ADVERSE EFFECTS OF CORPORATE LENIENCY PROGRAMS IN VIEW OF INDUSTRY ASYMMETRY

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Abstract
This paper studies the effects, leniency programs have on cartel stability and the subsequent abuse of market power. A game-theoretical model, which allows for asymmetry and retaliation, is employed to analyze this problem. We find that a leniency program does not always lead to a breach of trust; in certain industries leniency programs are unable to break collusion. Moreover, they may have the adverse effect in the sense that they strengthen cartel stability or lead to abuse of market power. A relatively large firm can use coercion to remove the option to a smaller firm to self-report. In industries characterized by a certain degree of asymmetry in market shares and high exit costs this is an even more likely scenario. In view of this limitation, policies aimed at the removal of the threat of retaliation need to be considered. This paper’s emphasis is placed on leniency programs for cartels, but the line of reasoning may also be extended to corporate whistle-blowing programs.

Keywords: antitrust policy, antitrust law, self-reporting, leniency programs

JEL Classification: K21, L41

1. Introduction
Leniency programs form a relatively new feature of antitrust law enforcement. Its main objective is to remove trust between cartel members. Trust is an essential element of every conspiracy. A similar approach is successfully employed in the prosecution of the mafia (the so called “witness protection program”). In practice, contact is established between a member of a conspiracy and the justice department with a proposition to serve as a witness against its co-conspirators. As a reward the witness receives (partial) amnesty from its own misconduct and protection from punishment by the other members of the (former) crime syndicate. In the ‘80’s and ‘90’s of the previous century the witness protection program proved to be a great success. Even though the trust between (family) members of the mafia was relatively strong the program enabled the successful conviction of a great number of criminals. No wonder a similar approach was adopted by the antitrust authorities in the fight against organized infringements of competition law. This paper examines the consequences of the introduction and use of leniency programs in their attempt to remove trust between cartel members. The emphasis of this paper is on leniency programs for cartels and the prosecution of price-fixing agreements. The reasoning can, however, also be applied to corporate whistle blowing programs and witness protection programs.

Several economists have previously expressed their doubts as to the success of leniency program’s application in this new industrial setting. This literature is reviewed in Spagnolo (2008) and includes such contributions like Buccorossi and Spagnolo (2006) or Ellis and Wilson (2001). The main intuition they provide in order to explain the existence of counterproductive effects of leniency programs is that in the framework of repeated interactions leniency may increase the firms’ ability to punish deviations (e.g. threatening to report to the antitrust authority after cheating occurs), thereby stabilizing the cartel agreements by reducing gains from defecting. In this way leniency can reduce the incentives to cheat and make cartels more stable. The current paper adds to these considerations by addressing another issue that has been underestimated in the design of leniency programs. An important element of the witness protection program, which is missing in the design of leniency programs for cartels, is to safeguard the witness from punishment by its former partners in crime. We show that, using the realistic assumption of industry asymmetry, the current design of leniency programs can’t prevent larger firms from using a threat of punishment as a means of coercion, effectively not allowing smaller firms to appeal for leniency. When the antitrust authority is unable to credibly protect leniency applicants from retaliation by convicted cartel members the program is abused by cartels. It actually serves to strengthen trust between its members. The program may have the adverse effect in the sense that it may facilitate cartel stability.
It should be stressed that any type of leniency program should contain the following crucial elements. Firstly, the criminal should provide sufficient evidence on the misconduct by its former partners to the authorities. Secondly, the criminal acts as a witness and receives a, previously agreed to, lenient treatment with regard to the criminal’s punishment. This ranges from a reduction to a fine to clemency from a prison sentence and can even entail a reward (see e.g. Kovacic 2006). A discretionary approach ensures the incentive is set according to the constraint faced by the proposed witness and no resources are wasted. Thirdly, the witness is protected from punishment by its former co-conspirators. When all policy parameters of these elements are customized to fit the typical case, the proposed witness accepts the offer, the crime syndicate is terminated, its members are convicted, no resources are wasted and, perhaps most importantly, an example is set for those firms or individuals considering the prospect to conspire.

Leniency programs for cartels differ from witness protection programs in two main aspects, first of all the protection aspect and secondly the fact that leniency programs are less customized. Both parts of the policy instrument have, however, proven to be detrimental to its success. In its new design and new environment these parameters have unfortunately remained underexposed. It can be shown that, unless the necessity to protect the reporter from punishment is acknowledged by the authorities, cartels may strengthen their ties by means of the leniency program. Customization of the program with respect to the size of the fine and protection after self-reporting can partially overcome this deficiency in the program. More generally, the leniency program will always need to be accompanied by the traditional law enforcement efforts of the competition authority.

A typical punishment strategy a firm might consider employing involves dumping or aggressive pricing. Not only can a “larger” (more efficient) firm usually establish lower marginal costs, the market share asymmetry also enables such a firm to establish a larger buffer than the smaller firm. When the larger firm employs its aggressive punishment strategy both firms incur losses. These eat away at both firms’ buffers. Since the larger firm’s buffer is generally greater it will be able to sustain these losses for a longer period of time. Employing aggressive strategy for a sufficient period of time will eventually push the smaller firm into bankruptcy. This set-up resembles the “long-purse story” explanation of predatory pricing (see e.g. Stigler 1964 or Tirole 1988).

The next point we want to address is the role of asymmetry for cartel stability. The bigger part of the literature on leniency programs uses undiversified companies and industry symmetry as a starting point. The main reason behind this is the general perception that asymmetry reduces cartel strength. Leading textbooks such as Tirole (1988) state that, based on work by e.g. Chamberlin (1929) and Stigler (1964), the coordination towards a focal price under differentiated costs and products is more difficult. Motta and Polo (2003) argue that asymmetries between large and small firms represent an obstacle for industry wide collusion. In reality firms are rarely truly symmetrical in their cost functions, products or market presence. Asymmetry is the rule rather than the exception. Symmetry would imply that all colluding firms apply for leniency at the same time. This is rarely the case. In general though symmetry increases the incentive to collude, but this scenario is not realistic and the introduction of a leniency program by an antitrust authority might change the incentives for firms. Asymmetry among firms in products, markets and cost functions is the subject of this paper. We model asymmetry by considering firms that have different market shares due to e.g. historic reasons.

