

# To Protect in order to Serve, adverse effects of leniency programs in view of industry asymmetry\*

Daniel Leliefeld<sup>†</sup> and Evgenia Motchenkova<sup>‡</sup>

## Abstract

This paper studies the application of leniency programs. An analysis of the structure and design of leniency programs and existing literature raises a new question: Are leniency programs effective, in the sense that they deter cartels from formation, in asymmetrical markets? A game theoretical model, which allows for asymmetry and predatory pricing, is used to provide an answer. A leniency program does not always lead to a breach of trust. We find that, in certain industries, leniency programs are unable to break collusion. They may have the adverse effect in the sense that they strengthen cartel stability or may even lead to abuse of market power. A relatively large firm can use coercion to remove the option to a smaller firm to self-report to the authorities, thus removing the risk of prosecution posed by the program. In industries characterized by a certain degree of asymmetry in market shares and high sunk costs this is an even more likely scenario. In view of this limitation, a number of policy implications are provided in the paper. Policies aimed at the removal of the threat of retaliation need to be considered in order to convict and deter these kinds of cartels.

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## 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 to this kind of scheme is successfully employed in the prosecution of the mafia (the so called "witness protection program") and by firms in their corporate whistle blowing

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<sup>†</sup>Employee of the Netherlands Antitrust Authority (NMa)

<sup>‡</sup>Assistant Professor, Free University Amsterdam, Department of Economics, emotchenkova@feweb.vu.nl

procedures. 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 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 on the application of the policy instrument in this new (economic) setting. This paper attempts to address another issue that has been underestimated in the design of leniency programs. An important element of the witness protection program 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 has the adverse effect in the sense that it facilitates organized violations of competition law.

Any type of leniency program should contain the following three elements. Firstly, the criminal (or whistle-blower) provides sufficient evidence on the misconduct by its former partners for the authorities to successfully prosecute and convict the other members (this is the "witness" part). Secondly, the former criminal receives a, previously agreed on, lenient treatment. This ranges between a reduction to a fine, clemency from a prison sentence and a reward. A discretionary approach makes sure the incentive is set according to the constraint faced by the proposed witness and no resources are wasted. The third element is the protection from punishment on the witness by its former conspirators. When all policy parameters of the three elements are customized to fit the typical case, the proposed witness accepts the offer, the crime syndicate is terminated and its members are convicted. Moreover, no resources are wasted and an example is set for those firms or individuals considering the prospect to conspire. The degree

of leniency for instance depends on the strength of trust in the criminal organization and the degree of protection depends on the threat of punishment on the whistle-blower or self-reporter by its former partners in crime. The mere existence of the scheme should act to prevent the formation of trust and aims to remove the possibility to organize crime. Although some criminals receive amnesty for their wrong-doings, the approach, and especially the witness protection program, is generally regarded highly efficient in its aim to remove the detrimental effects of organized crime.

Leniency programs however are different from witness protection programs where it concerns the protection and the customization part of the program. As was said previously an important aspect of the witness protection program is the protection from punishment by former partners in crime. Another difference between the two is the aspect of customization of the parameters. Both parts of the scheme have proven to be detrimental to the success of the witness protection program. They have however been underestimated in the design of the program in its new industrial context. It can be shown that, unless the necessity of the protection from punishment is acknowledged by the authorities, cartels can 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 general though, the scheme will always need to be accompanied by an effort of the competition authority in traditional law enforcement.

A typical punishment strategy involves dumping or predatory pricing. Predatory pricing or predation can be seen as a special form of limit pricing. This is the practice of inducing a rival to exit a market or not to enter in the first place. The practice is first described by Bain (1949) and was picked up later on by Milgrom and Roberts (1982). This type of punishment strategy is different from the practices considered in the conventional literature on collusion such as Motta and Polo (2003) and Spagnolo (2004), since predatory pricing as a punishment strategy allows for negative profits. The credibility and impact of this type of punishment, through means of a pricing strategy depends on the asymmetry in size between firms, such as the difference in market share. Not only can a "bigger" firm usually establish lower marginal costs, the market share asymmetry has also enabled it to establish a larger buffer (accumulated economic profits) due to the joint monopolistic pricing during the period the cartel was active. When the bigger firm employs its predatory punishment strategy both firms incur losses. These eat away at both firms' buffers. Since the bigger firm's buffer is larger it will be able to sustain these losses for a longer period of time. Setting the predatory price for a sufficient amount of time eventually

pushes the smaller firm into bankruptcy. Though the bulk of the existing literature starts from the assumption of undiversified firms and industry symmetry, in reality this rarely holds. The reason behind this stance is the general perception that asymmetry reduces a cartel's strength. Text book material on collusion implies that the coordination towards a focal price under differentiated costs and products is more difficult (see for instance Tirole (1988)). Motta (2004) refers to asymmetry as follows: "asymmetries between large and small firms represent an obstacle for industry wide collusion". In reality firms are rarely 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 and this is rarely true.

