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Corporate versus Individual Leniency

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Cartel Prosecution and Leniency Programs: Corporate versus Individual Leniency*

Philipp Festerling†

September 2005

Abstract

The paper explores the interdependencies between corporate and individual leniency programs. In a duopoly model where corporations are separated into representing owners and operating managers, conflicts between the two types of agents arise if the relative benefits of participating in the corresponding leniency programs differ. As an example of what might cause differing relative benefits, the paper considers the inclusion of damage payments for owners which are not covered by the corporate leniency program. The main findings are: (1) Individual leniency applications are never observed. (2) Threats by managers to apply for individual leniency may, however, increase the owners' incentive to carry out corporate self-reports. (3) In other cases, the individual leniency program increases the owners' tolerance for cartel activity for two reasons: Either the corporate leniency program is sufficiently unattractive to the owners, or the owners rely on the option to apply for corporate leniency after the Antitrust Authority has opened a case. (4) Finally, the more distortion decreases, the more ineffective the individual leniency program becomes.

JEL: K21, K42, L13, L44.

Keywords: Leniency, corporate leniency, individual leniency, cartel, law enforcement, antitrust.

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1 Introduction

1.1 Background

Cartel activity engaged in by managers may lead to serious conflicts between the owners of the firm and the managers, particularly in cases where owners become aware of the managers' activities after the cartel has started. Also in cases where managers engage in cartel activity with the owners' explicit blessings, conflicts may arise due to asymmetric consequences once the activity has been detected by antitrust authorities. The catalogue of sanctions against managers ranges from immunity over monetary fines to prison sentences depending on the legal system and the severity of the offence. The owners' catalogue of direct consequences ranges from fines to restitution and subsequent civil (treble) damage payments. In addition, if a manager of a corporation receives a long prison sentence, the owners have to reorganize the internal structure of the firm. In the worst case, they have to find a new manager.

Also leniency programs affect manager and owners in the same corporation differently, particularly if the owners - as the legal representatives of the corporation - are required to fulfill eligibility criteria to receive leniency. These conditions typically comprise the prompt termination of cartel activity and in most cases ensuring the manager's full cooperation if he is the person who knows most. In addition, corporate leniency programs lose much of their attractiveness to the owners if they entail huge damage payments that are not covered by the program. Such uncovered costs may cancel out the effectiveness of corporate leniency programs.

Finally, managers may abuse the fear of damage payments to avoid tacit terminations without leniency. This possible extortion may be enhanced or even actually be created by the simultaneous implementation of individual leniency programs. Apart from the frequently quoted "race to the courthouse" among involved corporations where leniency programs are explicitly aimed at "crashing the trust" among cartel participants, an efficient leniency program - as a combination of corporate and individual leniency - thus also has to perform the much more subtle task of solving internal conflicts between managers and owners.

1.2 Literature review

Over the last few years, the number of scientific contributions regarding leniency programs has grown considerably. The probably most quoted authors are still Motta and Polo (2003) ("MP (2003)"). Their model is the first to embed leniency programs into a repeated game framework, as an important distinction compared to the classical literature on "law and economics", which goes back to Becker's (1968) seminal paper. Leniency applications occur if the expected fine reductions are sufficiently large. The positive effect of leniency programs is that leniency applications help lower proceedings costs and lead to temporary cartel breaks. As a negative effect, lower expected fines encourage cartel activity in general. Once initiated, cartel activity never triggers self-reports. Only if the antitrust authority opens an investigation will leniency applications be observed. The critical evaluation regarding self-reports has been confirmed by Spagnolo (2000). Spagnolo's idea is to allow positive rewards to induce firms to confess cartel activity; otherwise leniency programs cannot be effective. Ellis and Wilson (2002) suggest that firms may exploit leniency programs to gain competitive advantages or to strengthen the internal cartel stability. Leniency applications will not be observed, however, since the leniency program affects the firms indirectly. If the cartel's stability suffers, deviations occur.

The finding regarding missing incentives to approach the antitrust authority voluntarily, that is, before it opens an investigation, stands in sharp contrast to empirical observations, however. Self-reports constitute roughly 50 % of all leniency applications in the U.S., and after 2002 an even larger fraction in the EC.[1] This gap between theoretical results and empirical observations can be explained by the static nature of most of the first models. In the early stages of a cartel, corporations form expectations about the profitability of cartel activity, taking into account the possibility of applying for leniency. If the expectation exceeds the value of any other available strategy, the corporations establish the cartel. In a static model, however, this expectation does not change as the undetected cartel moves forward from one period to the next. Any incentive to apply for leniency voluntarily would already have existed at the beginning of the game. Only if the antitrust authority has opened an investigation, the forward expectation changes, which then may induce the corporations to participate in the leniency program.

The "next generation" models are mainly characterized by relaxing or specifying particular assumptions. Hinloopen (2002) considers leniency programs if fines are calculated

[1] See, for instance, Spagnolo (2000) and van Barlingen (2003).

after the European Commission's set of rule. He comes to the conclusion that leniency applications are unlikely unless the detection probability and fine limit would be raised unrealistically high. Hinloopen (2003) examines the effectiveness of leniency programs in a dynamic set-up with time-dependent detection probability. The effectiveness of leniency programs can thereby be improved as the detection probability rises. Spagnolo (2004) specifies the positive rewards by proposing that the first reporting firm should be rewarded by all those fines collected from the prosecuted firms. If such "courageous" leniency programs are not feasible, the antitrust authority should reward deviating firms by fine reductions in exchange for cooperation. Moreover, leniency programs may be effective by creating distrust among cartel members. Spagnolo's revised paper is the to explain self-reports. A necessary condition is to leave the standard grim trigger strategy framework while employing optimal penal codes. A direct comparison between the European and the American leniency system is the main topic of a paper by Feess and Walz (2004). They are particularly interested in analyzing the consequences of two major differences between both systems. In contrast to the European system, the U.S. leniency system does not require a specific amount of probative evidence before being regarded as eligible.[2] On the contrary, the European system still allows for fine reductions for those firms not being the first one - which the U.S. system does not. Feess and Walz conclude that optimal fines should be increasing in the amount of additional evidence delivered by others and independently of the own contribution. The only exception to this rule is related to so-called high-evidence providers in cases of self-reports where larger contributions should be rewarded by lower fines. Aubert et al. (2004) reconsider the possibility of paying positive rewards. They come to the conclusion that positive rewards to firm employees could be more effective than rewards paid to firms. However, the possibility of positive rewards may also deter socially desirable forms of cooperation between firms. An interesting contribution is the recent paper by Mullin and Snyder (2005) although it does not deal explicitly with leniency programs.[3] Mullin and Snyder examine the conditions under which targeting managers may enhance deterrence of criminal action on the firm's behalf. Their main result is that implementation of employee sanctions can increase the strength of deterrence in case of judgement-proof firms. In addition, employee sanctions can help to lower the probability of undesired shutdowns of honest firms as a consequence of enforcement errors. Finally, they

[2] Before 2002. After the reform in 2002, this requirement has been relaxed.

