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The Role of Contribution among Defendants in Private Antitrust Litigation*

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Abstract

To date the experience of the incidence of private actions for damages in antitrust cases has differed markedly across jurisdictions. The procedural rules surrounding private litigation may account for some of these differences. This paper explores the effect of rules concerning contribution among multiple defendants who are joint and severally liable for a cartel infringement. The no-contribution rule is shown to lead to higher levels of aggregate damages and more information revelation to the private plaintiff. However, the no-contribution rule also has the potential to neuter any public leniency programme, thereby possibly reducing the number of cartels detected.

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1 Introduction

The latest push at the EU level for more private enforcement of competition law, as evidenced by the recently published Green Paper¹ by the EU Directorate General for Competition and the promised follow-up white paper later this year, has generated a renewed interest in understanding how private enforcement works. With hard core cartels singled out by the majority of enforcement agencies as the worst form of infringement, it is of particular interest to understand what private enforcement can deliver in these cases. Anti-competitive agreements to collude on prices or quantities imply multiple defendants, all of whom have been engaged in a violation of competition law. To ease the burden on the private plaintiffs, such co-defendants have typically been made joint and severally liable, ensuring that the plaintiff need only sue one of the defendants. However joint and several liability raises the question of whether the defendant, who has been ordered to pay the damages caused collectively by all the defendants, can ask for contribution from the co-defendants. Interestingly the answer to this question appears to differ between the US, where the rule is very explicitly one of no contribution, and the majority of EU member states, where the rule most likely is that there is scope for contribution.²

The aim of this paper is to provide a better understanding of the impact of contribution rules when defendants are joint and severally liable by demonstrating how a "no-contribution" rule has the effect of introducing a type of leniency programme for co-defendants in the area of private enforcement, leading to more information being revealed. This information revelation effect is in addition to the already identified ability of the no-contribution rule to increase the expected total settlement. This provides two avenues through which the no-contribution rule delivers more deterrence of cartel like behaviour, better information about the violation and increased liability.

¹"Damages actions for breach of the EC antitrust rules" (2005). This has led to further discussions in EU member states. For example the Office of Fair Trading published their own discussion paper "Private actions in competition law: effective redress for consumers and business" in April 2007, (OFT discussion paper OFT916).

²See e.g. the 2007 special report of the Global Competition Review on "Private Antitrust Litigation".

One of the open questions is the extent to which actions by private plaintiffs which follow-on from public actions should be encouraged. With two parallel leniency programmes, one explicitly designed for the purpose by the competition authority and another arising as a side-effect of a rule about liability, comes the question of how they may interact with each other. We focus on the role of the ring-leader, who in the US cannot be granted immunity from prosecution.³ Intuitively, one would expect the ring-leader to be much better informed about the workings of the cartel and hence to be able to provide the most valuable information to a private plaintiff. The ring-leader could potentially threaten to settle an antitrust damage case with private plaintiffs in return for its private information about the cartel, thereby exposing other cartel members, including the firm who was granted immunity, to greater liabilities from private litigation. This poses a problem for a firm requesting immunity as any benefits from immunity may be outweighed by the additional private liability. Where the public leniency programme either directly or indirectly results in the firm granted immunity sharing at least parts of its information with private plaintiffs, this is particularly troublesome. Such a firm would potentially have less information than other co-defendant to offer the plaintiff in return for an early settlement, thereby guaranteeing it to be the last to settle. This suggests that the two "leniency programs" may well counteract each other and that care should be taken in the design of leniency programmes and private liability rules when it comes to issues such as joint and several liability, contribution, the treatment of ringleaders and the extent of information revelation to follow-on litigants. Concern about private enforcement undermining the public leniency programme is not new. The US Antitrust Criminal Penalty Enhancement and Reform Act of 2004 removed joint and several liability from a firm granted immunity under the leniency programme and in addition reduced the private liability of that firm to single damages. The analysis of this paper offers an insight into how private and public enforcement interact and in particular provide a better understanding of the role of any ringleaders in the design of a leniency programme.

³The US DoJ states that the applicant must not have coerced another party to take part in the offense and must not have been "the" instigator or "the" leader of the illegal activity. The Model Leniency Programme proposed by the European Competition Network equally advocates the exclusion of "An undertaking which took steps to coerce another undertaking to participate in the cartel" [p.3].

The literature on contribution in antitrust is relatively sparse, with early contributions by Easterbrook et al. (1980) and Polinsky and Shavell (1980) who offer a theoretical analysis of the merits of contribution and claims reduction.⁴ Both papers put considerable emphasis on risk-aversion, something which is less of an issue in our paper. Their models has subsequently been generalised. Cavanagh (1987) cites the corrugated container litigation in the US as an example of the ability of the no-contribution rule to increase the recovery by the plaintiff.⁵ He argues that the no-contribution rule is unfair on firms with only a marginal participation in a price-fixing conspiracy: “these companies, precisely because they are small players with marginal culpability, are rarely if ever offered settlement terms comparable to those provided to the ringleaders” Cavanagh (1987, 1920). The recent paper by Goetz et al. (2006) summarises and builds on most of the existing literature in the US regarding both the question of contribution and of set-off. Unlike previous papers, Cirace (1980) and Stanley (1994), they assume sequential settlement. However, as they do not ensure that the equilibria they find are subgame perfect, there are some doubts about the predictive power of their analysis. Cirace (1980) focuses on how contribution rules affect the incentives of defendants to settle early or late, showing how no-contribution leads to the former and contribution to the latter.

Stanley (1994) seems to be the only paper which clearly identifies the information revelation scope from early settlements. Both the modelling and the focus differ between his paper and ours. His assumes simultaneous bargaining between plaintiff and all of the defendants, whereas we assume sequential bargaining which we feel is closer to reality. While we focus on the ability of the private information

⁴There is a more substantial literature on joint and several liability. Part of this literature is concerned with the incentives or cases to settle and generally employ a model in which a single plaintiff makes simultaneous take-it-or-leave-it offers to several defendants, e.g. Kornhauser and Revesz (1989), Klerman (1996), Feess and Muehlheusser (2000). These papers focus on set-off rules and consider more general cases where some of the harm is caused by non-negligent actions, something which is not relevant in the antitrust setting. Because the plaintiff is assumed to make the offer, there is no scope for information being revealed. Kim and Song (2007) considers asymmetric information, but the focus is on information sharing between defendants, which the plaintiff may want to undermine rather than information sharing between the plaintiff and some of the defendants.

⁵As Stanley (1994, fn 100) points out, it also provides an example of information revelation in return for a lower settlement. The court in that case noted with approval this trade-off of a lower settlement in return for valuable information.

to enhance the level of damages awarded, Stanley (1994) focuses on the probability of the plaintiff prevailing in court. The focus in Stanley (1994) is on settlement rather than on the information revelation and the full equilibrium.

There are also a small number of papers looking at the effect of asymmetric information. Briggs, III et al.(1996) consider the interaction between public and private (follow-on) enforcement when defendants may act tough in negotiations with the competition authority to send a signal to any private plaintiff that a subsequent case would be weak. The focus of Briggs, III et al.(1996) is on the interaction rather than on any details of the private actions in terms of liability rules.