With industry asymmetry predatory pricing and the use of coercion are realistic possibilities as the following two examples indicate. The act of predatory pricing was practiced only recently in the Netherlands during a period of privatization of segments of the health care insurance market. Initially private and public insurance coincided. Some firms had specialized in the first, others in the latter. Provision of the private type of insurance meant the insurer had to maintain a higher solvency rate. When the public type was abolished, the solvency requirement was also lowered. What followed was a period of fierce competition. When the smoke cleared one of the formerly public insurers claimed the formerly private insurers abused their newly acquired buffers to dump insurance premiums. The matter is now under scrutiny of the Netherlands antitrust authority (NMa).

An illustration of coercion through the threat of retaliation can be found in the leniency application of British Petrol (BP) in the Bitumen Cartel. During its existence the colluders managed to increase trust between its members through the design of a collective punishment strategy. Every time a cartel member violated the cartel's agreements the other members were supposed to retaliate on the deviator. Among the documents, offered by BP in its leniency application, several bills were found, claiming payment for work that was never carried out. The cartel managed to create a threat of retaliation by joining forces, using an asymmetry of power, sustained by formal trust.

When the antitrust authority is unable to remove the credibility of retaliation the bigger firm has the option to employ a punishment strategy on the self-reporting party. Moreover if an antitrust authority puts too great an emphasis on leniency programs and neglects its traditional means of prosecution the leniency program is misused and enhances trust. This is even more likely when the threat and impact of a fine by the competition authority is low, as is usually

the case. In industries characterized by barriers to entry (such as sunk cost) and a degree of asymmetry the program is ineffective and will give rise to increased cartel strength. Policies aimed at the removal of the threat of punishment need to be considered in order to remove these kinds of cartels. A first means is to install 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 cannot be fully effective in its aim to prevent and prosecute all cartels. A certain amount of effort, in the sense of the traditional means of antitrust law enforcement, will always need to be directed towards certain industries besides the leniency program.

The structure of the paper is as follows. Section 2 provides an overview of the related literature. Section 3 contains a formal description of the game-theoretical model. In section 4, we solve the model and find sub-game perfect equilibria of the game. Finally, in section 5 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 Literature Review

The literature on applications of self-reporting schemes in antitrust starts with the paper by Motta and Polo (2003). They conclude that the introduction of leniency programs will increase the chance of capture of cartel. They use a game theoretical model to analyse whether a leniency scheme is a first best approach to combating collusive agreements. Besides this they also take a look at the issue of reducing fines for companies that weren't the first to report. Rather surprisingly their research shows, that, only when an antitrust authority is unable to acquire sufficient resources, it should rely on a Leniency Program. Their main argument for this is that it lowers the penalty and chance of getting caught of any misconduct. This seems straightforward, but it also implies that the implementation of leniency schemes might actually facilitate collusive behavior. It implicates that antitrust organizations should only use the law on leniency in combination with their traditional means of investigation.

Spagnolo (2004) concludes that courageous leniency programs are closest to the optimal fine. 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. He also gives some credit however to moderate leniency schemes that are more like the traditional system of law enforcement.

The above argument is closely related to the more general question of the optimal structure and design of leniency programs that has been extensively discussed in the literature. See, for example, Spagnolo (2004), Motchenkova (2004), Motchenkova and van der Laan (2005), or Buccorosi and Spagnolo (2001). 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. In the next three paragraphs we will elaborate on these issues.

Hammond (2000)<sup>1</sup> concludes that limiting fine reductions to the first reporter will lead to a "winner take all race dynamic" which leads to mistrust and tension among colluding partners. How this works is not hard to imagine. Hammond uses an example of a meeting being held by cartel members and one seat remains empty. Even though the absent member might just be stuck in traffic, mistrust ensures every member is tempted to go to the antitrust authority and report the misconduct. Intuitively one could also approach the dynamics from a different perspective. This is the subject of the next paragraph. It offers a more formal argument for the fact that a single fine reduction, limited to the first reporter, is more effective than having multiple reductions.

We can also argue that multiple fine reductions increase trust between conspirators. A leniency program that offers a fine reduction to the second (third et cetera) reporter reduces the deterring effect of the program. Suppose there are two possibilities to fine reduction. Rational behavior by all firms would lead to increased trust. The mere possibility to be exempted from a fine, without being the one that actually breaks the collusive agreement makes firms strengthen their ties. Informal meetings or making a formal bond with the other partners will induce the reporting party to notify its "most favored" ally. More general the second exemption creates an incentive to strengthen all ties between colluding partners. This can be seen as the counterpart of antitrust (pro-trust). Though formal modeling is possible, the intuitive reasoning is straightforward.

