for example, more private litigation depends critically on whether cartels are deterred due to the lack of profitability or deterred due to the private incentives to deviate. Unfortunately, we find the the present policy in the US and EU are not addressing these problems in a satisfactory way. This might imply that it is a risk that the most harmful cartels are not deterred at present.

Table 1: Comparative statics, non-zero effects only.

	$L = F$	$L \in [0, F]$	$L = \lambda F$
$S = 0$	$\frac{\partial F^{PC}}{\partial k} > 0, \ \frac{\partial F^{IC}}{\partial k} > 0$ $\frac{\partial F^{PC}}{\partial k} > \frac{\partial F^{IC}}{\partial k}$	$\frac{\partial F^{IC}}{\partial L} > 0$	$\frac{\partial F^{IC}}{\partial \lambda} > 0$ $\frac{\partial^2 F^{IC}}{\partial k \partial \lambda} > 0$
$S \in [0, (\alpha - 1)\pi^N]$	$\frac{\partial F^{PC}}{\partial S} < 0, \ \frac{\partial F^{IC}}{\partial S} < 0$	$\frac{\partial F^{PC}}{\partial S} < 0, \ \frac{\partial F^{IC}}{\partial S} > 0$ $\frac{\partial F^{IC}}{\partial L} > 0$	$\frac{\partial F^{PC}}{\partial S} < 0, \ \frac{\partial F^{IC}}{\partial S} > 0$ $\frac{\partial F^{IC}}{\partial \lambda} > 0$ $\frac{\partial^2 F^{IC}}{\partial k \partial \lambda} > 0$
$S = \sigma(\alpha - 1)\pi^N$	$\frac{\partial F^{PC}}{\partial \sigma} < 0, \ \frac{\partial F^{IC}}{\partial \sigma} < 0$ $\frac{\partial^2 F^{IC}}{\partial k \partial \sigma} < 0$	$\frac{\partial F^{PC}}{\partial \sigma} < 0, \ \frac{\partial F^{IC}}{\partial \sigma} > 0$ $\frac{\partial F^{IC}}{\partial L} > 0$ $\frac{\partial^2 F^{PC}}{\partial k \partial \sigma} < 0, \ \frac{\partial^2 F^{IC}}{\partial k \partial \sigma} > 0$	$\frac{\partial F^{PC}}{\partial \sigma} < 0, \ \frac{\partial F^{IC}}{\partial \sigma} > 0$ $\frac{\partial F^{IC}}{\partial \lambda} > 0$ $\frac{\partial^2 F^{PC}}{\partial k \partial \sigma} < 0, \ \frac{\partial^2 F^{IC}}{\partial k \partial \sigma} > 0$ $\frac{\partial^2 F^{IC}}{\partial k \partial \lambda} > 0$

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