The focus of the paper is on an industry with N firms who depending on the law and procedures may decide to form a cartel. To simplify the notation, our base model assumes that only one cartel member can get immunity from public prosecution and that such a firm cannot have been a ringleader. Where a cartel is uncovered, members are assumed joint and severally liable but we contrast the two cases of no-contribution and contribution. In the no-contribution model, a defendant who is taken to court faces the whole liability for the losses incurred by the plaintiff minus any amounts already settled and cannot recover any of this from co-defendants. In the contribution model, the defendant who is found liable in court can, if it is faced with a disproportionate liability, demand contribution from co-defendants.⁶ We will assume that those harmed by the cartel are sufficiently alike that any private case they would pursue can be consolidated into a single class action. While class action is not generally available in the EU, many of the jurisdictions have other means for claims to be consolidated.⁷

The remainder of the paper is organised as follows. Section two provides an overview of the basic model of joint and several liability with and without con-

⁶The literature has also considered a third model, in which there is no contribution, but there is set-off. This can be either the amount already settled for, or the liability of those who have settled, whichever is greater. This possible model was also discussed by the Antitrust modernization committee (AMC) in the US. This third model is not very interesting because no defendant can ever face more liability than the harm it has itself caused. It can ensure this simply by waiting for others to settle. In this case the recovery can for that reason alone not exceed the expected liability of the defendants as a whole.

⁷The special review by Global Competition Review on private antitrust litigation indicate that there is currently a debate about introducing some form of class action in many of the EU member states.

tribution and demonstrates that the no-contribution rule lead to a larger overall settlement for the plaintiff. Section three extends this to the case where defendants have private information about the case. We consider the case where revelation of this private information to the plaintiff will increase the total level of damages which can be established in court. The main insight of this section is that the no-contribution rule give an incentive to reveal information in return for a reduced level of damages, in effect introducing a private leniency programme. The section also highlights how a firm applying for public immunity may be at a disadvantage in the private settlement game. Section four follows this up by highlighting the effect of the public and private leniency programmes on the sustainability of collusion and in particular demonstrating when these two programmes interact positively and negatively. Section five provides an overview of the current legal position in the US and in one of the EU member states where there has been an active debate about strenghtening private antitrust litigation, the UK. Section six concludes. All proofs are collected in the appendix.

2 Sequential settlement with N defendants and one plaintiff.

Let there be N defendants who if found guilty are joint and severally liable for a breach of antitrust laws and a single plaintiff. Let D be the total amount of damages which would be awarded at trial and p be the probability of a court finding for the plaintiff and imposing the level of damages minus any contributions arising from pre-existing settlements. We will assume that both D and p are same for all defendants⁸ and that they are unaffected by the number of settlements and the amount settled to date.⁹ We assume no discounting so the total ex ante expected value of the case is $p \cdot D$. Because we will be considering a sequential settlement model, it is convenient to index rounds in reverse order such that if there are N rounds, round N is the first and round 1 is the last, so that the index indicates how many defendants are yet to settle. The last round, N , can only be

⁸Thus neither the probability of winning the case nor the amount of damages which can be established depends on the identity of the defendant.

⁹Thus the court does not infer anything directly about the probability of a violation or the quantity of damages from the past settlements.

reached if none of the previous rounds have resulted to a full trial. A full trial in which the court awards damages or dismisses the case ends the game. In the n 'th stage, there are hence n defendants who have not yet settled remaining.

The structure of stage n is:

1. The n remaining defendants make offers of settlement simultaneously;
2. Plaintiff decides whether to accept one of the offers or sue. If there are ties, she will randomise between the highest offers. If she sues, the game ends.

Below we solve for equilibrium settlements in the two cases.

2.1 No-contribution

With no-contribution, each defendant trades off making an offer which may be accepted, thereby concluding its involvement in the case, and running the risk of being sued at a later stage. Let S_i denote the accepted settlement offer in round i .¹⁰ When awarding damages, the court will take into consideration the settlements made to date. Thus the remaining expected liability in round n is $p \cdot \left(D - \sum_{t=n+1}^N S_t \right)$. The greater the amounts settled for in the early stages, the smaller the liability if a case comes to court.

Lemma 1 *With no-contribution among co-defendants, the equilibrium per-firm settlement is the same for all and given by.*

$$\bar{S} = \frac{p}{1 + (N - 1) \cdot p} \cdot D \quad (1)$$

The individual settlement is decreasing in the number of defendants, N , and the total settlement is increasing in N .

Proof. For this and all other proofs, see appendix. ■

The result in lemma 1 is in stark contrast to the result found in Goetz et al. (2006), who using a model with the same set-up found that settlements increased through the stages, i.e. $S_N < S_{N-1} < \dots < S_2 < S_1$. The reason for this is that

¹⁰In a slight abuse of notation, S refers both to the offer made by a defendant and the agreed settlement. This saves on notation and should not lead to confusion.

Goetz et al. (2006) implicitly assume that defendants are myopic, ignoring future settlement possibilities.¹¹

Interestingly, (1) is the same as the solution found in Stanley (1994), who considers a simultaneous settlement model. In both games the result is driven by the concern of the defendants not to be the marginal defendant who might get sued.

2.2 Contribution

In a number of jurisdiction, the defendant who is found liable to pay damages in court can demand contributions from the other defendants. We can demonstrate the following:¹²

Lemma 2 *In equilibrium, no defendant offers to settle, each defendant pay*

$$S^c = \frac{p}{N} \cdot D \quad (2)$$

and the total amount recovered by the plaintiff is $p \cdot D$.

Note that in the contribution case, there is no incentive to settle the case. This is in contrast to the no-contribution case where there is a strong incentive to settle. Secondly, the expected recovery of the plaintiff is lower than under no-contribution.¹³

Proposition 1 *With more than one defendant and a less than certain outcome of a court case, the total recovery in the case of no-contribution exceeds the total recovery in the case of contribution.*

Thirdly, in neither case is there a difference in the amount settled for by the first and the last defendant. This is in contrast to the practical observations¹⁴ that

¹¹Technically, their equilibrium is not sub-game perfect.

¹²This is consistent with Stanley (1994, 60-64), who provide a numerical example demonstrating that with multiple defendants, the contribution rule provides a disincentive for defendants to settle.

¹³The strategy associated with the no-contribution rule of pressuring a defendant to settle early to avoid facing exposure for the full harm caused by an antitrust violation is sometimes referred to as the "whipsaw" settlement tactic.

¹⁴See e.g. the discussion of the *In re Corrugated Container Antitrust Litigation*, 1981-1 Trade Cas. (CCH) ¶ 64114 (S.D. Tex. 1981) in Cavanagh (1987) and Stanley (1994).

those who settle early settle for a better deal. However, given that the model is symmetric, it would be odd if in equilibrium identical players were treated differently.

3 Private information

Where a plaintiff is pursuing a stand alone action, it seems uncontroversial that the defendants have better information than the plaintiff about both the form and the consequence of the alleged infringement. Where the plaintiff is pursuing an action following on from a competition authority decision, (s)he may be able to rely to a considerable extent on the findings of the competition authority and use information revealed in the decision to subpoena further information from the defendants. However, even in this case, not all relevant information is likely to be known to the plaintiff. For example, a competition authority may settle for a shorter duration for a safer conviction or a more appeals proof decision, especially if this still enables the authority within its guidelines to levy a deterring fine. As another example, EU Article 81 is violated both by agreements which have the object to fix prices and agreements which have the effect of fixing prices. If an authority can prove "object", it would clearly prefer to do that, leaving it up to any private litigant to demonstrate effect. More generally, we would expect a private plaintiff typically has less information than at least some of the defendants when it comes to demonstrating the full extent of the harm suffered. Such asymmetry of information may matter because the defendants with private information may use this to encourage the plaintiff to settle at a reduced rate. As pointed out in Stanley (1996, p 80-81), the incentives to reveal private information depends on whether or not there is scope for contribution.