Moreover, a scheme based on a single fine reduction "risk dominates" multiple fine reductions programs. The majority of economic theory on collusion and leniency programs focus on the

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<sup>1</sup>This paper is referred as DoJ (1993) in the literature section.

incentive constraint of firms. The intuitive reasoning above by Hammond uses a different angle. The perception of risk by individuals is perhaps different from the rational risk perception by a firm. The possibility that there is more than one equilibrium arises, if players do not have the same information or if one player fears the other player has limited (or other) information than himself.<sup>2</sup> The question arises what the rational reaction to such a situation might be. Harsanyi and Selten (1988) term the approach to a solution to such a situation "risk dominance".<sup>3</sup> This notion changes the common outcome of prisoners' dilemma. The one stage prisoners' dilemma is characterized by its suboptimal outcome for the players. The infinitely repeated game is characterized by the Pareto optimal outcome. Risk dominance, however allows for a more natural perception of the players interactions. In the real world, Blonski and Spagnolo (2003) argue, that agents do care about what would happen if other agents defected from the agreed strategy profile. In other words people try to make a perception of other players' positions. Even in an infinitely repeated game the outcome of the prisoners' dilemma isn't always Pareto optimal. The outcome eventually also depends on e.g. the discount factor. The "race to the courthouse" as mentioned by Hammond is an intuitive example of people's preferences for the risk dominant equilibrium instead of the Pareto superior equilibrium. The relationship building as mentioned in the previous paragraph is an example of reducing the risk of the Pareto optimal equilibrium, thus trying to overcome the risk dominant inferior equilibrium. Moving on from these intuitive approaches to the concept of risk domination Spagnolo (2004) uses a model to formalize the trust criterion. Two situations are compared. With an effective leniency program (i.e. fine reduction is sufficient to affect incentive constraint) the perceived risk of the collusive outcome, with a leniency program in which only the first reporter is eligible for a fine reduction, strictly dominates the perceived risk of a program with multiple fine reductions. This result also holds for more moderate programs in which fine reductions are less effective in influencing the incentive constraint. This means 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. With ineffective leniency programs (i.e. fine is insufficient to affect incentive constraint) the perceived risk accompanying the collusive outcome with a leniency program in which only the first reporter is

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<sup>2</sup>This is of course not applicable in case of complete information models with symmetrical firms.

<sup>3</sup>See "A General Theory of Equilibrium Selection in Games" by Harsanyi and Selten (1988). They describe risk dominance as follows: "Risk dominance tries to capture the idea that in this state of confusion the players enter a process of expectation formation that may lead to the conclusion that in some sense one of two equilibrium points is less risky than the other".

eligible for fine reduction strictly dominates the perceived risk of a program with multiple fine reductions.

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 Scherer (1980), 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.

Moreover, asymmetry in market presence reduces the incentive to self-report. An important breach with the traditional starting point of symmetry is made by Motchenkova and van der Laan (2004). Modeling a situation of differentiated market presence (some firms are big others are small) and asymmetric punishment effects, they show that asymmetry increases the incentives for the bigger company to keep the collusive agreement secret from the AA. Since the losses due to a asymmetric punishment effect in competitive markets, where the bigger firm is also present, are substantial. When the parameters of law enforcement are set incorrectly by the AA the larger firm will attempt to keep the agreement secret. If the threshold to report is raised however, the firm will self report and not enter into a collusive agreement afterwards. A policy implication is to use highly lenient programs with rather cartelized economies and raise the strictness over time. The "leniency" in the beginning will remove the bigger part of small firms involved in collusive agreements. This also establishes a situation where diversified firms will find it unattractive to start any new agreements. The existing agreements between the latter group of firms can be broken by introducing stricter leniency programs. An illustration of how an agreement can be kept secret is given below in section 3 of the paper, where a model is introduced of predatory pricing as a threat to the smaller player not to report.

This research implies that asymmetry raises the question of diversification of the application of leniency programs. It shows that in reality there is a need for a more or less customized



program to the current state of the economy. The prospect that, when a leniency program is introduced in an asymmetric industry, moderate cartels are pushed into secrecy and therefore evolve into hard core cartels is an interesting aspect. It raises the question how this increased secrecy can be broken. Further research, which is subject of this paper, will point out how the AA can deal with these types of cartels.

Finally, we will also touch upon the literature on predatory pricing, which represents a possible instrument of coercion for the bigger firm by posing a threat of retaliation on smaller firm in case of self-reporting. Predatory pricing is the practice of inducing a rival to exit a market by setting prices below marginal cost. The practice is first described by Bain (1949) and was picked up later on by Milgrom and Roberts (1982). They have shown that this strategy could be attractive for firms and, hence, has to be taken seriously by antitrust authorities. Moreover, recent history (e.g. American Tobacco, Standard Oil) has proven this type of scheme is being practiced in reality.