The fact that a cartel can be stable under asymmetrical conditions was recently proved by the EU Competition Directorate General that uncovered a beer cartel in Holland and (parts of) Belgium in which small players coexisted with larger firms (see EC decision 2007, reference IP/07/509). An illustration of coercion maintained by the threat of retaliation can be found in the leniency application of British Petrol (BP) in the Bitumen Cartel (see EC decision 2006, reference MEMO/06/324). During its existence the colluders managed to increase trust between the cartel’s members by designing a collective punishment strategy. Each time a cartel member violated the cartel’s agreements the other members agreed to punish the perpetrator. The cartel managed to create a threat of retaliation by joining forces, using an asymmetry of power, sustained by formal trust.

The literature on analysis of self-reporting schemes in antitrust starts with the paper by Motta and Polo (2003). They study a two-stage game in which the AA first chooses once and for all its antitrust policy followed by the competition phase in which the firms compete with each other, which is modelled as an infinitely-repeated oligopoly game. The cartel adopts grim-trigger strategies in which cheating on the cartel by either setting a different price or applying for leniency triggers competitive
behaviour forever, while the cartel continues collusion as usual each time it is caught by the AA. Under the optimal antitrust policy, introduction of ex-post leniency programs will increase the chance of the cartel being captured, but ex-ante leniency programs that grant reduced fines are ineffective. As later shown in Spagnolo (2004) and Rey (2003), effective ex-ante leniency programs require substantial rewards. This is also recommended in Kovacic (2006).

Spagnolo (2004) concludes that courageous leniency programs are closest to the optimal. He uses a game theoretical model to relate a first best “courageous” leniency scheme and a “moderate” leniency scheme to a benchmark case of traditional law enforcement. The courageous program is one in which the reporting party is actually rewarded with a part of the fine paid by the other parties besides receiving amnesty. In this way a first best solution is established according to Spagnolo.

The above arguments are closely related to the more general analysis of the optimal structure and design of leniency programs that has been extensively discussed in the literature. See, for example, Rey (2003), Hinloopen (2003), Feess and Walzl (2004), Motchenkova (2004), Buccorosi and Spagnolo (2006), Spagnolo (2008), Harrington and Chen (2007), Chen and Rey (2007), Harrington (2008), and Houba et al. (2009). The question of optimal design of leniency programs has two main debatable components. They are the number of fine reductions and the size of fine reductions. The research normally comes to the conclusion that the currently applied moderate leniency program could be made more effective by limiting a fine reduction to the first firm to report. Adding more than one possibility to a fine reduction reduces the deterring effect of the scheme. Most of the analysis also concludes that the first self-reporter should be fully exempted from the fine.

The current paper analyzes the effects of leniency programs on the survival of cartels formed by firms of different size (i.e. different market shares). We analyze a setup where the bigger firm can threaten to force the smaller firm to exit the market by employing aggressive strategy in case the smaller firm self-reports. The innovative aspect of the paper relates to considering how cartel members can react to the introduction of leniency programs in order to preserve the continuation of collusion. The punishment strategy for self-reporters is intended to counterbalance the incentives to reveal information to the antitrust authority. We find that a leniency program does not always lead to a breach of trust; in certain industries leniency programs are unable to break collusion. Moreover, they may have the adverse effect in the sense that they strengthen cartel stability or lead to abuse of market power. A relatively large firm can use coercion to remove the option to a smaller firm to self-report. In view of this limitation, policies aimed at the removal of the threat of retaliation need to be considered.

The structure of the paper is as follows. Section 2 contains a formal description of the model. In Section 3, we solve the model and find sub-game perfect equilibriums of the game. Finally, in Section 4 the policy implications are discussed and the analysis is concluded. In the appendix a comparative analysis of the approach to leniency programs used in the United States and in several European countries is provided.

2. The Model (Formal Analysis)

We consider two asymmetric firms, which may form a cartel, taking into account the enforcement activity of the antitrust authority. The asymmetry is related only to the size of the firms or their market shares, while it is assumed that firms have identical marginal costs. The antitrust authority commits to a certain enforcement policy, which uses leniency programs. Leniency programs grant either complete or partial exemption from fines to the firms, which reveal the existence of a cartel to the antitrust authority and come up with sufficient evidence. The main innovation of this model is that we consider firms that have different market shares. This implies different accumulated profits during the period of collusive pricing. Hence, unless the antitrust authority (AA) is able to remove any asymmetry in the accumulated profits (buffer) of each individual member of cartel, some “bigger” members enjoy a strategic advantage. A firm with a relatively large buffer will be able to employ the difference in buffer size as a means of coercion, such as the threat of punishment though aggressive pricing in case the rival deviates from cartel agreement by self-reporting. Essentially, $K$ denotes the costs of aggressive behaviour (through e.g. setting price below marginal costs for some periods) for the bigger firm. These costs are high when firms are more symmetric and, vise versa, these costs are low when asymmetries are high.

1 In this paper we adopt the legal definition of aggressive (predatory) pricing, which is characterized as setting price below the marginal cost.
The credibility and impact of this type of pricing strategy depends on the asymmetry in size between firms, such as the difference in market shares. Market shares are denoted by $\beta$ for “bigger” firm and by $1-\beta$ for “small” firm, with $\beta > 1-\beta$ and $0 < \beta < 1$.

First, we describe the policy choices of the antitrust authority. Second, we describe the timing of the game. And, finally, we specify the firms’ strategies.