Assume that each of the defendants may have private information which can increase the value of the case to the plaintiff. It can essentially do so in one of two ways. It can increase the probability that the court find for the plaintiff in any future cases. It can do so by enabling the plaintiff to establish a larger quantum, for example through establishing that a cartel was in existence for longer than could

previously have been proven.¹⁵ In the following we will model this as if the effect is the latter, but nothing qualitative rests on this. Specifically we assume that each defendant has some information which for defendant i can increase the liability in a subsequent court case by δ_i . Moreover, assume that there is no correlation between the information of the defendants so each adds an independent amount of liability, δ_i , which can simply be added up.

3.1 Symmetry

Assume first that if $\delta_i = \delta_j = \delta$ for all i, j so that no defendant has an informational advantage over another. We can then demonstrate the following.

Proposition 2 *With no-contribution, in equilibrium all but one defendant will reveal its private information. As a consequence the total settlement is increased relative to the no-private information case. With contribution, there is no information revelation and the settlements remain unaltered.*

This simple model highlights a second important feature of the no-contribution rule, namely that it leads to information revelation as defendants are willing to use information revelation as part of their offer. A defendant who hands over information to a plaintiff knows that with a no-contribution rule, this cannot give rise to any future claims. One can think of this as providing a leniency programme for private settlements which can increase the effectiveness of private actions. This private leniency effect does not depend on any of the assumptions relating to the defendants.

3.2 Asymmetry

It is not necessarily reasonable to assume that each member of a cartel can increase the overall liability by the same amount. In particular, we can think of two types of firms who may have a special position in this respect. One is a cartel member who applies for and obtains immunity from public punishment in return for providing all

¹⁵See Lande and Davis (2007, table 5) and in particular the Polypropylene Carpet Antitrust Litigation [93 F. Supp. 2d 1348 (N.D. Ga. 2000)].

relevant information to the competition authority.¹⁶ How much of this information diffuses to the plaintiff depends on procedures both regarding the report provided by the authority and the rules governing disclosure. Arguably this firm can be expected to have the least useful information to add to that already held by the plaintiff. The other is the ringleader or instigator of the cartel. One would expect that the firm who has been the ringleader of the cartel will have a more complete picture of how the cartel has worked and hence likely to be able to reveal more useful information to the plaintiff than any other cartel member.¹⁷

To get a handle on the effect of asymmetries in the value of the private information to the plaintiff, we first extend the model to the case where the amount each defendant can increase total liability by can be ranked. Assume that defendant N is able to increased overall liability the most and defendant 1 the least, $\delta_N > \delta_{N-1} > \delta_1$. We can show the following:

Proposition 3 *With no-contribution, the settlements, S_i^A , are increasing through the rounds so that the first defendant to settle, defendant N , settles for the lowest amount and last defendant, defendant 1, settle for the highest amount, given by*

$$S_1^A = \frac{p}{1 + (N - 1) \cdot p} \cdot D + \frac{1}{1 - p} \cdot \frac{\sum_{i=2}^N \delta_i - p \cdot (N - 1) \cdot \delta_1}{1 + (N - 1) \cdot p} \quad (3)$$

$$S_j^A = S_{j-1}^A - \frac{p}{1 - p} \cdot (\delta_j - \delta_{j-1}) \quad j \neq 1 \quad (4)$$

Although not the main aim of this section, note that proposition 3 is in line with casual empirical observations in the literature, e.g. Cananagh (1987) and Stanley (1994) that those who settle early, settle for less.

3.2.1 The immune firm

Proposition 3 allows us to consider the effect of information spill-over from the public investigation to the private action. There are two avenues for spill-overs.

¹⁶The existence of such public leniency programmes is widespread but the details of how they work differ. We focus on the extreme case where one and only one cartel member can get leniency from public prosecution and that such a firm is awarded complete immunity.

¹⁷The role of cartel members in the organisation of the cartel may naturally change over time and a cartel may be nervous about one and only one member having the full picture. The cartel members may, through the way they organise the cartel, have views about how such private information is distributed among members.

One is from any report or written decision by the competition authority which will in part be based on the information supplied by the defendant to the authority. The other is in terms of alerting the plaintiff to information it could attempt to subpoena from the authority or the defendants. Rules regarding the confidentiality of the information supplied in return for immunity differ across jurisdictions as do discovery rules. Holding back on information provided to the competition authority would typically constitute a violation of the immunity agreement and hence the immunity applicant has a strong incentive to provide all its information to the authority. Given all this, the firm who is granted immunity is likely to be the firm with the least valuable information, i.e. the lowest δ . In terms of the modelling, we can in addition think of part of the information of the immune firm increasing D through the spill-over.

Assume that firm j have got immunity and assume that all the information of j spills over to the plaintiff. In proposition 3 this essentially implies that D is increased by δ_j and that δ_j is set equal to zero and hence j will be the last to settle. The amount of settlement for this firm will then be

$$S_j^I = \frac{p}{1 + (N - 1) \cdot p} \cdot (D + \delta_j) + \frac{1}{1 - p} \cdot \frac{\sum_{i=1}^N \delta_i - \delta_j}{1 + (N - 1) \cdot p}$$

Comparing this with the expected settlement in the case of no private information given in (1), the effect of information revelation on an immune firm is

$$S_j^I - \bar{S} = \frac{1}{1 - p} \cdot \frac{\sum_{i=1}^N \delta_i - p^2 \cdot \delta_j}{1 + (N - 1) \cdot p} \quad (5)$$

Any firm contemplating applying for leniency would then need to compare this expected loss with the expected cost of not applying for leniency. The outcome of this cost-benefit exercise would clearly depend on size of the various parameters, including the size of the public fine. However, it is clear that the information revelation on its own has the potential to deter a firm from applying for immunity.

One policy response is to make some of the documents passed to the competition authority as part of the immunity arrangement inaccessible to plaintiffs in follow-on actions.¹⁸

¹⁸The OFT (2007) discussion paper suggests that this should be the case.

3.2.2 The ringleader

Levenstein and Suslow (2004) argue that a key feature of a successful cartel is that it is well organised. This typically requires someone to take the initiative to organise the cartel and design monitoring and punishment mechanisms. One might argue that there is likely to be a high correlation between having very valuable private information and being the ringleader because the defendant who organised the cartel is much more likely to have information about all defendants and also information about the internal workings of the cartel. A ringleader is in many cases barred from seeking immunity from the competition authority. As a defendant, such a firm is particularly valuable to the plaintiff and is the defendant most likely to be able to strike a beneficial deal with the plaintiff.

Assume that only one of the defendants, the ringleader, has information which, if passed on to the plaintiff can increase the level of damages imposed by the court from D to $D + \delta_{RL}$. For simplicity assume that $\delta_i = 0$ for $i \neq RL$. We can use the result in proposition 3 so show the effect of this.