### **3 The Model (Formal Analysis)**

We consider a set of two asymmetrical firms, which may form a cartel, taking into account the enforcement activity of the antitrust authority. The asymmetry is related to the size of the firms or their market shares. 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, compared to the earlier papers on leniency by Motta and Polo (2003) or Spagnolo (2004), is that we consider asymmetrical 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 through predatory pricing in case the rival deviates from cartel agreement by self-reporting. Essentially,  $K$  denotes the costs of predatory pricing for the bigger firm. These costs are high when firms are more symmetric and, vice versa, these costs are low when asymmetries are high. 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 2, 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.<sup>4</sup> 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  $F = \alpha\pi$ , 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.<sup>5</sup> Here  $\alpha$  is the coefficient of proportional fine.  $\pi$  denotes per period illegal profits from cartel formation. Competitive profits ( $\pi_n$ ) are assumed to be zero for simplicity. So that  $\pi$  can also be viewed as pure illegal gains. Note also that  $\pi_m$  is maximal per period payoff for each firm in case of full collusion (i.e. when firms are able to charge monopoly prices).

- The reduced fine  $f$  specified by the US leniency program is equal to zero.<sup>6</sup> This set-up allows for the most strict adherence to the leniency rules.

- 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

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<sup>4</sup>See historical overview and overview of structures of leniency programs in Appendix.

<sup>5</sup>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).

<sup>6</sup>See also Appendix.

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 law enforcement which incorporates leniency programs.

At time  $t = 0$  the antitrust authority sets parameters of the enforcement policy:  $F = \alpha\pi$  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 supergames (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,  $\delta \geq \frac{\pi_m}{2\pi_m - \pi_n} = \delta_c$ .<sup>7</sup> So, for further analysis we will direct our attention to the values of the discount factor  $\delta \geq \delta_c$ , 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.<sup>8</sup> It can choose between two actions: self-report or keep cartel secret.

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 (through predatory pricing) 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 currently "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.

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<sup>7</sup>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:  $\frac{\pi_m}{1-\delta} > 2\pi_m + \frac{\delta\pi_n}{1-\delta}$  for  $i = 1, 2$ . Hence,  $\delta \geq \frac{\pi_m}{2\pi_m - \pi_n} = \delta_c$ . Note also that with competitive profits normalized to 0, we have  $\delta_c = \frac{1}{2}$ .

<sup>8</sup>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.

### 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.  $\pi_m(\frac{\delta}{1-\delta})$ ). But it has to overcome a loss of size  $K$  (due to pricing below marginal cost) and a fine of size  $\alpha\beta\pi_m$  and there is the risk of a fine when setting a predatory price of  $p\alpha\pi_m(\frac{\delta}{1-\delta})$ . The latter is the expected fine Big might be granted, because of the abuse of its dominant position. Small receives its current share  $(1-\beta)\pi_m$  but loses its sunk cost  $S$ , 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)<sup>9</sup> : Big receives its current share of collusive profits  $\beta\pi_m$  and is fined  $\alpha\beta\pi_m$ . 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 set predatory prices. This means that predatory 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 predatory pricing ( $K$ ) , but after small leaves it will receive the entire (discounted) monopoly profit forever after  $\pi_m(\frac{\delta}{1-\delta})$ , though it also faces a risk of capture during the transition stage over its share of profits  $p\alpha\beta\pi_m$  and there is the chance of a fine  $p\alpha\pi_m(\frac{\delta}{1-\delta})$  during the monopoly price setting due to its misconduct (in the form of abuse of dominant position). Small receives its current share  $(1-\beta)\pi_m$  but loses its sunk 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  $\beta\pi_m(\frac{1}{1-\delta})$  but faces the risk of being fined  $p\alpha\beta\pi_m(\frac{1}{1-\delta})$ . Similarly, Small receives its current share forever  $(1-\beta)\pi_m(\frac{1}{1-\delta})$  but faces the risk of prosecution  $p\alpha(1-\beta)\pi_m(\frac{1}{1-\delta})$ .

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

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<sup>9</sup>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.

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:  $f = 0$  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).<sup>10</sup>

The discount factor is denoted by  $\delta = \frac{1}{1+r}$ , where  $r$  is the interest rate. The game tree and players' payoffs are summarized in Figure 1.

[Figure 1 about here]

We now proceed to establish the subgame perfect equilibria of the two-stage game, which is described in Figure 1, played by both firms once the policy parameters are set.