**Enforcement policy:** The main goal of the antitrust authority is to prevent the formation of cartels in the first place. However, if the cartel has already been formed, the antitrust authority aims to break the trust at the lowest possible cost. Here, following the reasoning in Section 1, we restrict the number of fine reductions in case of multiple applications for leniency to one. Only the first reporter gets complete exemption from the fine. This, as explained above, reduces trust among cartel members. This set-up is also motivated by the fact that the structure of leniency programs employed in US allows only for one fine reduction. Moreover, the US scheme also has a longer history than its European counterpart and has proven to be more successful. Following Becker (1968), we distinguish two main parameters of enforcement policy: penalty and probability of detection. Hence, the antitrust policy in the presence of leniency programs can be described by the following parameters:

- The full fines $F=ax$, which are proportional to illegal gains for firms that were proven guilty and have not cooperated with the antitrust authority, or are not the first to come forward with information about cartel.
- The reduced fine $f$ specified by the US leniency program is equal to zero. This set-up allows for the strictest adherence to the leniency rules;

**Demand:** The probability of law enforcement by the antitrust authority equals $p \in (0, 1]$. This variable can be thought of as an instantaneous probability that the firm is checked by antitrust authority and found guilty. Contrary to Motta and Polo (2003), we assume that whenever the antitrust authority checks the guilty firm, the violation is successfully discovered. Moreover, we assume that $p$ is determined by e.g. an exogenous budget of the antitrust authority financed by the government that can be used to promote enforcement, so that $p$ reflects the costs of efforts of antitrust authority put into law enforcement activities.

**Timing of the game:** Two asymmetrical firms play the two stage game in the presence of antitrust enforcement which incorporates leniency programs.

At time $t=0$ the antitrust authority sets parameters of the enforcement policy: $F=ax$ and $p$ and parameters of the leniency program (which allows for only one fine reduction and reduced fine $f$ equals 0). So, self-reporting becomes an attractive option at this stage. Prior to this stage $t<0$ firms may decide to form a collusive agreement. As conventional analysis of super-games (see Tirole 1988) implies, in the absence of the antitrust enforcement, collusion can arise in equilibrium only when the discount factor is large enough, namely, $\delta \geq \beta = \delta_s$. So, for further analysis we will direct our attention to the values of the discount factor $\delta \geq \delta_s$, which ensures that cartels are stable in the absence of antitrust enforcement and, hence, the first stage of the “revelation-retaliation” game is reached.

Next, the game between the two asymmetrical firms is played. At time $t=1$ (stage 1 of the game) the small firm moves. It can choose between two actions: self-report or keep cartel secret.

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2 See historical overview and overview of structures of leniency programs in Appendix.

3 The motivation for this type of structure and example of application of proportional penalty schemes in competition law enforcement was studied in Motchenkova and Kort (2006).

4 See also Appendix.

5 In the absence of any antitrust enforcement, i.e. when neither fines nor rate of law enforcement can be used, collusion can be sustained only when the short run gain from an unilateral deviation from collusive agreement by undercutting in prices together with competitive profits thereafter is smaller than the payoff from sustaining collusive strategy forever: $\beta \pi_m(1-\delta) > \pi_m + \delta \pi_m (1-\delta)$ for $i=1,2$. Hence, with competitive profits $\pi_m$ normalized to 0, we have $\delta \geq 1-\beta$ for “bigger” firm and $\delta \geq \beta$ for “small” firm. The second constraint is binding since $\beta > 1-\beta$. Hence, we have $\delta_s = \beta$.

6 We assume here that incentives for the bigger firm to keep the cartel secret are always higher since it gets higher expected gains from continuation. So, the big firm would either need stronger incentives or will self-report only later in time than the small firm.
Further, at time \( t=2 \) (stage 2 of the game) the big firm responds to the action of the small by choosing whether to punish the small firm for reporting the cartel or to abstain from punishment.

Note that the antitrust authority does not take an active part in the game. It only sets policy parameters, \( F, f, p, \alpha \), and the rules of leniency programs. This complies with the current “one size fits all” setting of the antitrust policy parameters.

Payoffs of both players in each of the four possible cases are described in the following subsection. Each time we refer with “Small” to the smaller firm and with “Big” to the other player.

**Strategies and Payoffs:**

1. Small has decided to report and Big responds by setting a predatory price: Big receives its current share \( \beta \pi_m \) of collusive profits and the monopoly profits forever after (i.e. \( \pi_m(\delta(1-\delta)) \)). But it has to overcome a loss of size \( K \) (due to aggressive pricing) and a one time fine of size \( \alpha p \delta \pi_m \) and there is the risk of a fine when setting a predatory price of \( p \delta \pi_m(\delta(1-\delta)) \). The latter is the net present value of the expected fine Big might have to pay, because of the abuse of its dominant position. Small receives its current share \( (1-\beta)\pi_m \) but loses an amount of \( S \) (exit cost), since it has to leave the market. Small cooperated with the antitrust authority, so it is exempted from a fine.

2. Small has decided to self-report and Big decides not to retaliate and simply moves to marginal costs pricing (competitive equilibrium): Big receives its current share of collusive profits \( \beta \pi_m \) and is fined \( \alpha p \beta \pi_m \). Small receives its current share \( (1-\beta)\pi_m \), but doesn’t make any economic profit forever after. Since it reported to the antitrust authority it isn’t fined.

3. Small has decided not to report and Big is inclined to use aggressive strategy. This means that aggressive pricing was attractive strategy already before the antitrust enforcement and leniency programs were introduced (\( t=0 \)). We will rule out this possibility later on when we discuss the solution of the game (it just imposes additional constraint on discount factor (\( \delta \leq \delta^{**} \), see section below). In this case Big receives its current share of monopoly profits \( \beta \pi_m \) less a loss due to the aggressive pricing (\( K \)), but after small leaves it will receive the entire (discounted) monopoly profit forever after \( \pi_m(\delta(1-\delta)) \), though it also faces a risk of detection during the transition stage over its share of profits \( p \delta \beta \pi_m \) and there is the chance of a fine in every period thereafter, which results in \( p \delta \pi_m(\delta(1-\delta)) \). Small receives its current share \( (1-\beta)\pi_m \) but loses its exit cost \( S \). Since the firm is bankrupt the authorities cannot levy a fine on the firm for its misconduct.

4. Small has decided not to report and Big is inclined to continue the collusive price setting: Big receives its share of collusive profits forever \( \beta \pi_m(1/(1-\delta)) \), but faces the risk of being fined in every period there after. This results in \( p \delta \beta \pi_m(1/(1-\delta)) \). Similarly, Small receives its current share forever \( (1-\beta)\pi_m(1/(1-\delta)) \) but faces the risk of prosecution in every period after \( p \delta \pi_m(1/(1-\delta)) \).