Corollary 1 *The expected liability of a defendant when the ringleader settles early is:*

$$\begin{aligned} \text{If } S_{RL}^R = 0 \quad S_i^R &= \frac{p}{1 + (N - 2) \cdot p} \cdot (D + \delta_{RL}) > \bar{S} \quad i \neq RL \\ \text{If } S_{RL}^R > 0 \quad S_i^R &= \frac{p}{1 + (N - 1) \cdot p} \cdot D + \frac{1}{1 - p} \cdot \frac{\delta_{RL}}{1 + (N - 1) \cdot p} > \bar{S} \quad i \neq RL \end{aligned}$$

Notice that $S_{RL}^R = 0$ is more likely where the ringleader knows a lot and hence δ_{RL} is large. In this case there are two sources for the increase in liability of the non-ringleaders. One is that the quantum is higher due to information revelation and the other is that there is one fewer firm to shoulder the liability. While it might still be worthwhile for a firm to apply for immunity once a cartel has been detected, it is clear that there are values of δ_{RL} such that no firm would reveal the existence of the cartel in return for immunity.

4 Interaction with public leniency programmes

There is by now an extensive literature on public leniency programmes and how these interact with other parts of competition law, see Spagnolo (2006) for a survey.

The basic idea expressed in one of the early models by Motta and Polo (2003) is that the public leniency programme can undermine a cartel because it makes it possible for firms to avoid a substantial fine by applying for leniency. From a mechanism design perspective, the aim is to set up a prisoner's dilemma game between the cartel members.

Let Π_N be the stage game Nash equilibrium profit, Π_C the collusive profit and δ the discount factor. We will make a number of simplifying assumptions to keep the analysis simple. We focus on the case where a cartel member applies for immunity after an investigation has been initiated. If a firm can be deterred from seeking immunity after the investigation has started, then the same would be true if the firm came forward before. We will assume that there is a probability α that the industry will be investigated by the competition authority and that without further information the competition authority will find a violation with probability ρ , in which case it imposes a fine F on each firm. Following Motta and Polo (2003) we assume that a finding of a violation will halt cartel activity for the period of detection but if the cartel is inherently stable, it will continue after that. Absent a positive probability of detection by the competition authority, the cartel is assumed stable. A follow-on case from evidence of a violation imposes an expected liability on firm i of S_i as demonstrated in section 3 above. The size of S_i will depend both on the strategy of other defendants and on the procedural rules.

In the benchmark case, there is no collusion and the stage game Nash strategy is played in each period. In that case the value function of the No Collusion strategy (V_{NC}) is given by:

$$V_{NC} = \Pi_N + \delta V_{NC} = \frac{\Pi_N}{1 - \delta} \quad (6)$$

4.1 Collusion with no Leniency Policy

We first want to understand what the pure effect of private enforcement is in the absence of a public leniency programme. The value function of the Collusion and No Leniency strategy (V_{CNL}), where the firms play the stage game Nash equilibrium in the period in which they are found to have violated competition law

and the collusive strategy in all other periods, is given by:

$$V_{CNL} = \alpha [\rho [\Pi_N - F - S_i] + (1 - \rho)\Pi_C] + (1 - \alpha)\Pi_C + \delta V_{CNL} \quad (7)$$

Which we can solve to get:

$$V_{CNL} = \frac{\Pi_C}{1 - \delta} - \alpha\rho \frac{\Pi_C - \Pi_N + F + S_i}{1 - \delta}. \quad (8)$$

Direct comparison of V_{NC} and V_{CNL} give us the following lemma

Lemma 3 *Assume that there is no leniency programme but that private enforcement is possible. Let P_C be the critical combined probability that the cartel is detected and convicted given by*

$$P_C \equiv \frac{\Pi_C - \Pi_N}{\Pi_C - \Pi_N + F + S_i} \quad (9)$$

Then collusion is sustainable if $\alpha \cdot \rho < P_C$, i.e. if the combined probability is low enough. Higher values of F and S_i decreases P_C .

Lemma 3 implies that the higher the public and private damages are, the less likely is collusion. Moreover, private and public enforcement work together by impacting on the critical probability, P_C , in the same way.

It is well understood in the literature that a no-contribution rule increase the expected private liability of cartel members, see e.g. Goetz et al. (2006), and hence can have a chilling effect on the incentive to go to the authorities asking for immunity from public punishment.¹⁹ Lemma 3 confirms this insight as the no-contribution rule leads to a higher S_i , and hence to more deterrence of cartel activity.

4.2 Collusion with no Leniency Policy and strategic revelation

The focus of section 3 was on the information revelation powers of the no-contribution rule. In this subsection we consider the effect of this in isolation from the public

¹⁹This is even more the case where some of the defendants are wealth constrained. A plaintiff will never pursue a defendant who would be unable to pay the full level of damages. A firm with immunity from a public fine might be expected to have more wealth left over to meet any private liability. Whether or not this is the case in equilibrium is another matter, as the wealthiest firm would have less of an incentive to apply for immunity if this singles it out for subsequent private litigation. See also Randall (2006) for a discussion of this.

leniency programme. Assume that firm i has relevant private information it can reveal to the private plaintiff. We know from section 3, proposition 2 that while this reduced the expected liability of this firm to $S_R < S_i$, it also increase the liability of all other firms. Since higher private damages can reduce the stability of the cartel, the cartel would like to guard against this. One way to ensure this is to punish any firm which settles in return for information revelation. We will assume that rivals lose all trust in a defendant who deviate by revealing private information to the plaintiff and hence they play the stage game Nash strategy forever. The value function of the defendant who reveals information for a reduction in private damages (V_R) can be written as:

$$V_R = \alpha [\rho [\Pi_N - F - S_R] + (1 - \rho)\Pi_C] + (1 - \alpha) \Pi_C + \alpha\rho\frac{\delta}{1 - \delta}\Pi_N + (1 - \alpha\rho)\delta V_R$$

where the continuation payoff given by the last two terms depends on $\alpha\rho$ since a reversal to the stage-game Nash equilibrium only occurs where the competition authority is successful in bringing a case against the cartel. Solving, we get:

$$V_R = \frac{\Pi_C}{1 - (1 - \alpha\rho)\delta} - \alpha\rho\frac{\Pi_C - \frac{1}{1-\delta}\Pi_N + F + S_R}{1 - (1 - \alpha\rho)\delta} \quad (10)$$

Lemma 4 *Assume that there is no leniency programme, that private enforcement is possible and that at least one defendant has private information about the harm caused. Let P_R be the critical combined probability that the cartel is detected and convicted given by*

$$P_R \equiv \frac{\Pi_C - \Pi_N - \frac{1-\delta}{\delta}(S_i - S_R)}{\Pi_C - \Pi_N + F + S_i} \quad (11)$$

Then revelation of private information does not takes place if $\alpha \cdot \rho < P_R$.