[3] Mullin and Snyder (2005) consider a one-time criminal action committed by a manager on the behalf of the firm. The action is not repeated nor does it require explicit involvement of other firms and managers.

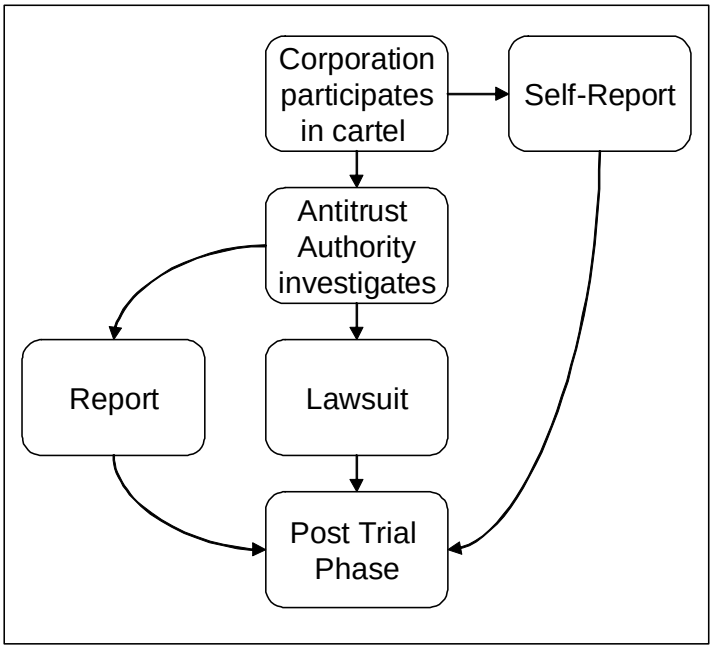

Figure 1: The "traditional" perspective

show that it is generally inefficient for the government to forbid indemnification, that is, the absorption of the manager's legal expenses by the firm. The only rationale for forbidding indemnification would be the case of an increased probability of conviction resulting from the manager's cooperation in exchange for appropriate fine reductions.

The "traditional" viewing angle. The general framework of many of the above-mentioned papers is illustrated in Figure 1. A corporation participates in a cartel, which may be detected by the Antitrust Authority. Without leniency program, the Antitrust Authority attempts to prosecute the corporation upon detection, and the game passes into the post-trial phase. With leniency program, the corporation may alternatively decide to enter a leniency agreement with the Antitrust Authority to avoid the lawsuit. Roughly spoken, the leniency contract consists of an agreement offering the corporation a fine reduction conditioned on complete cooperation with the Antitrust Authority, i.e. providing all relevant information about the cartel. The corporation's advantage consists thus in the fine reduction, the Antitrust Authority's advantage consists in increased efficiency concerning the possibility to prosecute the remaining, non-cooperating cartel participants.

Leniency applications may be filed either before the Antitrust Authority has detected the cartel (self-report) or after the Antitrust Authority has opened an investigation (report). The above-mentioned papers differ then in the specification of the particular assumptions in place, defining how detection occurs, how prosecution takes place, what the post-trial phase looks like and so forth.

1.3 The characteristics and main findings of this model

1.3.1 The general model set-up

The principal difference between the present model and the models above is the strict separation of corporate management and representation. Each corporation is divided into a group of owners who own and represent the corporation, and a manager who operates the corporation. Contrary to Aubert et al. (2004), the managers in this model actually commit illegal cartel activity, and the owners are not directly involved in the business management.[4] The transfer of the business management from the owners to the manager entails an information delay, which enables the manager to conceal business activities for the owners, at least temporarily. The particular business activities in this paper are cartel meetings with managers of other corporations. For simplicity, the paper considers a market with two corporations only.

Uninformed owners may learn about cartel activity in two ways: The Antitrust Authority opens an investigation after detecting evidence of cartel activity. The opening of an investigation is thus conditioned on the stochastic event that the Antitrust Authority has received signals of an existing cartel. The Antitrust Authority never receives false signals, nor does it misinterpret actual signals.[5] [6] The investigation involves communication between the Antitrust Authority and the corporations, which lets uninformed owners recognize the corporations' involvement in illegal cartel activity. This assumption seems natural as the owners are the legal representatives of the corporation. Alternatively, the owners may learn about the manager's covert activities from internal sources.

This setup could lead to one of two situations, which form the basis of the subsequent analysis: The owners learn about the cartel *before* the Antitrust Authority opens an in-

[4] In terms of Alexander and Cohen's (1996, 1999) empirical studies, the corporations in this paper correspond either to large firms or firms in which the management has, at most, a small equity stake.

[5] The paper does not consider so-called type I and type II enforcement errors.

[6] The opening of an investigation in this paper roughly corresponds to the appointment of a U.S. Grand Jury.

vestigation, or the owners learn about cartel activity *because* the Antitrust Authority has opened an investigation, as shown in Figure 2. Contrary to the left panel of Figure 2, the