It should be stressed that for any \( t > 2 \), decisions of both players do not change, and payoffs obtained at \( t=2 \) will be discounted. This is due to the fact that the coefficient of the proportional penalty and the rate of law enforcement are fixed and, hence, the environment does not change. Moreover, we assume that in case of self-reporting trust is broken and firms do not go back to collusion ever again. Therefore, outcomes (1) and (2) are stable by assumption.

We summarize the above description of the game as follows:

**Stage 0**: The Antitrust Authority announces the parameters of the penalty scheme: \( p \) and \( F \), and the parameters of leniency program: \( \delta = 0 \) and the number of fine reductions.

**Stage 1**: The smaller firm decide whether to reveal information about the existence of the cartel to the antitrust authority or not (once and for all decision).

**Stage 2**: The bigger firm observes the decision of the smaller firm and decides whether to punish it for self-reporting or not (once and for all decision).

If no self-reporting is chosen by the smaller firm and the bigger firm decides to continue collusion, then the repeated game, between authority and firms, where authority can discover violation with probability \( p \) in each period, is played till infinity (under assumption that even in case violation is discovered by antitrust authority, firms go back to collusion).\(^7\)

The discount factor is denoted by \( \delta = 1/(1+r) \), where \( r \) is the interest rate. The game tree and players’ payoffs are summarized in Figure 1.

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\(^7\) We assume here that in case one of the firms self-reported, trust will be broken forever and firms will not go back to collusion anymore.

\(^8\) Similar assumption is employed in Motta and Polo (2003).
We now proceed to establish the sub-game perfect equilibriums of the two-stage repeated game, which is described in Figure 1, played by both firms once the policy parameters are set.

3. Solution of the Game

To find the sub-game perfect equilibriums of the game we employ backward induction. First we consider the decision of the bigger firm which is taken in Stage 2, and next the decision of the smaller firm which is taken in Stage 1. Three different parts of the game in Figure 1 can be distinguished as sub-games. First, Small has a choice whether to report or not. It will base its decision on the reaction to its choice it expects from the bigger player. Therefore Big faces two possibilities. If Small has reported their common illegal conduct, Big has to decide whether to retaliate or not. In case of no retaliation, Big sets its price equal to marginal or variable costs so that small is “punished” for reporting to the antitrust authority, but keeps operating. In case of retaliation Small firm is driven out of the market. If Small decides not to report, Big faces the same decision. Clearly Small’s initial action depends on the Big’s reaction. Since it knows Big’s position and is aware of the value of all other parameters (e.g. law enforcement and discount value) it will choose to play accordingly.

3.1. Collusion is the preferred strategy before leniency is introduced

We start by considering the choice of the bigger firm between retaliation and collusion (i.e. by comparing outcomes (3) and (4) described in previous section). Note that if outcome (4) is preferred over outcome (3) by the bigger firm, collusion is also the preferred strategy before leniency is introduced (under traditional antitrust enforcement). This happens when \( \beta \pi_m(1/(1-\delta))-p\alpha\beta \pi_m(1/(1-\delta)) > \beta \pi_m-\pi_m(\delta/(1-\delta))-p\alpha\beta \pi_m-\pi_m(\delta/(1-\delta)) \). This inequality implies that retaliation is more attractive than collusion for the bigger firm in both situations (with or without the availability of a leniency program) when the discount factor is greater than the following threshold:

\[
\delta > \frac{K}{K + \pi_m(1-\beta)(1-p\alpha)} = \delta^{**}(K, p, \alpha).
\]

So, for any values of the discount rate above the threshold \( \delta^{**} \), there is no collusion before the leniency program is introduced and the game doesn’t apply. In the remainder of this paper all values of the discount rate over threshold \( \delta^{**} \) are regarded as values for the parameter \( \delta \), in which equilibrium (3)
(no self-reporting, retaliation) arises. This equilibrium isn’t of any interest to answering the questions posed above and will therefore be left out of the analysis.

Expression (1) gives us the first incentive compatibility constraint. It is represented in Figures 2 and 3 by the line \( \delta^{**} \), which plots \( \delta(K) \) as a function of \( K \) in the \((\delta,K)\) plane. In addition, as discussed above, comparative statics of the behaviour of \( \delta^{**}(K,p,\alpha) \) with respect to the main parameters of the model shows that

\[
\frac{\partial \delta^{*}(K,p,\alpha)}{\partial K} > 0 \quad \text{if} \quad p\alpha < 1, \quad \frac{\partial \delta^{*}(K,p,\alpha)}{\partial K} < 0 \quad \text{if} \quad p\alpha > 1, \quad \frac{\partial \delta^{*}(K,p,\alpha)}{\partial p} > 0, \quad \frac{\partial \delta^{*}(K,p,\alpha)}{\partial \alpha} > 0. \tag{2}
\]

These inequalities show that the likelihood of collusion is increased further and predation is less likely when higher values of \( p \) and \( \alpha \) apply before the introduction of the leniency program. The first derivatives of \( \delta^{**} \) with respect to \( K \), \( p \) and \( \alpha \) are positive when \( p\alpha < 1 \) (i.e. in the setting with low expected penalty). Meaning that raising either of these parameters will increase the height of this threshold, thus increasing the likelihood of the situation in which collusion is sustainable. Intuitively this makes sense, since retaliation is also illegal and increasing \( K \) implies more symmetry. This complies with general theory on collusion and symmetry (see Motta and Polo 2003).

Finally, in order to ensure consistent behaviour (meaning that collusion is sustainable and there are no incentives to retaliate in the absence of the possibility of self-reporting and subsequent clemency) we will consider only interval \( \delta_{c} < \delta < \delta^{**} \), so that outcome (3) is ruled out and collusion is sustainable before the revelation game starts.

Recall from Section 2 (footnote 5) that \( \delta = \beta \). Taking into account (1), this implies that interval \([\delta_{c}, \delta^{**}]\) is not empty when \( \delta^{**} > \beta \), i.e. when \( K > \pi_{m}\beta(1-p\alpha) \) with \( p\alpha < 1 \) or when \( K > (\pi_{m}\beta(1-p\alpha)) \) with \( p\alpha > 1 \). This implies that the issue we are considering becomes especially sharp in industries characterized by relatively low asymmetry (i.e. where \( K \) is high).