The intuition for the result is that if a future detection by the authority is sufficiently unlikely, rocking the boat now by revealing any private information and terminating any future collusion is not worthwhile. Looking at (11), the bigger is the gap between private damages without revelation and damages with settlement in return for revelation, i.e. the bigger is $S_i - S_R$, the smaller is P_R and the more likely is the defendant to reveal information to the plaintiff. Finally comparing (11) and (9), we see that for $S_i > S_R$, $P_R < P_C$ and hence when information revelation is a possibility, it is the level of P_R which is important for

the future success of the collusion. Combining proposition 2, lemma 3 and lemma 4 we get

Corollary 2 *Assume that there is no public leniency programme. With the no-contribution rule collusion require $\alpha\rho < P_R$. With the contribution rule, collusion require $\alpha\rho < P_C$. As $P_C \geq P_R$, collusion is harder to sustain under the no-contribution rule.*

This provides some evidence that the no-contribution has a direct effect on deterring cartels through increasing the liability of some members of the cartel. Recall from section 3 that information revelation can increase liability even more when there is a ringleader (corollary 1).

4.3 Collusion with Leniency Policy

The main aim of this section was to understand how a private and a public leniency programme would interact. At this point we introduce a public leniency programme where a firm in return for relevant information is offered a reduced fined $R < F$. We make the extreme assumption that the firm seeking immunity has enough information to ensure that the cartel members are convicted, i.e. $\rho = 1$. Moreover, to give the firms the strongest possible incentive to apply for leniency, in the following we will assume that a successful applicant will get full immunity, $R = 0$. As a consequence of the unambiguous harm caused to other cartel members, we assume that the rivals lose all trust in the firm and hence that collusion breaks down forever.²⁰ Finally, using the insight from section 3, we allow the private damages liability of the firm seeking immunity to face higher damages than otherwise, $S_L \geq S_i$.

The value function of a cartel member who would seek immunity given an investigation (V_{CLR}) can be written as:

$$V_{CLR} = \alpha [\Pi_N - S_L] + (1 - \alpha)\Pi_C + \alpha \frac{\delta}{1 - \delta} \Pi_N + (1 - \alpha)\delta V_{CNL}$$

²⁰While this assumption is extreme, a deviation of this type where the firm publicly harm its rivals is unambiguous in a way in which deviating by undercutting is not except in the most simple of models.

where the continuation payoff given by the last two terms depends on α since a reversal to the stage-game Nash equilibrium only occurs where the competition authority initiates a case. Solving, we get:

$$V_{CLR} = \frac{\Pi_C}{1 - (1 - \alpha)\delta} - \alpha \frac{\Pi_C - \frac{1}{1-\delta}\Pi_N + S_L}{1 - (1 - \alpha)\delta} \quad (12)$$

Lemma 5 *Assume that there is a leniency programme offering immunity and that private enforcement is possible. Let P_L be the critical combined probability that the cartel is detected and convicted, given by*

$$P_L \equiv \frac{\alpha}{1 - (1 - \alpha)\delta} \frac{\Pi_C - \Pi_N + (1 - \delta) S_L}{\Pi_C - \Pi_N + F + S_i} \quad (13)$$

If $\alpha \cdot \rho < P_L$ an investigation will not trigger an application for immunity.

As with Lemma 4 this result is driven by what happens next if a firm applies for immunity, namely that collusion breaks down forever. This indirect effect is added to the effect that the higher is ρ , the more likely is a future public fine.

Note that if the increased private liability from deviating, S_L , is high enough, $P_L > 1$ and (13) is always satisfied, so even if α goes towards unity where the industry is investigated for sure, a firm will not be seeking public leniency. Since the first term in (13) is less than unity, a necessary but not sufficient condition is that $(1 - \delta) S_L > F + S_i$. This in turns requires S_L to exceed S_i by a non-trivial margin. The discussion in section 3.2.1, especially the expression in equation (5), concerning what an immune firm had to offer the plaintiff in settlement suggests that this may indeed be the case depending on the procedural rules regarding information disclosure. More generally with joint and several liability, the successful leniency applicant does face a greater risk of being the last to be sued and hence facing a larger expected private liability.

Private rather than public revelation will occur if $P_L > P_R$. Comparing (11) and (13), this requires that

$$\frac{\alpha}{1 - (1 - \alpha)\delta} S_L + \frac{1}{\delta} (S_i - S_R) > \frac{(1 - \alpha)}{1 - (1 - \alpha)\delta} (\Pi_C - \Pi_N)$$

A sufficient condition for this is that $\frac{\alpha}{(1-\alpha)} S_L > (\Pi_C - \Pi_N)$ which holds if the damages exceeds the one period cartel harm sufficiently, perhaps due to treble

damages or the probability of investigation is high enough. Thus very generous private damages rules can also undermine the public leniency programme. As the main aim of multiple damages awards is to encourage private actions, one obvious solution would be to reserve any multiplication to stand alone cases.

Finally, we can isolate the effect of a general increase in private damages resulting from the no-contribution rule and the increase resulting from information revelation. In the former case we simply set $S_L = S_i$.

Lemma 6 *The effect of the no-contribution rule arising from its increase of private damages for all defendants is to harm (support) the public leniency programme if $F > (<) \frac{\delta}{1-\delta} (\Pi_C - \Pi_N)$, i.e. if public fines are high (low). The effect of the no-contribution rule arising from information revelation always harms the leniency programme.*

Note that for the first part of the lemma, the comparison is between the one-off gain from seeking leniency (F) and the present discounted loss from doing so as collusion breaks down forever ($\frac{\delta}{1-\delta} (\Pi_C - \Pi_N)$). From the Lemma, a no-contribution rule harms the leniency programme if the public fine is substantial. If not, the higher overall fine through the no-contribution rule may support the public leniency programme. This provides some support for the notion that private enforcement can help public enforcement where the latter is inadequate.

4.4 Strategic deterrence of immunity applications

None of the effect of the no-contribution rule discussed so far are directly targeted at the firm who applies for immunity. However from section 3, particularly the results in sections 3.2.1 and 3.2.2, it is clear that this is a distinct possibility. The aim of this section is to consider the strategic behaviour of firms in order to punish the immune defendant directly. Because there is a significant difference in the private liability of an immune firm between the case where other defendants reveal or do not reveal information, there may be scope for a credible threat. This threat is more serious where it comes from a well informed defendant such as a ringleader and we will focus on this case.

The strategy we want to consider is simple: If anyone applies for immunity, all other defendants go to the plaintiff and settle in return for full information revelation. If not, all pay the full public fine but only face the lower level of private liability. If any defendant provide information to the plaintiff where no one has sought immunity, this is treated as a deviation from the collusive arrangement and dealt with accordingly. To show that this is a feasible strategy, two conditions must be satisfied. One is that no-one applies for immunity, $\alpha \cdot \rho < P_L$. which require that the additional private liability from applying for immunity, S_L , is high enough. The other is that no firm want to reveal information to the plaintiff given that there was no application for immunity, $\alpha\rho < P_R$, which require that the reduction of the private liability, S_R , must be sufficiently large.

From lemma 4 and 5 we know that $\min \{P_R, P_L\} > 0$ and hence such equilibria where a firm is deterred from seeking immunity exist. A cartel member would neither reveal information publicly nor privately.

5 The legal position in the US and UK

Traditionally, in both the US and the UK, members of a price fixing conspiracy have been joint and severally liable for damages and neither country allowed contribution or off-set.²¹ In both countries, there have been more or less radical reforms of this position, but in different directions.²²

The US Antitrust Criminal Penalty Enhancement and Reform Act of 2004 removed joint and several liability from a firm granted immunity under the leniency programme and in addition reduced the liability of that firm to single damages. As Randall (2006) points out, this may have an adverse effect on plaintiffs. By changing the liability rule, the incentives to settle have also changed. In particular the reform has changed the incentive of the defendant with the deepest pockets from never wanting to ask for immunity, to being the keenest to do so. While this

²¹The legal origin of this in the UK and the US is *Merryweather v. Nian* (1799) 8 Term Rep. 186;101 ER 1337.