## 4 Solution of the Game

To find the subgame perfect equilibria 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 games. If Small has reported their common illegal conduct, Big has to decide whether to predate or not to predate on its former partner. In the literature not predated is often referred to as a punishment strategy. Big sets its price equal to marginal or variable costs so that small is "punished" for reporting to the antitrust authority. Predatory pricing however seems like a bigger punishment for Small. It's being driven out of the market! If Small decides not to report,

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<sup>10</sup>Similar assumption is employed in Motta and Polo (2003).

Big faces the same decision. Setting a price according to a predatory scheme or (in this case) not to predate and therefore continue the collusive agreement. 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.

#### 4.1 Collusion is the preferred strategy before leniency is introduced

We start by considering the choice of the bigger firm between predatory pricing 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  $\beta\pi_m(\frac{1}{1-\delta}) - p\alpha\beta\pi_m(\frac{1}{1-\delta}) > \beta\pi_m - K + \pi_m(\frac{\delta}{1-\delta}) - p\alpha\beta\pi_m - p\alpha\pi_m(\frac{\delta}{1-\delta})$ . This inequality implies that predatory pricing 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:

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

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 chapter all values of the discount rate over threshold  $\delta^{**}$  are regarded as values for the parameter  $\delta$ , in which equilibrium (3) (*no self-reporting, predatory pricing*) 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 behavior of  $\delta^{**}(K, p, \alpha)$  with respect to the main parameters of the model shows that

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

These inequalities mean that the likelihood of collusion is increased further 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 predatory pricing 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 behavior (meaning that collusion is sustainable and there are no incentives to predate 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 3 that  $\delta_c = \frac{\pi_m}{2\pi_m - \pi_n}$ . Hence, normalizing  $\pi_n = 0$ , we get that  $\delta_c = \frac{1}{2}$ . Taking into account (1), this implies that interval  $[\delta_c, \delta^{**}]$  is not empty when  $\delta^{**} > \frac{1}{2}$ , i.e. when  $K > \pi_m(1 - \beta)(1 - p\alpha)$  with  $p\alpha < 1$  or when  $K > |\pi_m(1 - \beta)(1 - p\alpha)|$  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).

## 4.2 Determination of other thresholds for equilibrium intervals

Big's choice between predatory pricing and marginal cost pricing 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 predate*) are used by the smaller firm and the bigger firm respectively. Outcome (1) in the model is the situation in which strategies (*report, predate*) are used. Big is not inclined to predate 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 predate*) to arise holds when the following inequality is satisfied:  $\beta\pi_m - \alpha\beta\pi_m > \beta\pi_m - K + \pi_m(\frac{\delta}{1-\delta}) - \alpha\beta\pi_m - p\alpha\pi_m(\frac{\delta}{1-\delta})$ . This inequality implies that competitive pricing is more attractive for the bigger firm than predatory pricing after the smaller firm applied for leniency if the discount factor is less than the following threshold:

$$\delta < \frac{K}{K + \pi_m(1 - p\alpha)} = \delta^*(K, p, \alpha). \quad (3)$$

Differentiating this expression with respect to  $K$  implies that

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

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 predatory price setting. 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 a capture 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 predatory pricing 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:  $(1 - \beta)\pi_m > (1 - \beta)\pi_m(\frac{1}{1-\delta}) - p\alpha(1 - \beta)\pi_m(\frac{1}{1-\delta})$ . This inequality implies that self-reporting is more attractive for Small when the discount factor is lower than the following threshold:

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

This is a clear indication that raising the rate of capture 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 (*report, predate*) are employed by the smaller firm and the bigger firm respectively. Equilibrium (4) in the model is the situation in which strategies (*not report, not predate*) are used. Now the smaller player is confronted with a choice between being predated on by Big (and the associated loss of its sunk 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:  $(1 - \beta)\pi_m(\frac{1}{1-\delta}) - p\alpha(1 - \beta)\pi_m(\frac{1}{1-\delta}) > (1 - \beta)\pi_m - S$ . This inequality implies that collusion is more attractive for the small firm if discount factor is higher than the following threshold:

$$\delta > \frac{(1 - \beta)\pi_m p\alpha - S}{(1 - \beta)\pi_m - S} = \delta^{****}(K, S, p, \alpha). \quad (6)$$

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

$$\begin{aligned} \delta^{****} > \delta^{***} & \text{ when } \left\{ \frac{p\alpha > 1}{(1-\beta)\pi_m > S} \text{ or when } \left\{ \frac{p\alpha < 1}{(1-\beta)\pi_m < S} \right. \right. \cdot \text{ In this case we have also that } \delta^{****} > 1. \\ \delta^{****} < \delta^{***} & \text{ when } \left\{ \frac{p\alpha > 1}{(1-\beta)\pi_m < S} \text{ or when } \left\{ \frac{p\alpha < 1}{(1-\beta)\pi_m > S} \right. \right. \cdot \text{ In this case we have also that } \delta^{****} < 1. \end{aligned}$$



### 4.3 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 subcases depending on the size of  $\delta^{****}(K, S, p, \alpha)$  can arise. When  $\left\{ \frac{p\alpha > 1}{(1-\beta)\pi_m > S} \right\}$  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  $\left\{ \frac{p\alpha > 1}{(1-\beta)\pi_m < S} \right\}$  we obtain that  $\delta^{****} < 1$ . Hence, the distribution of outcomes is given by the right hand side of Figure 2.