**3.2. Determination of other thresholds for equilibrium intervals**

Big’s choice between aggressive strategy and simple competitive strategy is based on a comparison of the outcomes (1) and (2). The outcome (2) in the model is the situation in which strategies (report, not retaliate) are used by the smaller firm and the bigger firm respectively. Outcome (1) in the model is the situation in which strategies (report, retaliate) are used. Big is not inclined to retaliate in case of reporting by Small when Big considers its payoff in equilibrium (2) to be higher than its payoff in equilibrium (1). The condition for equilibrium (report, not retaliate) to arise holds when the following inequality is satisfied: \( \beta(\pi_{m}-\alpha\beta\pi_{m}) > \beta\pi_{m}-K+\pi_{m}\delta(1-\delta) - \alpha\beta\pi_{m}-\alpha\pi_{m}\delta(1-\delta) \). This inequality implies that competitive pricing is more attractive for the bigger firm than retaliation after the smaller firm applied for leniency if the discount factor is less than the following threshold:

\[
\delta < \frac{K}{K + \pi_{m}(1 - p\alpha)} = \delta^{*}(K,p,\alpha). \tag{3}
\]

Differentiating this expression with respect to \( K \) implies that

\[
\frac{\partial \delta^{*}(K,p,\alpha)}{\partial K} > 0 \quad \text{if} \quad p\alpha < 1. \tag{4}
\]

This implies that when \( p\alpha < 1 \) (i.e. expected penalty is low) the equilibrium (2) is less likely to occur the smaller the size of \( K \). Recall that \( K \) is the size of the buffer of Small, since it equals the cost of e.g. driving the smaller firm out of the market. After Small loses its buffer it can’t sustain the losses associated with the aggressive behaviour by Big. Intuitively this means that the greater the size difference (asymmetry), the lower \( K \) and therefore threshold \( \delta^{*} \) will be lower when asymmetry is greater. It also implies that raising the risk of being fined will increase \( \delta^{*} \). Intuitively it means that the smaller the asymmetry and the higher the chance of detection and substantial fine, the more likely the perceived discount rate is below the threshold \( \delta^{*} \).
Next, we move to Stage 1 and consider the decision of the smaller firm given no retaliation is chosen by Big in the second stage of the game. Outcome (2) is preferred over outcome (4) by Small if the following inequality is satisfied: 

\[(1-\beta)\pi_m > (1-\delta)\pi_m/(1-\delta) - p\alpha(1-\beta)\pi_m/(1-\delta).\]

This inequality implies that self-reporting is more attractive for Small when the discount factor is lower than the following threshold:

\[\delta < p\alpha = \delta^{***}(K, p, \alpha).\] (5)

This is a clear indication that raising the probability of detection and the proportional fine will make the smaller firm to choose equilibrium (2) over the payoff from equilibrium (4), and will therefore decide to self-report instead of continuing to collude.

Finally, we also have to compare the payoffs for Small in case outcome (1) arises and in case outcome (4) arises. Equilibrium (1) in the model is the situation in which strategies \((\text{report, retaliate})\) are employed by the smaller firm and the bigger firm respectively. Equilibrium (4) in the model is the situation in which strategies \((\text{not report, not retaliate})\) are used. Now the smaller player is confronted with a choice between being predated on by Big (and the associated exit cost) or going along with Big in the collusive price setting. The latter implies that Small prefers to choose a strategy leading to the collusive price setting over a strategy leading to bankruptcy. This occurs when the payoff of equilibrium (4) is higher than the payoff in equilibrium (1) for Small. I.e. the following inequality is satisfied: \((1-\beta)\pi_m(1/(1-\delta))-p\alpha(1-\beta)\pi_m(1/(1-\delta)) > (1-\beta)\pi_m - S\). This inequality implies that collusion is more attractive for the small firm if discount factor is determined by the following inequalities:

\[\delta > \frac{p\alpha\pi_m(1-\beta)-S}{\pi_m(1-\beta)-S} = \delta^{****}(K, p, \alpha), \quad \text{when } S < \pi_m(1-\beta)\] (6)

\[\delta < \frac{S - p\alpha\pi_m(1-\beta)}{S - \pi_m(1-\beta)} = \delta^{***}(K, p, \alpha), \quad \text{when } S > \pi_m(1-\beta)\] (7)

Closer analysis of expressions (6), (7) and (5) shows the following regularities:

\[\delta^{****} > \delta^{***} \text{ when } p\alpha > 1 \text{ and } (1-\beta)\pi_m > S, \text{ or when } p\alpha < 1 \text{ and } S \geq (1-\beta)\pi_m.\] In this case we have also that \(\delta^{****} > 1\).

\[\delta^{****} < \delta^{***} \text{ when } p\alpha > 1 \text{ and } S \geq (1-\beta)\pi_m, \text{ or when } p\alpha < 1 \text{ and } (1-\beta)\pi_m > S.\] In this case we have also that \(\delta^{****} < 1\).

3.3. Derivation of Equilibrium Solutions

Next, once we have determined all the thresholds in terms of the discount factor, we can move to the description of equilibrium outcomes for each possible combination of the parameter values.

Firstly, two cases need to be distinguished: when \(p\alpha > 1\) and when \(p\alpha < 1\). Inequality \(p\alpha > 1\) corresponds to the case when the expected penalty is already high enough to prevent any misconduct (in a static setting) in the absence of leniency programs. The other inequality corresponds to the situation when traditional antitrust enforcement is not strong enough.