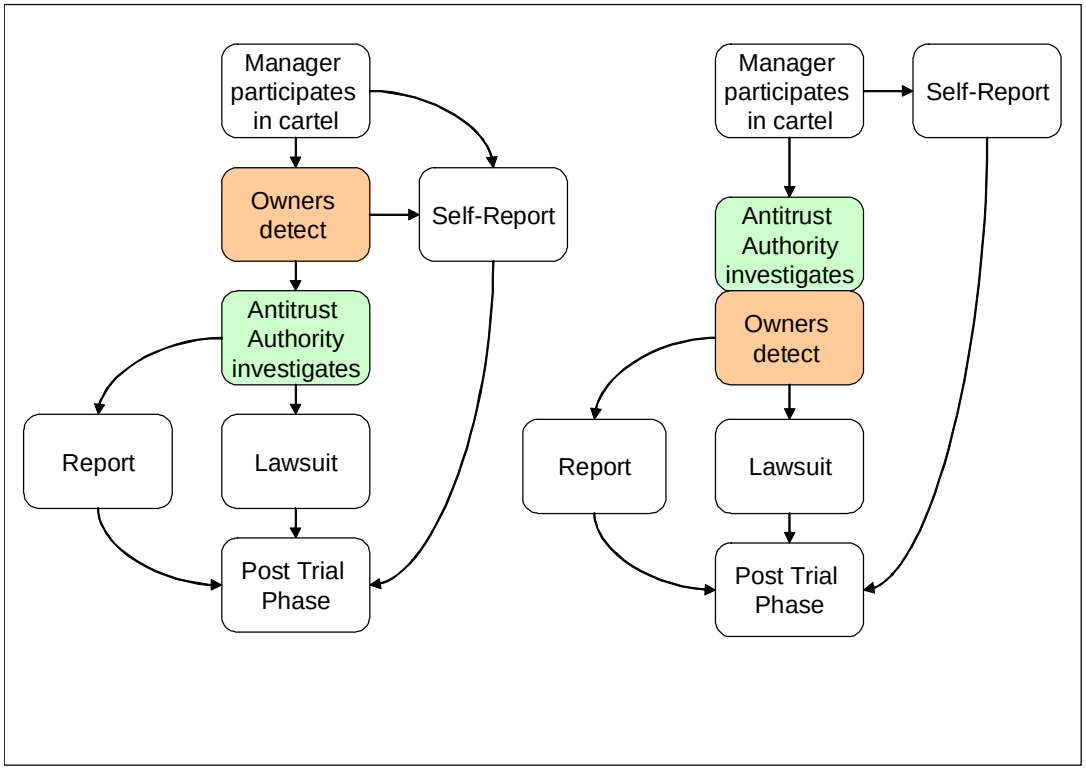

Figure 2: The perspective of this paper

box "Owners detect" in the right panel does not define an independent stage. Detection by the owners is a direct and immediate implication of the Antitrust Authority opening an investigation. Which of the situations in Figure 2 finally occurs, depends on the stochastic processes of the game. It determines, however, the number of options available to the owners.

Owner-manager relation. The manager receives an exogenously fixed fraction of the per-period profits in return for his performance. This assumption implies that the owners cannot adjust the profit allocation rate appropriately in order to exert control over the manager. The paper allows, however, for the possibility that the owners, upon detection, may implement a compliance program that bars the manager from participating in further

cartel meetings. With reference to Figure 2, the phrase *upon detection* refers to the boxes "Owners detect" in the left and right panel. The compliance program incurs costs that are related to specific internal auditing activities or payment for a lawyer whose task it is to follow the manager's every step. For simplicity, the compliance program cannot be abandoned once being implemented.

An additional assumption bars the manager from resigning and the group of owners from firing the manager. The primary reason for this assumption, as well as the assumption concerning the fixed payment scheme, is a substantial need for simplification, as it keeps the model closed. Otherwise, additional assumptions would have been necessary specifying outside options for the manager, a labour market for managers, and so forth. Adding all these assumptions would probably have implied some kind of model explosion.[7]

External detection and prosecution. Assume for the moment that the manager in each corporation is identical to the group of owners. The remaining underlying model then comes closest to the model of MP (2003). Many of the basic assumptions in this paper are "borrowed" from their model. Cartel activity in each period t is detected with some exogenously fixed detection probability α where $\alpha \in (0, 1)$. The Antitrust Authority opens an investigation at the beginning of period $t+1$ and prosecutes the corporation with some exogenously fixed prosecution probability p where $p \in (0, 1)$. The corporation thus only realizes at the beginning of period $t + 1$ whether it has been detected by the Antitrust Authority during period t or not. A successful prosecution implies some specified financial sanctions for the corporations. After the lawsuit, the corporations may restart the cartel. Contrary to MP (2003), this paper considers the explicit inclusion of damage payments as one part of the financial consequences, apart from fines.

Motta and Polo modelled the investigation and prosecution stage as two consecutive periods during which the corporations are forced to interrupt the cartel. In this paper, the investigation and prosecution are modelled as an instantaneous event at the beginning of that period following a period of detection. The outcome of the lawsuit is immediately known. The reason for this simplification is that this paper does not consider an endogenisation of the detection and prosecution probability related to the budget and the capabilities of the Antitrust Authority, possibly as suggested by MP (2003).

[7] Section 3.1 discusses the implications of the assumptions in general and their significance for the results in particular.

Internal detection. Return to the assumption that the manager and the group of owners are not identical. If the managers of both corporations enter into an illegal cartel agreement at the beginning of a period t, the owners detect the cartel at the end of the same period with some exogenously fixed detection probability $(1-\theta)$ where $\theta \in (0,1)$. For simplicity, detection by the owners occurs simultaneously, that is, both groups of owners detect the cartel at the same time. This assumption moderates the dynamics of the model's results since it neglects possible tensions between the two groups of owners due to information advantages. However, this paper focuses on the relation between the manager and the group of owners within the same corporation. From this point of view, the simplification affects the results to some negligible extent only.

Fines and leniency. Separating the corporation into a group of owners and the manager also affects the notion of "the" leniency program and the litigation process in general. In this paper, successfully prosecuted cartel activity leads to imposition of corporate fines on the corporation, which actually punishes the owners, and personal fines on the manager. In addition, the corporation has to pay damages. In most jurisdictions, however, it is not the federal court that imposes the obligation to pay damages. In some cases, the federal court may impose restitution payments only. Damage payments are based on the assumption that the publicity in relation to and as a consequence of investigations and lawsuits may initiate civil actions against the corporations. All fines and damage payments are exogenously fixed, which is a standard assumption simplifying the calculations. In addition, indemnification is not possible. Contrary to Spagnolo (2004), cartel offenders do not risk increasing fines for repeated violations. The paper does not consider either the effects of different ways of calculating the fine as it has been done for the European case by Hinloopen (2002), or the possibility of prison sentences for managers.

The leniency program $\mathcal{L}$ consists of two components. The corporate leniency program $\mathcal{L}^c$ is addressed to the corporation as a legal entity, and only the owners, as the legal representatives for the corporation, may apply. In contrast, the individual leniency program $\mathcal{L}^i$ is addressed to the manager as a natural person. Following the typical design of leniency programs, the corporate leniency program is available both before or after an investigation has been opened, whereas the individual leniency program is available before the opening of an investigation only.[8] Contrary to Spagnolo (2000) and (2004), the possibility for

[8] Throughout this paper, the phrase *the leniency program* denotes both components at the same time, $\mathcal{L} = \mathcal{L}^c + \mathcal{L}^i$. If a particular component is considered alone, it is called by its specific name.

receiving corporate leniency after an investigation is opened is thus included. Contrary to MP (2003), leniency will only be granted to the first agent to come forward, whether it is the manager or the group of owners. Leniency is granted on fines only and always implies a complete fine reduction. The possibility for fine reductions for the second agent to come forward, as employed in the EC leniency program, is not considered. Two specific assumptions of this paper conclude the description of the leniency program. First, the owners are required to ensure the manager's complete cooperation and to implement the compliance program before applying for corporate leniency. The latter requirement implies that corporate leniency is available only once, contrary to MP (2003), where leniency is available infinitely many times. If the corporations do not enter a leniency agreement, a cartel may be restarted infinitely many times, even after successful prosecution.[9] Secondly, the managers are assumed to keep information about the cartel, in general, and probative evidence, in particular, in their possession. All information has to be delivered to the Antitrust Authority in case of a leniency application. The Antitrust Authority's probability for prosecuting the remaining non-cooperating corporation increases strictly due to the increased amount of evidence. Contrary to Feess and Walz (2004), the amount of evidence is not asymmetrically distributed among the managers.