[Figure 2 about here]

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 sunk costs and relatively strong antitrust enforcement, depending on the degree of asymmetry the following three outcomes can arise. When there is high asymmetry (i.e.  $K < |\pi_m(1-\beta)(1-p\alpha)|$ ), outcome (3) will arise in equilibrium.<sup>11</sup> This means that in this industry predatory pricing is the most attractive strategy even before a leniency program is introduced. With an intermediate degree of asymmetry (i.e.  $|\pi_m(1-\beta)(1-p\alpha)| < K < |\pi_m(1-p\alpha)|$ ), outcome (1) arises in equilibrium.<sup>12</sup> 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.<sup>13</sup> This implies that with high penalties in the industries

<sup>11</sup>Proof: since  $\delta^{**} < 0$  and  $\delta^* < 0$ , any  $\delta$  in the interval  $(0,1)$  is higher than  $\delta^{**} \rightarrow (3)$  is played in equilibrium.

<sup>12</sup>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.

<sup>13</sup>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

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 sunk 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 (i.e.  $K < |\pi_m(1 - \beta)(1 - p\alpha)|$ ), outcome (3) will arise in equilibrium. When there are low asymmetries (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 sunk costs for small firm are too high. This result is quite intuitive, since with high sunk costs the threat of a possible retaliation can force small firm to keep the cartel secret and not to apply for leniency.

To summarize the above discussion it needs to be stressed that, even when penalties are high enough to block the cartel formation, (i.e.  $p\alpha > 1$ ) there could be adverse effects of leniency programs on the incentives to the firms to break the cartel. There could be a threat of retaliation and of even stronger collusion in the industries with an intermediate level of asymmetry (i.e.  $|\pi_m(1 - \beta)(1 - p\alpha)| < K < |\pi_m(1 - p\alpha)|$ ). 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 sunk costs are high.

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

[Figure 3 about here]

In the case where  $p\alpha < 1$  the following regularities are satisfied for any parameter values:  $\delta^{***} = p\alpha < 1$ ,  $\delta^* > 0$ ,  $\delta^{**} > 0$ ,  $\delta^{**} > \delta^*$ . Note also that when  $\left\{ \frac{p\alpha > 1}{(1-\beta)\pi_m > S} \right.$  and  $\delta^{****} < 1$ , we have that  $\delta^{****} - \delta^{***} = \frac{S(p\alpha - 1)}{(1-\beta)\pi_m - S} < 0$ . Hence,  $\delta^{****} < \delta^{***}$  for any parameter values. This is 

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in case Small chooses to reveal information about the cartel. Next, since any  $\delta < \delta^{***}$ , when  $\delta^{***} = p\alpha > 1$ , taking into account the best response of Big, the smaller firm will prefer outcome (2) over (4). Hence, (2) is played in equilibrium.

also depicted in the right panel of Figure 3. Moreover, in both cases described above (namely  $\delta^{****} < 1$  and  $\delta^{****} > 1$ , with  $p\alpha < 1$ ), we have that  $\delta^{**} - \delta^{***} > 0$ , when  $K > p\alpha\pi_m(1 - \beta)$  (denoted by  $K_1$  in Figure 3) and  $\delta^* - \delta^{***} > 0$ , when  $K > p\alpha\pi_m$  (denoted by  $K_2$  in Figure 3).<sup>14</sup>

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. Though a comparison between US antitrust law and its European counterpart is hazardous, the US system seems to be more strict. Especially when considering it only grants a single fine reduction for the first to self-report. 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 1** *When traditional antitrust enforcement is weak. ( $p\alpha < 1$ ):*

*Proposition 1 (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.*

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 1 (2). In industries characterized by a high discount rate. ( $\delta > \delta^{**}$ ) predatory pricing 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 in the previously mentioned type of

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<sup>14</sup>Proofs of these simple regularities are available from authors upon request.

industry. 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 1 (3). In industries with low sunk costs ( $S < (1 - \beta)\pi_m$ ), high asymmetry ( $K < p\alpha\pi_m(1 - \beta)$ ), and a low discount rate there is a threat of retaliation on the self-reporting firm. Outcome (1) with self-reporting and predatory pricing arises in equilibrium.*