We start our analysis with the discussion of a sufficiently high penalty (the case where \(p\alpha > 1\)). In this setting two sub-cases depending on the size of \(\delta^{****}(K, S, p, \alpha)\) and on the size of exit costs can arise. When \(p\alpha > 1\) and \((1-\beta)\pi_m > S\), we obtain that \(\delta^{****} > 1\), and the distribution of outcomes can be described as is done in the left hand side of Figure 2. When \(p\alpha > 1\) and \((1-\beta)\pi_m < S\), we obtain that \(\delta^{****} < 1\). Hence, the distribution of outcomes is given by the right hand side of Figure 2.
Figure 2 presents the locuses $\delta^*$, $\delta^{**}$, $\delta^{***}$, and $\delta^{****}$ (derived in previous subsection and given by (3), (1), (5), and (6) respectively) in $(K,\delta)$-space. The left panel of Figure 2 implies that, in industries with low exit costs and relatively strong antitrust enforcement, depending on the degree of asymmetry the following three outcomes can arise. When there is high asymmetry ($K < |\pi_m\beta(1-p\alpha)|$), outcome (3) will arise in equilibrium. This means that in this industry retaliation is the most attractive strategy even before a leniency program is introduced. With an intermediate degree of asymmetry (i.e. $|\pi_m\beta(1-p\alpha)| < K < |\pi_m(1-p\alpha)|$), outcome (1) arises in equilibrium. In this case Big (strong) firm will choose to retaliate on a smaller firm after the latter chooses to self-report. This is the outcome the antitrust authority wants to avoid. In these types of industries a greater emphasis needs to be put on the protection part of a leniency program. Perhaps through stricter monitoring after a firm reported to the AA. Finally, when there are low asymmetries (i.e. $K > |\pi_m(1-p\alpha)|$), outcome (2) will arise in equilibrium. This implies that with high penalties in the industries with high $K$ (or low asymmetries) there is no danger of retaliation or collusion. The first best outcome with self-reporting and competitive pricing afterwards arises. In this setting leniency programs appear to be effective.

The right panel of Figure 2 represents the results of the analysis for industries with relatively high exit costs and relatively strong antitrust enforcement. Here, again depending on the degree of asymmetry between firms, the following outcomes can arise. When there are high asymmetries ($K < |\pi_m\beta(1-p\alpha)|$), outcome (3) will arise in equilibrium. When asymmetries are low (i.e. $K > |\pi_m(1-p\alpha)|$), outcome (2) arises in equilibrium. For an intermediate level of asymmetry both outcome (1) and outcome (4) can arise in equilibrium. So in addition to the possibility of retaliation, there is a small danger of collusion, when exit costs for small firm are too high. This result is quite intuitive, since with high exit costs the threat of a possible retaliation can force small firm to keep the cartel secret and not to apply for leniency. The above analysis can be summarized in the following proposition.

**Proposition 1:** When traditional antitrust enforcement is strong (i.e. $p\alpha > 1$), after introduction of leniency programs there exists a threat of retaliation and of even stronger collusion in the industries with an intermediate level of asymmetry (i.e. $|\pi_m\beta(1-p\alpha)| < K < |\pi_m(1-p\alpha)|$).

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\(^9\) **Proof:** since $\delta^{**}<0$ and $\delta^*<0$, any $\delta$ in the interval $(0,1)$ is higher than $\delta^*$, hence (3) is played in equilibrium.

\(^10\) **Proof:** since $\delta^{**}>1$ and $\delta^*<0$, any $\delta < \delta^{**}$ and any $\delta > \delta^*$. This in turn implies that outcome (4) is preferred over (3) by Big in case Small chooses not to self-report and outcome (1) is preferred over (2) by Big in case Small chooses to reveal information. Next, since any $\delta < \delta^{***}$, when $\delta^{****}>1$, taking into account best response of Big, Small will prefer outcome (1) over (4). Hence, (1) is played in equilibrium.

\(^11\) **Proof:** since $\delta^{**}<1$ and $\delta^*>1$, any $\delta < \delta^{**}$ and any $\delta > \delta^*$. This in turn implies that outcome (4) is preferred over (3) by Big in case Small chooses not to self-report and outcome (2) is preferred over (1) by Big in case Small chooses to reveal information about the cartel. Next, since any $\delta < \delta^{***}$, when $\delta^{****}$ and $p\alpha > 1$, taking into account the best response of Big, the smaller firm will prefer outcome (2) over (4). Hence, (2) is played in equilibrium.
To summarize the above discussion it needs to be stressed that, even when penalties are high enough to block the cartel formation in static settings, (i.e. $\alpha > 1$) there could be adverse effects of leniency programs on the incentives to the firms to collude in a dynamic setting. There could be a threat of retaliation and of enhanced collusion in the industries with an intermediate level of asymmetries (i.e. in industries where $|\pi_m(1-p\alpha)/K|<|\pi_m(1-p\alpha)|$). This implies that, in this kind of industries, a strong emphasis on the protection of leniency applicants needs to be introduced and particular attention should be paid to industries where exit costs are high.

Next, we continue our analysis with the discussion of the case where $\alpha < 1$. In this setting again two sub-cases, depending on the size of $\delta^{****}(K,S,p,\alpha)$ can arise. When $\alpha < 1$ and $(1-\beta)\pi_m < S$ we obtain that $\delta^{****} > 1$, and, hence, the distribution of outcomes can be described as is done in the left panel of Figure 3. When $\alpha < 1$ and $(1-\beta)\pi_m > S$) we obtain that $\delta^{****} < 1$, and, hence, the distribution of outcomes is given in the right panel of Figure 3.\(^{12}\)

![Figure 3](image)

**Figure 3.** Equilibrium outcomes when $\alpha < 1$.  

In the case where $\alpha < 1$ the following regularities are satisfied for any parameter values: $\delta^{****} = \alpha < 1$, $\delta^*>0$, $\delta^{**}>0$, $\delta^{*}>0$. Note also that when $\alpha < 1$, $(1-\beta)\pi_m > S$, and $\delta^{****} < 1$, we have that $\delta^{****,\delta^{****}} = S(\alpha - 1)/(1-\beta)\pi_m - S < 0$. Hence, inequality $\delta^{****} < \delta^{***}$ holds for any parameter values. This is also depicted in the right panel of Figure 3. Moreover, in both cases described above (namely, $\delta^{****} < 1$ and $\delta^{****} > 1$, with $\alpha < 1$), we have that $\delta^{**}=\delta^{***}=0$, when $K>\alpha p\pi_m(1-\beta)$ (denoted by $K_1$ in Figure 3) and $\delta^*\delta^{****}=0$, when $K>\alpha p\pi_m$ (denoted by $K_2$ in Figure 3).\(^{13}\)

Finally, based on the above analysis, we conclude that the following proposition holds. It relates four industry types to an environment with rather weak law enforcement (the product of the rate of capture and the coefficient of proportional fine is smaller than one). This situation applies to most European countries and to EU antitrust law as well. The US anti-cartel enforcement seems to be stricter. It only grants a single fine reduction to the first reporter. In addition it generally uses criminal law and includes possibility of imprisonment also for violations of antitrust law. For a more detailed insight into these matters see the appendix. Having established that the environmental condition of the above proposition holds we can move on to the industry characteristics and complement these statements with policy implications.