The general framework of this model with personally liable managers, the inclusion of damage payments, the separation of the leniency program into its two components, and so forth, let the model of this paper resemble the corresponding situation in the U.S., apart from prison sentences which are a key feature of the U.S. legal system. However, all other assumptions about the leniency program are directly linked to corresponding rules in the U.S. leniency program.

1.3.2 The findings

Opening an investigation: the final stage. The game is solved by backward induction. All variables and parameters of the model are given, and it is assumed that the managers have begun cartel activity and the game has reached the stage where the Antitrust Authority opens an investigation. Throughout the remainder of this paper, the stage or subgame that is reached each time the Antitrust Authority opens an investigation is denoted as the *final stage*. With reference to Figure 2, this means that the game has

[9] A corresponding assumption about the individual leniency program, to be presented below, states that individual leniency applications trigger the infinite reversion to the non-cooperative market outcome. Thus, individual leniency is also available only once.

reached the box "Antitrust Authority investigates", which in the right panel also includes the box "Owners detect". It will be shown below that it does not matter for the analytical solution of the final stage by which particular history the final stage has been reached, that is, whether the particular history corresponds to a game progression in compliance with the left or right panel.

The lower panel of Figure 3 illustrates one possible progression until the beginning of the final stage, which corresponds to the right panel of Figure 2. The symbol π^c indicates a period with cartel activity, and the dashed arrows indicate the (conditional) probabilities by which this particular progression has occurred. The upper probabilities refer to the internal detection probability, whereas the lower probabilities refer to the external detection probability. In Figure 3, the beginning of the final stage is the beginning of the third

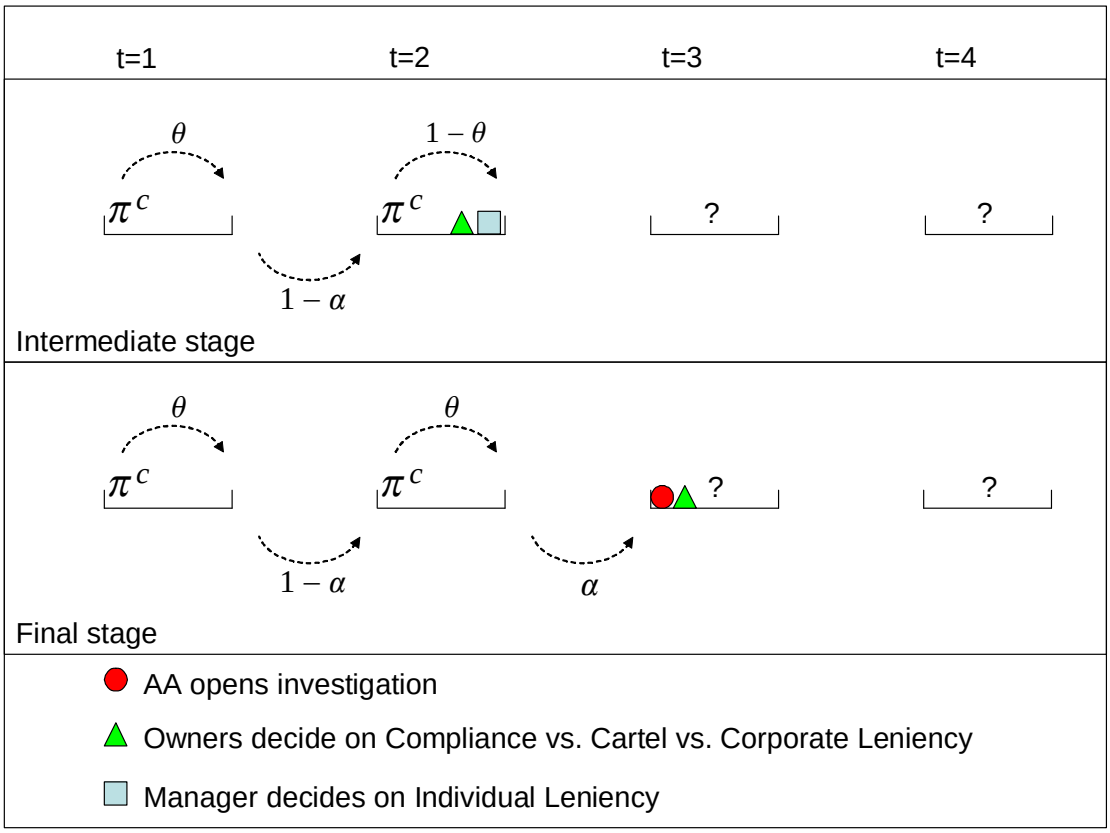

Figure 3: The timing

period. Indeed, it could have been any period $t > 1$. Once the Antitrust Authority has opened an investigation, both corporations know that the Antitrust Authority is going to bring an action against all involved agents for past cartel activity. At this point, the owners of each corporation have to decide among three different strategies: (1) The infinite cartel strategy s^c, which allows the manager permanent continuation of cartel activity regardless of possible future investigations and lawsuits, (2) the compliance strategy s^{cp}, which involves the voluntary implementation of the compliance program, and finally (3), the corporate report strategy s^{cr}, which involves the application for corporate leniency. Only the latter strategy could prevent a lawsuit.

Assume for the moment that the owners would be willing to implement the compliance program voluntarily in order to eliminate the manager's option to enter further cartel agreements. If the expected outcome of the lawsuit with respect to fine and damage payments is larger than the expected outcome in case the owners would apply for corporate leniency, they obviously prefer the latter option. A sufficiently large difference in expectations may even induce owners to participate in the corporate leniency program, who otherwise would have preferred to allow the manager the cartel continuation. This effect is related to one of the possible beneficial welfare effects of the corporate leniency program. The expected net benefit of cooperating with the Antitrust Authority may sufficiently compensate for previous cartel activity, which then leads to the application for corporate leniency.

The points of indifference between the three strategies are expressed in terms of the detection probability, α, as a function of the prosecution probability, p. The involvement of the (*ex ante*) detection probability α refers to possible future detections during the post-trial phase if the owners should decide to allow the manager to continue the infinite cartel strategy.[10]

The result for the final stage implies a division of the (α, p) unit square into three parameter regions. Since all variables and parameters of the model are given, the owners are able to locate their position within the (α, p) unit square. If either the detection probability α or the prosecution probability p is sufficiently low, the owners prefer to allow the manager to continue the cartel. This case will be denoted as Case 3 in subsequent sections. If both the detection and prosecution probabilities are sufficiently large, the owners prefer to implement the compliance program. Within this region, if the prosecution probability is

[10] The *ex ante* detection probability has to be distinguished from the *ex post* probability by which the particular final stage under consideration has occured. This event has been assumed in conjunction with the backward induction method.

sufficiently large, the owners prefer additionally to apply for corporate leniency. The latter case is denoted as Case 1, and the former as Case 2.