²²In the 2007 review of Antitrust Litigation, Global Competition Review in questions 33 and 34 inquired about joint and several liability and contribution respectively. The 19 jurisdictions covered in general has joint and several liability, with a few cases of qualifications due to actual cases. Contribution was likewise thought to available in all but one of the 19 jurisdictions, again some with qualifications. The odd one out was the US where the rule is explicitly that there is no contribution.

may increase detection through the leniency programme, it may also mean that the defendant with the deep pocket is not there for the plaintiffs when they need it and hence the plaintiffs may not be fully compensated if the remaining defendants do not have the financial means to meet the total liability. The US has hence with this reform traded off a reduction of fairness to the plaintiffs against maintaining the effectiveness of their leniency programme.

The US Modernization Commission in their April 2007 report²³ recommend that rules regarding contribution are reformed in the future:

“Congress should enact a statute applicable to all antitrust cases involving joint and several liability that would permit non-settling defendants to obtain reduction of the plaintiffs’ claims by the amount of the settlement(s) or the allocated share(s) of liability of the settling defendant(s), whichever is greater. The recommended statute should also allow claims for contribution among non-settling defendants.” (Recommendation 46).

The arguments in the report are mainly based on notions of fairness to the defendants. The impact of the report remains to be seen.

Currently in the UK, defendants in a price-fixing conspiracy are joint and severally liable. The Office of Fair Trading in its discussion paper OFT (2007) suggest various proposals broadly in line with current US practice.²⁴ As regards contribution, the Civil Liability (Contribution) Act 1978 changed matters so that there is generally a right to contribution. No existing cases come close to the scenario described by a price-fixing conspiracy. It is only because the Act is silent on the matter than it is considered that it also covers cases where the liability arises from an agreed illegal act. We cannot then be sure that the court would allow contribution in this case.²⁵ However as pointed out in Mitchell (2003, 13.18), that “where a claimant has acted dishonestly, this will not automatically debar him from bringing a claim under the 1978 Act, but it may well lead the court to treat

²³Antitrust Modernization Commission, Report and Recommendations, April 2007.

²⁴Office of Fair Trading, Private actions in competition law: effective redress for consumers and business, discussion paper April 2007, OFT916, Paragraphs 7.17 - 7.23.

²⁵See also House of Lords decision in Dubai Aluminium Company Limited v. Salaam (Original Respondent and 2nd Cross-Appellant) and Other .

him in an unsympathetic fashion when it comes to consider what would be a ‘just and equitable apportionment between the claimant and a debtor’. Thus even if the court did allow contribution, they are free to set the amount very low, and possibly even at zero.²⁶

6 Conclusion

Focusing on whether or not contribution among multiple antitrust defendants should be feasible, we have shown how the design of the legal system can have quite subtle but substantial effects on the ability of the law to deter cartel behaviour. The no-contribution rule has a number of benefits over the contribution rule. One previously identified in the literature is that the total settlement is higher. This in itself helps deter cartel activity by increasing the penalty on the cartel members if caught. Another effect is that with no-contribution, defendants are willing to settle in return for revealing compromising information. With contribution, anything revealed to the plaintiff which increases the total liability of the cartel will rebound on the defendant revealing information through later demands for contributions. This extra information increases the total liability of the cartel and hence also leads to an increase in deterrence.

Once we have identified a new avenue for leniency, it is natural to wonder how this would interact with public leniency programmes. Concern has been expressed about the adverse effect of private damages on public leniency programmes through increasing the potential liability of each of the cartel members so that cartel members have little incentive to reveal a cartel where there has been no prior investigation. We identify a second concern, namely that the firm seeking public leniency is in particular danger of having to face most of the private damages claims. These can be made larger where a ringleader is able to threaten credibly to reveal all to a private plaintiff. Thus no-contribution rules have potentially more negative effects on public leniency programmes.

In policy terms, it may be the case that joint and several liability and no-contribution is incompatible with a successful public leniency programme. Since

²⁶The latter point is made by Ferris J in *K v P* [1993] Ch 149.

the latter is seen as one of the great antitrust policy success stories, it would appear that if something has to give, it would be either joint and several liability or no-contribution. In the US we have seen that it was the former which was abolished so that the firm obtaining immunity from public fines also was protected from joint and several liability. In the EU it is far from clear whether there is even a perceived need for reform and if so, in what direction it would go. Neither the 2005 EU green paper nor the associated country reports mention contribution as an issue.

Adopting a contribution rule may lead to under-deterrence. We would expect there to be a correlation between the level of harm immediately evident, D , and the fine F . Thus the more authorities underestimate the harm of the cartel, the less likely is the leniency program to work. This arises not just because the fine is set unrealistically low, but more importantly because the subsequent expected private damages absent information revelation would be unrealistically low.

Our analysis rests on a number of simplifying assumptions. One of the more critical assumptions which simplified the analysis considerably is that there is a single plaintiff. We conjecture that the qualitative results would continue to hold if either one plaintiff accounts for the majority of the harm caused or that any information revelation is plaintiff specific and that other plaintiffs can be prevented from acquiring the information. Where private enforcement is possible without consolidating the claims in some way, defendants might be reluctant to provide information to one plaintiff for fear that this information would get disseminated to other plaintiffs with whom they had not yet reached a settlement. In such a case we would still get the higher damages arising from the "whipsaw effect" but not necessarily those associated with information revelation. The existence of several plaintiffs may be due to lack of information among the plaintiffs about each others existence and one might expect that this is a problem more associated with stand alone cases than follow-on actions where the class of those harmed would be more obvious. If information revelation is seen as desirable, making the class as large as possible, possibly by having an opt-out rule rather than an opt-in rule, may be appropriate. This provides yet another example of the importance of consistency across the procedural rules in order to get maximal effects.

Another assumption, made in section 3 is that the plaintiff in the case of asymmetry knows who can benefit its case the most. If what the defendants have to trade against a reduced settlement is information, it may in reality be hard to demonstrate its value without giving it away. Imagine that the plaintiff knows that some defendants know more than others and that in particular there is a ringleader. The plaintiff also knows the identity of the firm who has obtained immunity through the public leniency programme. Consider the following reasoning by the plaintiff. The ringleader cannot be the firm who got immunity. Secondly, the firm who has got immunity is the least useful to settle with. Knowing that a reduction in settlement can substantially be recovered from the last firm to settle, offer the "ringleader" deal to all firms who have not applied for immunity, thereby recovering all the information in time to threaten to sue the immune firm. Compared to the scenario in section 3, this would really hurt any immunity applicant greatly and make such an application less likely.