**Proposition 2:** When traditional antitrust enforcement is weak (i.e. $\alpha < 1$), the following four effects of impact of industry structure on incentives to self-report can be found:

**Proposition 2(1):** In industries with little asymmetry ($K$ is high) and low discount rate the first best outcome with self-reporting and competitive pricing afterwards (equilibrium (2)) can be achieved.

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\(^{12}\) We do not provide detailed proofs of these results here, since they follow the same lines as in case where $\alpha > 1$. Detailed proofs and clarifications are available from authors upon request.

\(^{13}\) Proofs of these simple regularities are available from authors upon request.
This result shows that a leniency program can have the desired effect, i.e. destabilizing cartel and inducing more competition. However, the aim of the leniency program to establish competition in cartelized industries is only achieved when firms within an industry are more or less of the same size and little emphasis is put on future profits. This result is counterintuitive to the reasoning where symmetry creates a common focal price and facilitates collusion. Clearly asymmetry can be an important aspect for the stability of cartels. By far the largest number of industries can be described along the above lines. The firms within these industries have a strong incentive to start competing healthily, deviate from collusion or report to the AA upon introduction of the program. A new question that can be raised is whether collusion in these types of industries is as harmful to society as collusion is in industries characterized by a higher discount rate.

**Proposition 2(2):** In industries characterized by a high discount rate \( (\delta > \delta^{**}) \) retaliation is always the most attractive strategy for any type of firm (regardless of asymmetry). Outcome (3) arises in equilibrium.

Industries that do put an emphasis on future profits will have a reason to do so. Mostly these industries are comprised of rather larger firms than the previously mentioned type of industry.\(^{14}\) Natural monopolists are willing to make great investments in networks since they know they will be able to profit from these for many years. The introduction of a leniency program has no effect what so ever in this type of industry since there is usually only a single firm active in the market. In other words there is no collusion in the first place. The prevention and regulation of monopolists lies beyond the scope of this paper.

**Proposition 2(3):** In industries with low exit costs \( (S < (1-\beta)\pi_m) \), high asymmetry \( (K < \rho\pi_m(1-\beta)) \), and a low discount rate there is a threat of retaliation on the self-reporting firm. Outcome (1) with self-reporting and retaliation arises in equilibrium.

The event of fierce competition isn’t always an illustration of “healthy” competition (where healthy refers to pricing at or slightly above marginal cost). A war on prices or a period of repetitive advertising on prices might be an indication of dumping or predatory pricing. These practices reduce welfare, since investments are wasted through the destruction of capital. Moreover the consequence of this aggressive behaviour is the exit of firms from the industry and healthy competition is further away than it ever was. Proposition 2(3) shows that the introduction of a leniency program in some cases may lead to aggressive pricing (retaliation can occur as a response to self-reporting) and a loss of welfare. Besides the welfare loss the antitrust authority will also have to spend resources in the future to regulate the newly created monopolists. This scenario is especially likely to occur in asymmetrical industries with a relatively low sunk cost and a greater emphasis on future profits. When sunk costs are low, small firm will not lose much when predated upon, and will therefore be more inclined to report. On the other hand, due to the low discount factor for the big firm the potential fine of collusion will outweigh the future gain from cartel. This will cause retaliation. It is the promise to protect any party to self-report to the antitrust authority that helps to overcome this scenario. This promise needs to be clear and credible, though resources need not be wasted. Therefore a promise to protect should be incorporated in the leniency guidelines.

**Proposition 2(4):** In industries with high exit costs \( (S > (1-\beta)\pi_m) \) and discount factor in the range \( \delta^* < \delta < \delta^{**} \) collusive equilibrium (4) is sustainable even after leniency programs are introduced. Moreover, in industries with high exit costs (4) is sustainable for a bigger range of discount factors compared to low exit cost industries.

The worst effect the introduction of a leniency program can have is the strengthening the stability of cartels. The results of the analysis show this does occur, however. In industries characterized by high sunk costs this scenario is more likely to occur. The reason the stability of the cartel is increased lies in the possibility for large firms to use the leniency program as a means to increase the trust they put in

\(^{14}\) Note also that discount rates do, in fact, change with time for all industries. Thus, according to the model, a leniency policy that has one effect when the interest rate in the economy is law might have a different effect when the interest rate is high. Another interpretation is when higher discount rate is associated with higher industry stability. The discount rate \( (\delta) \) can be interpreted as probability that the firm will survive in the next period. So that higher \( \delta \) implies higher industry stability. In this sense, industries that are comprised of larger firms, which are stronger and have higher probability of survival, would be more stable and, as a result, can be viewed as industries characterized by the higher discount rate.
other firms not to report to the AA. The larger firm “trusts” the smaller not to report to the AA. It can do so since the smaller firm knows the punishment of the larger firm is severe. This scenario can never be prevented completely. The chance, this scenario develops however, can be lowered by developing a comparable promise to protect the reporting firm as is described in the previous paragraph. Besides this type of policy approach the leniency programme should always go accompanied by an effort of traditional antitrust law enforcement directly aimed at the industries described above. When the threat of a fine due to the more traditional prosecution increases, more firms will choose to abandon the cartel.