The results for the final stage are not surprising, but they are a necessary prerequisite for the analysis of the intermediate stage, following below, which actually constitutes the core part of the paper.

Internal detection: the intermediate stage. Knowing what the owners would do after the Antitrust Authority has opened an investigation, the next step involves going one stage backwards by considering the stochastic event of internal detection of ongoing cartel activity by the owners before the Antitrust Authority (possibly) opens an investigation. Throughout the remainder of this paper, the stage or subgame that is reached if the owners have detected a cartel internally, is denoted as the *intermediate stage*. The beginning of the intermediate stage corresponds to the box "Owners detect" in the left panel of Figure 2. The upper panel of Figure 3 depicts an example where the owners have detected ongoing cartel activity at the end of period $t = 2$, while the Antitrust Authority has not opened an investigation yet. At this point, the owners have to make a decision about the implementation of the compliance program and the application for the corporate leniency program by carrying out a corporate self-report. Alternatively, they may allow the manager to continue the cartel. Under specific circumstances, to be explained below, the manager may do an individual self-report. The crucial point concerning the intermediate stage is related to the assumptions about internal and external detection. At the end of the second period, neither the owners nor the manager know whether the Antitrust Authority is going to open an investigation at the beginning of the third period. In a given case, the chronological distance between the beginning of the intermediate and the beginning of the final stage would be the shortest possible distance ever. This infinitesimal period of uncertainty affects the owners' as well as the manager's decision at the intermediate stage decisively. It is assumed that not even the immediate implementation of the compliance program can affect the likelihood of this particular investigation at the beginning of the third period, just as little as the expected outcome of the subsequent lawsuit. The assumption takes into account that the investigation and the lawsuit were related to past cartel activity. Only if the beginning of the third period is passed without an investigation has taken place, the corporation would be relieved from any further risk of detection. The only way to avoid this uncertainty is to execute a spontaneous self-report. This option is feasible for both the manager and the owners. The example of Figure 3 lets the beginning of the intermediate

stage take place at the end of period $t = 2$. Indeed, it could have been any period $t \geqslant 1$.

Case 3. Case 3 is the least interesting case from an analytical point of view. The parameter region which defines Case 3 corresponds to the situation, where the owners prefer the continuation of the infinite cartel strategy s^c at the final stage, since both the detection and prosecution probabilities are sufficiently low. The result for Case 3 shows that if the owners do not prefer to terminate the cartel at the final stage, they do not prefer to terminate cartel activity at the intermediate stage either. As a consequence, if the owners accept the manager's cartel participation without reservation, the manager itself does not have any incentive to apply for individual leniency either. Thus, both components are ineffective.

Case 2. Case 2 contains one of the main results of this paper, and corresponds to the situation where the owners prefer not to apply for corporate leniency at the (possible) final stage. The corporate leniency program is sufficiently unattractive for the owners, since the sum of complete fine reduction and damage payments exceeds the expected sum of the corporate fine and damage payments in relation to a lawsuit. The owners therefore prefer to accept the lawsuit at the final stage, rather than apply for corporate leniency, in the hope that the Antitrust Authority does not win the case. On the other hand, the owners do not prefer the infinite cartel strategy either. The expected present discounted payoff of the infinite cartel strategy is lower than the corresponding value of the voluntary compliance strategy. The owners' preferences therefore imply the implementation of the compliance program at the final stage.

At the intermediate stage, however, the individual leniency program comes into effect. As mentioned, implementing the compliance program at the intermediate stage does not affect the still existing possibility that the Antitrust Authority might open an investigation into past cartel activity. The possibility only disappears if the compliance program has been in effect for at least one period. The owners are willing to bear this risk. During this period of uncertainty, however, the manager would strictly benefit by applying for individual leniency. A complete fine reduction is better than any expected positive fine, and the manager knows that the owners would not apply for corporate leniency if the Antitrust Authority should open an investigation.

The financial consequences in relation to the individual leniency application would damage the owners to such an extent that they would prefer to make a deal with the

manager to abstain from implementing the compliance program if the manager abstains from applying for individual leniency. In fact, the owners allow the manager to continue the cartel. As soon as the Antitrust Authority opens an investigation, that is, as soon the final stage occurs, the owners can freely implement the compliance program since the manager's option to apply for individual leniency vanishes.

Case 1. The main difference between Case 1 and 2 is related to the general willingness of the owners to apply for corporate leniency if the Antitrust Authority opens an investigation. This implies a change of perspective since the relevant conditions concerning the points of indifference are now expressed in terms of the detection probability α as a function of the amount of probative evidence, which will be delivered upon application. The amount of probative evidence is denoted as φ, where $\varphi > p$, and where $\varphi \in (0, 1)$. The dependence of α on φ reflects the risk for each group of owners not to be the first to come forward at the final stage. Also in Case 1 does the individual leniency program $\mathcal{L}^i$ affect the final outcome considerably.

Without individual leniency program, the owners would choose among three available strategies in dependence to the detection probability $\alpha(\varphi)$. For high values of $\alpha(\varphi)$, the owners prefer to carry out a corporate self-report. This preference corresponds to the so-called "run to the courthouse". If both groups of owners know that they would apply for corporate leniency at the final stage, high values of $\alpha(\varphi)$ enhance the owners' incentive to approach the Antitrust Authority already now, at the intermediate stage. For low values of $\alpha(\varphi)$, the owners prefer to allow the manager the temporary cartel continuation. As soon as the Antitrust Authority opens an investigation, however, both groups of owners hurry up to be the first one to carry out a corporate report. The probability for the occurrence of the final stage is sufficiently low, which increases the value of the expected cartel profits until then. Finally, for medium values of $\alpha(\varphi)$, the owners prefer the compliance strategy s^{cp}. The preference for this particular strategy is based upon the fact that the detection probability $\alpha(\varphi)$ is neither sufficiently large, inducing the owners to carry out a corporate self-report, nor sufficiently low, inducing the owner to allow the temporary cartel strategy.

With an individual leniency program, however, the particular strategy for medium values of $\alpha(\varphi)$ becomes infeasible for the same reasons as in Case 2. As as consequence, the parameter regions supporting the strategies for high and low values of $\alpha(\varphi)$, respectively, extend towards the middle, until the medium range is completely covered.

As the main implication of this result, the individual leniency program increases the

parameter range for which the owners prefer either to carry out a corporate self-report or to allow temporary cartel continuation. This result depends, however, on the fraction of damage payments in relation to the sum of damage payments and the corporate fine. Comparative statics show that decreasing the fraction of damage payments lets the levels of indifference concerning the strategies for high and low values of $\alpha(\varphi)$ move downwards and upwards, respectively, until they finally converge. The decrease of damage payments increases the values for both the temporary cartel strategy and self-report strategy more than the value of the compliance strategy in the middle region. Upon convergence, the solutions for the cases without and with individual leniency program coincide.