7 References

- Briggs III, H. C., K. D. Huryn and M. E. McBride, 1996, "Treble Damages and the Incentive to Sue and Settle ", *The RAND Journal of Economics* 27, 770-786.
- Cavanagh, Edward D., 1987, "Contribution, Claim Reduction, and Individual Treble Damage Responsibility: Which Path to Reform of Antitrust Remedies", *Vanderbilt Law Review* 40, 1277-1337
- Cirace, J., 1980, "A game theoretic analysis of contribution and claim reduction in antitrust treble damage suits", *St. John Law Review* 55, 42-62
- DG competition, 2005, "Damages actions for breach of the EC antitrust rules", *Green Paper DG Competition*
- Easterbrook, F.H., W.M. Landes and R.A. Posner, 1980, "Contribution among antitrust defendants: a legal and economic analysis", *Journal of Law and Economics* 23, 331-370.
- Feess, E. and G. Muehlheusser, 2000, "Settling multidefendant lawsuits under incomplete information", *International Review of Law and Economics* 20, 295-313.
- Goetz, C.J., R.S. Higgins and F.S. McChesney, 2006, "More can be better: Contribution and setoffs in antitrust", *The Antitrust Bulletin* 51, 631-660
- Kim, J.-Y., and J. Song, 2007, "Signal Jamming in Pretrial Negotiation with Multiple Defendants, *Journal of Economics* 91, 177-200.
- Klerman, D., 1996, "Settling Multidefendant Lawsuits: The Advantage of Conditional Setoff Rules", *25 Journal of Legal Studies* 445 (1996)
- Kornhauser, Lewis A. and Richard L. Revesz, 1988-89, "Sharing Damages Among Multiple Tortfeasors", *Yale Law Journal* 98, 829-883
- Lande, Robert H. and Joshua P. Davis, 2007, "Benefits From Private Antitrust Enforcement: An Analysis of Forty Cases", Report of the American Antitrust Institute's Private Enforcement Project.
- OFT, 2007, "Private actions in competition law: effective redress for consumers and business", Office of Fair Trading discussion paper OFT916.
- Mitchell, C., 2003, *The Law of Contribution and Reimbursement*, *Oxford University Press*.
- Motta, M., and M. Polo, 2003, "Leniency Programs and Cartel Prosecution", *International Journal of Industrial Organization* 21, 347-379.
- Polinsky, A. Mitchell and Steven Shavell, 1981, "Contribution and Claim Reduction among Antitrust Defendants: An Economic Analysis", *Stanford Law Review* 33,
- Randall, J., (2006), "Does De-Trebling Sacrifice Recoverability of Antitrust Awards", *Yale Journal on Regulation* 23,
- Spagnolo, G., 2006, "Leniency and Whistleblowing in Antitrust", CEPR discussion paper 5794
- Stanley, T.J., 1994, "An analysis of the rules of contribution and no contribution for joint and several liability in conspiracy cases", *Santa Clara Law Review* 35, 1-122.

8 Appendix: Proofs

8.1 Proof of Lemma 1.

Proof. Let S_i be the equilibrium offer in round i . Consider round 2. A defendant can always make a losing offer and pay S_1 . Hence a defendant in round 2 should offer $S_2 = S_1$. Now consider round 3. If the offer in round 3 is not accepted, then with some probability the defendant will settle either in round 2 or round 1. Whatever the probabilities of settlement in each period, since the equilibrium settlement is the same, the expected value of future settlement is the same. Hence the expected value of not settling is $S_2 = S_1$. Thus the offer in round 3 should be $S_3 = S_2 = S_1$. Proceeding by induction, consider round n , with $S_{n-1} = \dots = S_2 = S_1$. If an offer in round n is rejected, whatever the probabilities of settling in each of the $n - 1$ future rounds, the expected value of the future settlement is S_1 . Hence it must be true that $S_n = S_1$ for all n . Consider the last round. As the $N - 1$ other defendants have settled for amounts S_i , the last defendant if taken to court expects damages of $p \cdot \left(D - \sum_{i=2}^N S_i \right)$ to be awarded and hence offers to settle for that amount. Solving $S_1 = p \cdot \left(D - \sum_{i=2}^N S_i \right)$ and $S_i = \bar{S}$ for all $i = 1, \dots, N$ yield the expression in (1).

Since it is possible for the plaintiff to terminate the game in any round by suing one of the remaining defendants, we need to demonstrate that this is never optimal. Suing in round n yields $(N - n) \cdot \bar{S}$ in prior settlement and an expected award of $p \cdot (D - (N - n) \cdot \bar{S})$, while accepting the offer of \bar{S} in each round yields total settlement $N \cdot \bar{S}$. The latter dominates if

$$N \cdot \bar{S} \geq (N - n) \cdot \bar{S} + p \cdot D - p \cdot (N - n) \cdot \bar{S}$$

or

$$\begin{aligned} (1 - p) \cdot n \cdot \bar{S} &\geq p \cdot (D - N \cdot \bar{S}) \\ &= (1 + (N - 1) \cdot p) \cdot \bar{S} - p \cdot N \cdot \bar{S} = (1 - p) \cdot \bar{S} \end{aligned}$$

which is true for $n \geq 0$.

Finally, differentiate the expression for \bar{S} to get $\frac{d\bar{S}}{dN} = \frac{-p^2}{(1+(N-1) \cdot p)^2} \cdot D < 0$ and $N \cdot \bar{S}$ to get $\frac{d(N \cdot \bar{S})}{dN} = \frac{(1-p) \cdot p}{(1+(N-1) \cdot p)^2} \cdot D > 0$. ■

8.2 Proof of Lemma 2

Proof. Assume that $N - 1$ of the defendants have settled for the total amount S . In that case the expected liability of the final defendant, should the case go to court, would be $p \cdot (D - S)$ and hence the plaintiff would not settle for less.

If $p \cdot (D - S) > S / (N - 1)$, the defendant could ask for contributions if sued, but not if it settled for $p \cdot (D - S)$. The total liability of each defendant once they have paid contribution would be $\frac{1}{N} \cdot (S + p \cdot (D - S))$, which is increasing in S and hence in any of the offers made by the $N - 1$ defendants who settle early. Hence the optimal offer from each is 0 and hence $S = 0$, from which follows that the plaintiff sues one defendant to get the expected award $p \cdot D$, which is shared equally between the N defendants.

If $p \cdot (D - S) < S / (N - 1)$, the average offer to settle [the right-hand-side] is higher than the liability for the final defendant. This cannot be an equilibrium since at least one of the first $N - 1$ defendants could lower their offer and be strictly better off. ■

8.3 Proof of Proposition 1

Proof. The total recovery with no-contribution can be written as

$$S \equiv \sum_{i=1}^N S_i = \frac{N}{N - (N - 1) \cdot (1 - p)} \cdot p \cdot D$$

which clearly exceeds the total recovery with contribution, $p \cdot D$ if and only if either $N > 1$, $p < 1$, or both. ■

8.4 Proof of Proposition 2.

Proof. Consider first no-contribution. We need only consider the last two stages. Let D_3 be the remaining liability going in to the last two rounds. Note that D_3 reflects both the settlements up to that point and any increase in liability as a consequence of revealed information. If the settlement in round 2 involves revelation, S_r , then the expected damages in round 1 are $p \cdot (D_3 + \delta - S_r)$. Consider a candidate equilibrium where both offer S_{nr} and neither reveal information. The plaintiff would be indifferent between those two offers and an offer of S_r together

with revelation if

$$S_r + p \cdot (D_3 + \delta - S_r) = S_{nr} + p \cdot (D_3 - S_{nr})$$

or if

$$S_r = S_{nr} - \frac{p}{1-p} \cdot \delta < S_{nr}$$

Hence a defendant would be better off making an offer involving revelation, S_r , in the penultimate round. More generally, assume that $N - n$ of the defendants reveal information and ask if one of the firms who have not yet revealed, defendant j , should. The plaintiff would be indifferent between non-revelation, S_{nr} , and revelation, S_r , if

$$\begin{aligned} & \widehat{S}_{-1,j} + S_r + p \left(D + (N - n + 1) \delta - S_r - \widehat{S}_{-1,j} \right) \\ = & S_{-1,j} + S_{nr} + p \left(D + (N - n) \delta - S_{nr} - S_{-1,j} \right) \end{aligned}$$

where $S_{-1,j}$ is the total offer of all other defendants than j and 1 and $\widehat{S}_{-1,j} > S_{-1,j}$ is the adjusted settlement of those same defendants once one more firm has revealed its private information. Individual settlements are increasing in the amount of information revealed. We can rewrite this as

$$S_r = S_{nr} - \frac{p}{1-p} \delta - \left(\widehat{S}_{-1,j} - S_{-1,j} \right) < S_{nr}$$

Hence all but one defendant will settle in return for information revelation and the total liability for the game becomes $D + (N - 1) \cdot \delta$.