*In industries with high sunk costs ( $S > (1 - \beta)\pi_m$ ) the threat of retaliation is much stronger than in industries with low sunk costs. Outcome (1) can arise for a wider range of combinations of  $K$  and  $\delta$ . See left panel of Figure 3.*

The advent 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 reduces welfare, since investments are wasted through the destruction of capital. Moreover the consequence of predatory pricing is the exit of firms from the industry and healthy competition is further away than it ever was. The introduction of a leniency program in a cartelized industries leads, regardless of industry asymmetry and firm preference for current or future profits, to predatory pricing 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 high degree of sunk cost and a greater emphasis on future profits. 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 1 (4). In industries with low sunk costs ( $S < (1 - \beta)\pi_m$ ), little asymmetry ( $K$  is high), and a high discount rate collusion (equilibrium (4)) is sustainable even after leniency programs are introduced.*

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 little asymmetry and an intermediate to high emphasis on future profits this scenario is more likely to occur, especially when sunk costs are low. 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 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.

## 5 Conclusions

Upon the introduction of leniency programs to antitrust law enforcement a body of literature has started to develop. Some researches (see Motta and Polo (2003)) have pointed out that this type of policy approach should only be considered when an AA has a lack of resources. This argument is based on the fact that (the current application of) leniency programs lowers the penalty and chance of getting caught to those that misbehave. Further research by Spagnolo (2004) has shown that in order to move closer to an optimal fine the leniency program should actually be able to provide a reward to those that self-report. Another means to make use of firms' strategic risk considerations is to limit the number of fine reductions to the first firm to report. The analysis in this paper adds to the current economic literature on leniency programs in the application of law enforcement of 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, facilitates 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. The type of punishment used in the model is predatory pricing. It is however the mere threat of (any type of) punishment that 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 of a 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 4 implies that even when penalties are high enough to block cartel formation (i.e. the product of rate of capture and coefficient of proportional fine is greater than one) there could be adverse effects of leniency programs on the incentives of the firms to break cartel. There is a threat of retaliation and even of stronger collusion in the industries characterized by an intermediate degree of asymmetry. This implies that in this kind of industries strong self-reporter's protection program should be introduced and particular attention should be paid to the industries where sunk costs are high (high barriers to entry).

When the product of rate of capture and coefficient of proportional fine is lower than one, (which is currently generally the case for European countries), the effectiveness of leniency programs largely depends on the environment and on the type of the industry. In this case the focus of competition authority should be on those industries characterized by a low to intermediate degree of asymmetry and an intermediate to high discount rate. In this type of industry, 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 a breach of trust.

Another effect of the introduction of a leniency program is predatory pricing. 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 predatory pricing can be the effect of the introduction of the program, especially when barriers to entry are substantial. Besides having to spend resources on regulating these new (semi) monopolists, the destruction of capital associated with the predatory price setting is detrimental to welfare.

To summarize the above analysis, in industries characterized by barriers to entry (such as sunk cost) and degree of asymmetry leniency programs may be ineffective and give rise to increased cartel strength or cause exit of weaker rivals due to retaliation by stronger firms. Policies aimed at the removal of the threat of punishment through predatory pricing 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 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.

## 6 Appendix: Historical Overview and Structure of LPs

General Competition Law			Leniency Program	
Country	First initiative	Organization in charge	LP introduction	LP latest revision
EU	1959	Commission	1996	2002
US	1890	DoJ	1978	1997
UK	1998	Office of Fair Trading	1998	2004
Netherlands	1998	Nma	2002	2006
Germany	1958	Bundeskartellamt	2002	2006

Country	Size of Fine	Limitation of Fine	Number of fine reduct.	Max fine reduction first reporter	Max fine reduction other reporters
EU	Base level of fine is determined by gravity and duration.	10% of total annual turnover of year before conviction	> 1	100%	up to 75%
US	Fine is determined on the basis of gravity, illegal gains from offence, and damage to society.	no upper bound	1	100%	no fine reduction
UK	Seriousness and relevant turnover form a basis.	10% of total UK turnover of year before conviction	> 1	100%	50%
NL	A base fine of 10% of the estimated illegal gains.	450.000 euro or 10% of total annual turnover of year before conviction	> 1	100%	50%
Germany	Seriousness and duration form a basis.	10% of total annual turnover of year before conviction	> 1	100%	50%