The beginning of the game: the initial stage. The analysis of the initial stage comprises the determination of the relevant levels of indifference concerning the managers' incentives to keep cartel discipline, taken as given, what might happen at later stages of the game, and unilateral deviation incentives. In general, the managers' main concern is related to the probability for any kind of elimination of their possibilities to continue with cartel activity. If this probability is great enough, each manager would have sufficient incentive to deviate unilaterally at the beginning of the game. The interesting question whether the leniency program increases the parameter range for which the managers prefer to keep cartel discipline, will not be answered completely, unfortunately. For Cases 3 and 2, the answer is simple. In the former case, the region has not increased, whereas in the latter case it has. The problem is Case 1, where both outcomes may occur. In addition, the change of the relevant parameter spaces from the (α, p) to the (α, φ) unit space would require an enormous calculation effort to present clear conditions.

The main result of this paper. The main result of the paper consists of a presentation of three different situations where the manager's option to choose an individual leniency program affects the owners' preferences decisively. The causes for this result as well as the reactions of the owners may differ from case to case. The combining elements of all three cases is, however, that the owners would have preferred the voluntary implementation of the compliance program if the individual leniency program was not in place. The possible reactions of the owners to this threat are related to the owners' evaluation of the corporate leniency program. Case 2 corresponds to a situation where the owners evaluate the corporate leniency program as sufficiently unattractive. Their only option - in order to avoid the manager's application - is to accept temporary cartel continuation until the

Antitrust Authority opens an investigation, at which point the influence of the individual leniency program stops. In Case 1, however, the owners appreciate the corporate leniency program, and their relevant strategical trade-off concerns the question whether they prefer a corporate self-report at the intermediate stage or a corporate report at the final stage. Comparative statics show, however, that the result depends decisively on the assumption about the damage payments, which have to be paid by the owners. Damage payments drive a wedge between the expected benefits of cooperating with the Antitrust Authority for the owners and the manager. Without damage payments, the individual leniency program would be completely ineffective, and Antitrust Authorities could save administrative resources by simply abandon the program.

The results show that the option of an individual leniency application becomes relevant for the manager only if the owners prefer to terminate ongoing cartel activity. This result is quite paradoxical, as the designer of such programs probably intended to create an appropriate incentive system for the manager, in case the manager prefers to terminate cartel activity, while the owners prefer to continue the conspiracy. The results confirm, however, the view of the U.S. Department of Justice (DoJ), as expressed by Scott D. Hammond:[11]

> "The real value and measure of the Individual Leniency Program is not in the number of individual applications we receive, but in the number of corporate applications it generates. It works because it acts as a watchdog to ensure that companies report the conduct themselves."

For understandable reasons, he focuses only on the shiny side of the medal.

The paper does not present a final answer to the question of whether corporate leniency programs generally do a better job without individual leniency programs. The outcome of Case 2 obviously cannot be in the interest of antitrust authorities. The same is true for one of the two outcomes in relation to Case 1. These adverse effects are, however, balanced with the beneficial effect in relation to the corporate self-reports. The final decision about what might be socially more desirable, may depend on specific circumstances in a particular jurisdiction. It cannot be ruled out that antitrust authorities might tolerate increased

[11] "Cornerstones of an effective leniency program". Speech by Scott D. Hammond, Director of Criminal Enforcement at the Antitrust Division of the U.S. Department of Justice. Presented before the ICN Workshop on Leniency Programs, Sydney, Australia, November 22-23, 2004.

preference for cartel activity if the increased preference for self-reports, on the other side, implies a strong advertising effect for the antitrust authority.

The model and its results are particularly relevant for jurisdictions where civil damage payments constitute a major determinant of the overall deterrence effect as composed of the sum of fines and damage payments. The increase of the overall deterrent through large civil damage payments is inquestionable. The model's results point out, however, that a political desire for large civil damage payments may hardly be compatible with the contemporary requirement for efficiency of a leniency program if it is not taken into account that civil damage payments may cause a sufficiently large shift and distortion of the relative benefits of participation in the leniency program for owners and managers, respectively.

1.3.3 The course of action

The formal analysis of the complete model with leniency program is presented in section 2.3. Section 3 discusses the significance of the assumptions for the results and considers a specific modification of standard corporate leniency programs, by suggesting a leniency program which also covers damage payments. Before starting with the complete model, however, section 2.1 presents the basic assumption, and section 2.2 solves a benchmark model without leniency program. The results of the benchmark model will then frequently be used in subsequent sections. Some of the proofs can be found in the appendix at the end.

2 The model

2.1 The basic assumptions

This section presents the basic assumption of the game. Consider an infinite extensive game consisting of two identical corporations that compete with each other in every period $t = 1, .., \infty$ on a closed market. The market conditions do not change. Market demand, costs of production and size of the market remain constant through time. Each corporation itself consists of a group of owners (f) and a manager (m). The manager is hired by the owners to transact the periodical business operations on behalf of the group of owners.

Manager payment scheme. In return for his work, the manager receives an exogenously fixed fraction of the per-period profits as payment.

Assumption 1 The manager and the group of owners share the per-period profits according to the rule $\beta \in (0,1)$ assigning the manager $\beta\pi_t$ and the group of owners $(1-\beta)\pi_t$. For simplicity, (1) β is exogenously fixed, (2) β does not change through time, and (3) β is equal for both corporations.

Antitrust Authority. If both managers behave non-cooperatively on the market, each corporation realises a per-period profit equal to $\pi^{nc} \geqslant 0$. Alternatively, if the managers of both corporations enter into an illegal cartel agreement, each corporation yields a per-period profit equal to π^c, where $\pi^c > \pi^{nc}$. Unilateral defection from the cartel agreement yields a one-shot deviation profit equal to $\pi^d > \pi^c$ for the defecting corporation, followed by infinite reversion to the non-cooperative market outcome from the subsequent period on. However, cartel activity creates evidence, which may be detected by the Antitrust Authority, whose primary task is to enforce the antitrust laws. In particular, any form of competition restricting cooperation is forbidden. Upon detection, the Antitrust Authority opens an investigation against both corporations and attempts to collect all legal evidence, which is eventually used in the concluding lawsuit against both corporations. If the Antitrust Authority wins the lawsuit, the owners and the manager of each corporation receive monetary fines. In addition, the owners have to pay damage payments. After the lawsuit, the managers may restart the cartel.