In the case of contribution total expected liability is shared among the defendants. Any discount given to defendant i can be clawed back by a defendant j who has been asked to pay more. If K defendants reveal their information, the expected liability of defendant j who has not yet revealed its information is $\frac{p \cdot (D + K \cdot \delta)}{N}$. If j revealed its information, its expected liability would be $\frac{p \cdot (D + (K+1) \cdot \delta)}{N}$, representing an increase of $\frac{p \cdot \delta}{N}$, its share of the additional liability. Hence no firm has an incentive to reveal information and the equilibrium settlement is then equal to S^C given in (2). ■

8.5 Proof of Proposition 3

Proof. Note that defendant j is always able to offer a better deal to the plaintiff than defendant $j - 1$ because the former can increase the liability of the remaining

defendants by more. The implication of this is that defendant 1 always settle last. The equilibrium is anchored by what happens in the last round. Consider the last two rounds where defendant 1 and one other defendant, i , remain in the game and let D_3 be the remaining liability, that is the total level of provable damages minus any amounts settled for to date. If the plaintiff settles with i , the expected payoff is $S_i + p \cdot (D_3 + \delta_i - S_i)$. If the plaintiff settle with defendant 1 instead, the expected settlement is $S_1 + p \cdot (D_3 + \delta_1 - S_1)$. The lowest offer by i which makes the plaintiff indifferent between the two offers is then given by

$$S_i + p \cdot (D_3 + \delta_i - S_i) = S_1 + p \cdot (D_3 + \delta_1 - S_1)$$

which can be rewritten as

$$S_i = S_1 - \frac{p}{1-p} \cdot (\delta_i - \delta_1) \quad (14)$$

and further rewritten as (4). It is obvious from both (4) and (14) that the size of the settlement is increasing through the rounds. Recall that defendant 1 will at most offer a settlement equal to the expected damages awarded, i.e.

$$S_1 = p \cdot \left(D + \sum_{i=2}^N (\delta_i - S_i) \right)$$

Using (14) and solving we get

$$S_1 = \frac{p}{1 + (N-1) \cdot p} \cdot D + \frac{1}{1-p} \cdot \frac{\sum_{i=2}^N \delta_i - p \cdot (N-1) \cdot \delta_1}{1 + (N-1) \cdot p}$$

An implicit assumption is that there is no corner solution so that $S_N > 0$, which requires

$$S_N = \frac{p}{1 + (N-1) \cdot p} \cdot D + \frac{1}{1-p} \cdot \frac{\sum_{i=1}^N \delta_i - p \cdot N \cdot \delta_1}{1 + (N-1) \cdot p} - \frac{p}{1-p} \cdot (\delta_N - \delta_1) > 0$$

This can be rewritten as

$$(1-p)p \cdot (D - \delta_N) + \sum_{i=1}^N \delta_i - p^2 \cdot N \cdot \delta_N + (1-p) \cdot \delta_1 > 0$$

which holds if δ_N is not too large relative to D and δ_i or if p is not too close to 1.

■

8.6 Proof of lemma 3

Proof. Comparing (6) and (8), collusion is more profitable than no collusion if.

$$\frac{\Pi_N}{1-\delta} < \frac{\Pi_C}{1-\delta} - \alpha\rho \frac{\Pi_C - \Pi_N + F + S_i}{1-\delta}$$

solving with equality we get (9) and $\alpha \cdot \rho < P_C$. Finally, from (9) $\frac{\partial P_C}{\partial F} = \frac{\partial P_C}{\partial S_i} < 0$.

■

8.7 Proof of lemma 4

Proof. The firm does not reveal information if the expected profit of colluding without revelation, given in (8) is greater than the expected profits given by (10), i.e. if $V_R < V_{CNL}$. This is true if

$$\frac{\Pi_C}{1 - (1 - \alpha\rho)\delta} - \alpha\rho \frac{\Pi_C - \frac{1}{1-\delta}\Pi_N + F + S_R}{1 - (1 - \alpha\rho)\delta} < \frac{\Pi_C}{1 - \delta} - \alpha\rho \frac{\Pi_C - \Pi_N + F + S_i}{1 - \delta}$$

from which we get,

$$-\alpha\rho \frac{-\frac{1}{1-\delta}\Pi_N + F + S_R}{1 - (1 - \alpha\rho)\delta} < \frac{\alpha\rho(1 - \alpha\rho)\delta\Pi_C}{(1 - (1 - \alpha\rho)\delta)(1 - \delta)} - \alpha\rho \frac{-\Pi_N + F + S_i}{1 - \delta}$$

since we will not allow $\alpha\rho = 0$, solving with equality gives (11) and revelation is not profitable if $\alpha\rho < P_R$. ■

8.8 Proof of lemma 5

Proof. Collusion without applying for leniency (8) is more profitable than collusion and applying for immunity (12) if $V_{CLR} < V_{CNL}$ which imply that

$$\frac{\Pi_C}{1 - (1 - \alpha)\delta} - \alpha \frac{\Pi_C - \frac{1}{1-\delta}\Pi_N + S_L}{1 - (1 - \alpha)\delta} < \frac{\Pi_C}{1 - \delta} - \alpha\rho \frac{\Pi_C - \Pi_N + F + S_i}{1 - \delta}$$

which we can write as

$$\alpha \cdot \rho < \frac{\alpha}{1 - (1 - \alpha)\delta} \frac{\Pi_C - \Pi_N + (1 - \delta)S_L}{\Pi_C - \Pi_N + F + S_i} \equiv P_L$$

Hence for $\alpha \cdot \rho > P_L$ a firm would apply for immunity even if the private liability would be higher than S_i . ■

8.9 Proof of lemma 6

Part two follow from direct inspection of (13) that P_L increases with S_L . For the first part, set $S_L = S_i$ in (13) and differentiate to get

$$\frac{\partial P_L}{\partial S_i} = \frac{\alpha}{1 - (1 - \alpha)\delta} \frac{(1 - \delta) F - \delta (\Pi_C - \Pi_N)}{(\Pi_C - \Pi_N + F + S_i)^2}$$

where

$$\frac{\partial P_L}{\partial S_i} > (<) 0 \quad \text{if} \quad F > (<) \frac{\delta}{1 - \delta} (\Pi_C - \Pi_N)$$