4. Conclusions

The analysis of this paper adds to the current economic literature on leniency programs for cartels and illegal price-fixing activities, but the reasoning can also be applied to corporate whistle-blowing programs and witness protection programs. It reveals a number of adverse effects of the introduction of leniency programs in view of industry asymmetry. The main conclusion is that the introduction of a leniency program, regardless of the size of the fine, might facilitate the stability of cartels in certain industries. This is mainly due to a leniency program’s inability to remove the threat of punishment on a self-reporter (or whistle-blower) by its former partners. After a firm is convicted it remains with sufficient resources to retaliate on the reporting party. It enables some firms to use coercion as a means to increase trust in the cartel. Though the removal of trust is the aim of the program, the introduction of the scheme actually provides colluding firms with the means to stabilize the cartel.

Increasing the size of the fine and limiting the number of fine reductions to the first party to report isn’t sufficient to (fully) overcome the adverse effect of the introduction of the leniency program. The analysis in this paper implies that the program’s effectiveness largely depends on the environment and the type of industry to which it is being applied. Raising the rate of capture (through e.g. limiting the number of fine reductions) and the size of the penalty do help to diminish the adverse effect. The size of the fine can for instance be increased by putting a greater emphasis on aggravating circumstances, such as coercion. It will however not be sufficient to tackle cartels in industries with an intermediate level of asymmetry. When an AA is unable to raise sufficient resources to increase the rate of capture through traditional law enforcement, in this type of industry it should direct its focus on the promise to protect self-reporters from retaliation by former collusive partners. Since the current type of policy approach is sufficiently effective in a great number of industries, diversification of the program can give rise to a more efficient use of resources. Customization of the program, where it comes to protection, size and number of the fine reduction, paralleled by a traditional effort of law enforcement aimed at industries in which the adverse effect is likely to occur will help to make the program more effective.

The analysis of Section 3 implies that, even when penalties are sufficiently high to block the formation of cartels, the leniency program can still withhold firms from self reporting. Because of the threat of retaliation after a cartel is uncovered, trust between cartel members will be stronger in those industries characterized by an intermediate degree of asymmetry and barriers to entry, due to the introduction of the scheme. This implies that in these kinds of industries a strong self-reporter’s protection program should be introduced besides the leniency program.

When penalties are lower (i.e. the product of the rate of capture and the coefficient of the proportional fine is lower than one), which is currently generally the case in most European countries, the effectiveness of leniency programs largely depends on the environment the firms find themselves in and on the type of the industry. In this case the focus of the competition authority should be on those industries characterized by a low to intermediate degree of asymmetry and an intermediate to high discount rate. Since, in these types of industries, regardless of any barriers to entry, chances are that, the introduction of a mild leniency program facilitates collusion. It serves to strengthen trust between colluders, rather than to create a breach of trust.

Another effect of the introduction of a leniency program is reversion to aggressive pricing in order to retaliate on the reporting partner. Though this might at first look like healthy competition it eventually reduces welfare. In an environment of high fines (product is greater than one) this is a more likely scenario and it will occur in industries characterized by an intermediate level of asymmetry and low barriers to entry. However also in an environment of low fines aggressive pricing can be the effect of the introduction of the program, especially when barriers to entry are low. Besides having to spend resources on regulating these new (semi) monopolists, the destruction of capital associated with the retaliation strategy is detrimental to welfare.
To summarize the above analysis, in industries characterized by high barriers to entry/exit (such as high exit costs) and degree of asymmetry leniency programs may be ineffective and give rise to increased cartel strength. In industries with low exit costs leniency programs may be more effective, but retaliation is more likely to occur as a response to self-reporting. Policies aimed at the removal of this threat of punishment through aggressive behaviour need to be considered in order to remove these kinds of hard core cartels. A first means is to employ higher fines in order to remove a bigger part of the illegal gains. Putting more emphasis on aggravating circumstances, such as coercion, in the fining guidelines can also be an effective approach. Another regulatory measure is to introduce the promise to “protect” the reporting party after reporting in the leniency application. In general though a leniency program along can not be fully effective in its aim to prevent and prosecute all cartels. A certain amount of effort will always need to be directed towards certain industries beside the leniency program.

The currently employed model calls for the decision to collude to be made prior to the decision to introduce a leniency policy. This, to some extent, limits the applicability of the model only to analysis of pre-existing cartels. The natural extension would be to enrich this model by employing a sequential repeated game framework where in each period in the presence of leniency programs the following two stage game is played. In the first stage firms decide whether to form cartel or not, the second stage is the revelation decision with the subsequent retaliation decision. Similar structure is implemented in Houba et al. (2009) with symmetric firms and in the absence of retaliation. However, incorporating asymmetric firms and possibility of retaliation in such an advanced framework may make the model intractable and difficult to solve. In this manuscript we forego excessive technical difficulties and adopt a simplified version of the model in order to concentrate on how possibility of retaliation can influence the effectiveness of leniency programs for already formed cartels.

References


APPENDIX

Historical Overview and Structure of LPs

Table 1. Fining Systems and Structure of Leniency Programs

<table>
<thead>
<tr>
<th>Country</th>
<th>Size of Fine</th>
<th>Limitation of Fine</th>
<th>No of Fine Reductions</th>
<th>Max Fine Reduction first reporter</th>
<th>Max Fine Reduction other reporters</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU</td>
<td>Base level of fine is determined by the gravity and duration</td>
<td>10% of the total annual turnover of the year before conviction</td>
<td>&gt;1</td>
<td>100%</td>
<td>Up to 75%</td>
</tr>
<tr>
<td>US</td>
<td>Base level of fine is determined by the gravity, illegal gains and damage to society</td>
<td>No upper bound</td>
<td>1</td>
<td>100%</td>
<td>No fine reduction</td>
</tr>
<tr>
<td>UK</td>
<td>Seriousness and relevant turnover form a basis</td>
<td>10% of total UK turnover of the year before conviction</td>
<td>&gt;1</td>
<td>100%</td>
<td>50%</td>
</tr>
</tbody>
</table>


Table 2. Timing of Introduction of Competition Law and Leniency Programs

<table>
<thead>
<tr>
<th>General Competition Law</th>
<th>Leniency Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country</td>
<td>First Initiative</td>
</tr>
<tr>
<td>EU</td>
<td>1959</td>
</tr>
<tr>
<td>US</td>
<td>1890</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1998</td>
</tr>
<tr>
<td>Germany</td>
<td>1958</td>
</tr>
</tbody>
</table>