External Detection. Detection, as applied in this model, does not necessarily refer to probative evidence in a legal sense. It simply refers to the probability that the Antitrust Authority takes note of the existence of an illegal cartel. Detection may occur through three different channels: (1) Cartel activity may make it necessary to produce some form of written document, which directly or indirectly confirms the existence of the illegal agreement. The detection probability denotes the probability that this document comes into the Antitrust Authority's possession.[12] (2) Damaged consumers may make a request to the Antitrust Authority. The detection probability here denotes the probability that such a request is made. (3) The Antitrust Authority may screen the industry or carry out an internal analysis on its own initiative, which reveals the cartel. The detection probability

[12] Although this possibility is regarded as less likely, it should not be ruled out.

then refers to the probability that the Antitrust Authority receives a signal about the conspiracy. In this model, the detection probability covers all three possibilities in the sense of a *probability on average* that the Antitrust Authority takes note of the cartel without further specifying how this may happen in the concrete case. In general, the Antitrust Authority never receives false signals, nor does it misinterpret genuine signals.

Assumption 2 Cartel activity in period t is detected by the Antitrust Authority during the same period with probability α, where $\alpha \in (0, 1)$.

Prosecution and fines. Upon detection, the Antitrust Authority opens an investigation at the beginning of the period following the period of detection. The corporation therefore only realizes at the beginning of period $t + 1$ whether it has been detected by the Antitrust Authority during period t or not. The investigation passes directly into a concluding lawsuit against both corporations, which the Antitrust Authority wins with a given prosecution probability. Since detection necessarily precedes the investigation, investigations are opened on the condition only that a cartel has existed, which also has been detected. The Antitrust Authority does not open an investigation by mistake.

The probably most difficult part of the investigation is collecting legal evidence to prove the cartel's existence before court. Legal evidence may be collected through dawn raids or hearing of witnesses. The prosecution probability may then be interpreted in the following way: The prosecution probability refers to the *average* value of the legal evidence collected during the investigation aimed at prosecuting the detected cartel. This assumption does not, however, take into account that a longer investigation phase would typically result in a larger prosecution probability. This feature does not enter the model for simplification reasons. Rather, it assumes a standardized investigation length. Upon prosecution, the group of owners and the manager of each corporation receive monetary fines. In addition, each group of owners has to pay damages.

The investigation and the lawsuit are modelled as instantaneous events at the beginning of the period following the period of detection. The outcome of the lawsuit is immediately known and, in a given case, the fines and damages have to be paid during the same period. The principle of *ne bis in idem* applies.[13] Independently of the lawsuit's outcome, the managers of both corporations may establish a new cartel after the lawsuit.

[13] The principle *ne bis in idem crimen judicetur* states that nobody may be indicted for the same crime twice. In this case, the indictment involves cartel activity during period $t = 1$.

Assumption 3 Upon detection during period t, the Antitrust Authority opens an investigation against the corporations at the beginning of period $t+1$. The investigation is concluded by a lawsuit against the corporations, which the Antitrust Authority wins with probability $p \in (0,1)$. Upon prosecution, the group of owners and the manager are imposed monetary fines $\mathcal{F}^f > 0$ and $\mathcal{F}^m > 0$, respectively. In addition, the group of owners has to pay damages equal to $\mathcal{T} \geqslant 0$. The outcome of the lawsuit is immediately known at the beginning of period $t+1$ before the operational business decision for the same period has to be made. In a given case, the fines and damages have to be paid during the same period.

Internal detection. In addition to external detection by the opening of an investigation by the Antitrust Authority, the owners may learn about ongoing cartel activity internally.

Assumption 4 The managers may initially conceal the existence of a cartel for both groups of owners. A sudden increase in corporate profits from π^{nc} to π^{c} does not uncover cartel activity *per se*. Cartel activity in period t is detected by the group of owners at the end of period t with probability $1-\theta$, where $\theta \in (0,1)$. For simplicity, (1) once the owners have detected a cartel for the first time, the managers are exposed to permanent observation by the owners, and (2) both groups of owners learn simultaneously about cartel activity.

The process of internal detection resembles the process of external detection, as defined by Assumption 2. The crucial difference between both processes is that owners, once they have detected the manager's cartel activity, remain informed, whereas the Antitrust Authority has to detect a new cartel each time with probability α.

Manager-owner relation. The following two assumptions define the relation between the manager and the owners within each corporation, in addition to Assumption 1, which considers the payment scheme only.

Assumption 5 The manager cannot resign from his position, and owners cannot fire the manager.

Assumption 6 Upon detection, the owners may implement a compliance program $\mathcal{C}$, which forces the manager to comply with the antitrust laws. The compliance program

$\mathcal{C}$ generates per-period costs equal to $c > 0$ for the owners. For simplicity, the compliance program cannot be abandoned once it has been implemented.

The utility function. Finally, the last of the basic assumptions defines the utility function for the manager and the group of owners.

Assumption 7 The utility function for the group of owners and the managers is identical and given by $\sum_{t=1}^{t=\infty} \delta^{t-1}\pi_t$, where π_t refers to each agent's profit in period t, and $\delta \in (0,1)$ denotes the common discount factor.

2.2 A benchmark: Model 1 without leniency

The basic assumptions so far define a self-contained model, which serves as a benchmark for the complete model with leniency program, which will be presented below, starting at section 2.3. The results for the benchmark model allow direct comparison of traditional law enforcement instruments, as they are considered in this section, with modern law enforcement instruments, as they are considered in section 2.3.

2.2.1 The timing and the main analytical interest

At the beginning of the first period at time $t = 1$, the managers enter into an illegal cartel agreement since $\pi^d > \pi^c > \pi^{nc}$ and deviation does not create evidence. If, however, unilateral deviation incentives are sufficiently strong, the cartel breaks down immediately and the game passes into the infinitely repeated non-cooperative market game. One of the two relevant questions of the benchmark model is thus whether the managers prefer to keep cartel discipline. The present discounted payoff for the deviation strategy is given and does not depend on any future event. Once the corporations have entered the punishment path, the extensive game transforms into an infinitely repeated non-cooperative game with the same profits in each period. The decision concerning deviation therefore depends on the expected value of the cartel strategy, which, in contrast, depends on the probability of the occurrence of various given events, as they are defined by Assumptions 1 to 7.

The timing and order of all possible events and the correspondingly related strategical questions that arise for the case where none of the managers deviate, can be seen in Figure 3 if one ignores all features that are related to the leniency program. Whether the owners decide to implement the compliance program *before* the Antitrust Authority possibly opens

an investigation (upper panel) or *after* the Antitrust Authority has opened an investigation (lower panel) affects neither the expected nor the actual outcome of the (possible) lawsuit at the beginning of the third period. In either case, the compliance program or the "new" cartel would be effective from the third period on. The distinction between the intermediate and final stage refers only to the chronological order of the two stochastic events "Owners decide" and "Antitrust Authority investigates". For the benchmark model, however, this distinction becomes irrelevant. The second relevant question for the benchmark model comprises the determination of an appropriate condition, which states when the owners become indifferent between implementing the compliance program and allowing the manager to continue with the cartel.