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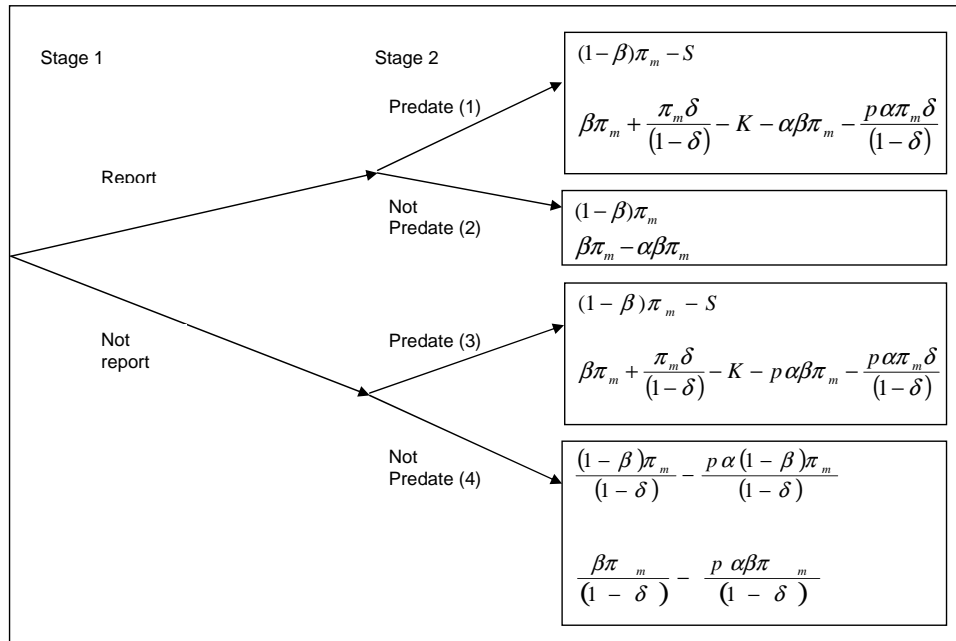


Figure 1: Game tree and players' payoffs.

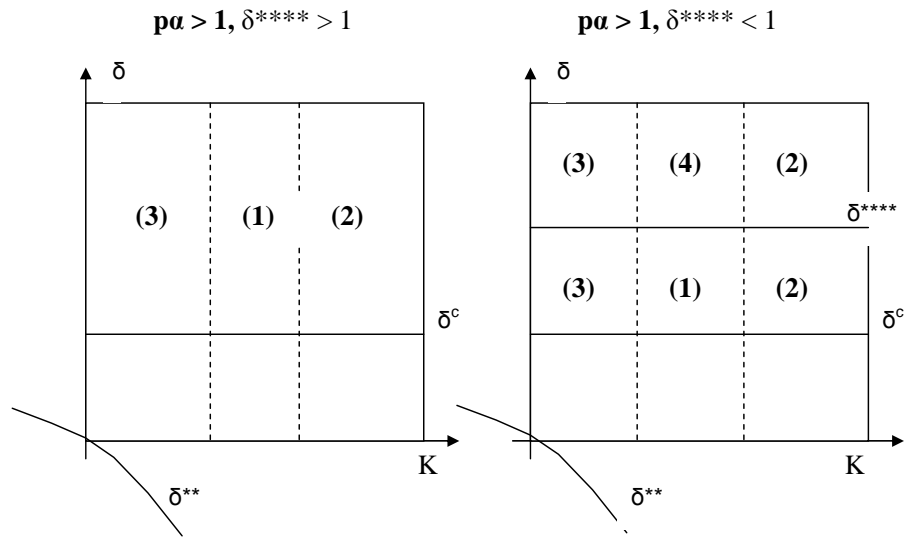


Figure 2: Equilibrium outcomes when  $pa > 1$ .

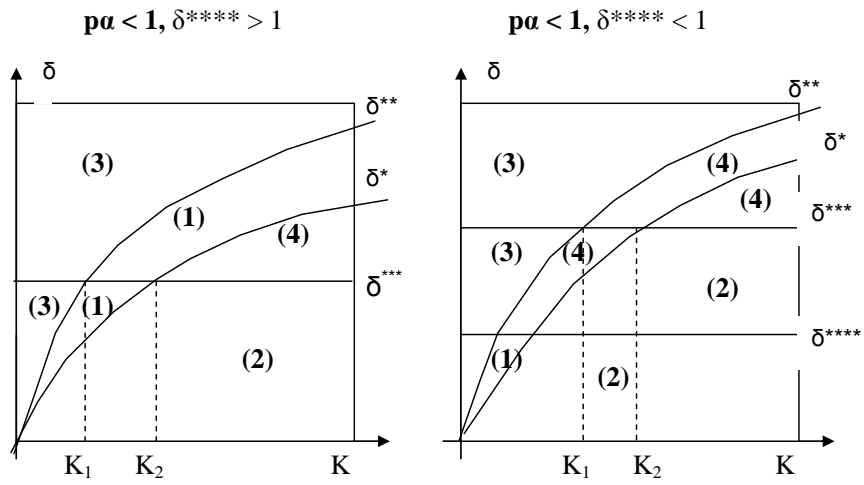


Figure 3: Equilibrium outcomes when  $pa < 1$ .