2.2.2 Solution

Implementing the compliance program. According to Figure 3, assume the owners have detected the manager's involvement in illegal cartel activity. As mentioned, the two scenarios in the upper and lower panel are equivalent with respect to the owners' decision concerning implementation of the compliance program. Also, it is not necessary to take the (expected) outcome of the (possible) lawsuit at the beginning of the third period into account in the following expressions.

If the owners prefer allowing the manager to continue cartel activity, the owners make a per-period profit equal to $(1-\beta)\pi^c$. Each single period cartel activity may also lead to (future) detection by the Antitrust Authority, which implies an expected per-period profit deduction equal to $\delta\alpha p(\mathcal{F}^f + \mathcal{T})$. The expected value of the present discounted payoff of the infinite cartel strategy to the owners is thus given by:

$$\mathcal{V}_f^c = \frac{(1-\beta)\pi^c - \delta\alpha p(\mathcal{F}^f + \mathcal{T})}{1-\delta} \tag{1}$$

Alternatively, if the owners implement the compliance program, the present discounted value is given by:

$$\mathcal{V}_f^{cp} = \frac{(1-\beta)\pi^{nc} - c}{1-\delta} \tag{2}$$

Equating both values and solving for α yields:

$$\alpha_{cp}(p) = \frac{\mathcal{X}}{\delta p(\mathcal{F}^f + \mathcal{T})} \tag{3}$$

where $\mathcal{X} = (1-\beta)(\pi^c - \pi^{nc}) + c$. If the given pair $(\alpha, p) \in (0,1)x(0,1)$ lies on or below $\alpha_{cp}(p)$, the owners prefer tolerating the manager's cartel activity. Otherwise, they implement the compliance program. The critical value $\alpha_{cp}(p)$ is (i) a decreasing function in p, (ii) $\alpha_{cp}(p) \to \infty$ as $p \to 0$ and (iii) $\alpha_{cp}(p) \leqslant 1$ if $\mathcal{X} \leqslant \delta p(\mathcal{F}^f + \mathcal{T})$. Holding p fixed, $\alpha_{cp}(p)$ is increasing in $\mathcal{X}$ and decreasing in both δ and $(\mathcal{F}^f + \mathcal{T})$. Expression (3) exhibits no surprising dependences. The level for the detection probability α that makes the owners indifferent between implementing the compliance program and tolerating the manager's cartel activity is obviously increasing in the difference between the per-period cartel and non-cartel profit, decreasing in the costs for the compliance program as well as decreasing in the expected fine and damage payments.

Since the following analysis does not really make sense if the given level of the sum of the corporate fine and the damage payments is too low, the following requirement shall be satisfied throughout the remainder with respect to the sum $(\mathcal{F}^f + \mathcal{T})$:

$$\exists\ p \in (0,1) \text{ s.t. } \mathcal{X} = \delta p(\mathcal{F}^f + \mathcal{T}) \tag{4}$$

The condition requires a minimum level for the sum $(\mathcal{F}^f + \mathcal{T})$. Otherwise, the corporations would always prefer the cartel strategy since $\alpha_{cp}(p) > 1$ for all values of p. Thus, the values of $\mathcal{F}^f$ and $\mathcal{T}$ are taken as given, and the sum $(\mathcal{F}^f + \mathcal{T})$ satisfies requirement (4). Later, the analysis considers different corporate fine-damage payment ratios in order to carry out comparative statics.

Figure 4 illustrates condition (3) in the (α, p) unit square. All points on or below $\alpha_{cp}(p)$ correspond to feasible combinations of the detection and prosecution probability for which the owners would prefer to tolerate the manager's cartel activity, as point B for instance. Since all variables and parameters of the model are given and known, the owners are able to locate the precise position of the given value of (α, p) under consideration in the (α, p) unit square. Point A, for instance, refers then to the case where the owners would prefer to implement the compliance program.

Deviating at the beginning of the game At the initial stage, each manager has to decide whether to deviate unilaterally or keep cartel discipline. The decision is thereby affected by that what might happen at some later stage of the game when the owners and the Antitrust Authority get involved. In particular, the decision is affected by the expectation about how likely the implementation of the compliance program is, and how

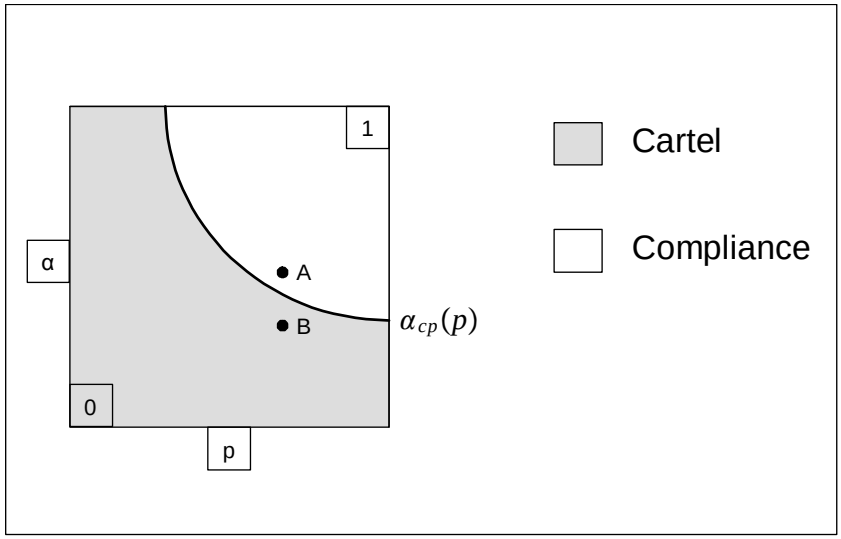

Figure 4: The owners' preferences

likely it is that the Antitrust Authority detects and prosecutes the cartel, for a given fine $\mathcal{F}^m$.

Owners prefer cartel activity. Assume first $\alpha \leqslant \alpha_{cp}(p)$, implying that the owners would tolerate cartel activity, which in turn implies that secrecy towards the owners is not relevant in this case. The value of the expected present discounted payoff of an infinite cartel strategy to the manager is given by:

$$\mathcal{V}_m^c = \frac{\beta\pi^c - \delta\alpha p\mathcal{F}^m}{1-\delta} \tag{5}$$

which, in principle, resembles expression (1). The deviation strategy yields on the other hand:

$$\mathcal{V}_m^d = \beta\left[\pi^d + \frac{\delta}{1-\delta}\pi^{nc}\right] \tag{6}$$

Equating both expressions and solving for α results in:

$$\alpha_d(p) = \frac{\beta\left[\delta(\pi^d - \pi^{nc}) - (\pi^d - \pi^c)\right]}{\delta p\mathcal{F}^m} \tag{7}$$

If the given pair $(\alpha, p) \in (0,1)x(0,1)$ lies on or below $\alpha_d(p)$, the manager has no incentive to deviate from the cartel agreement unilaterally. Otherwise, the cartel is not going to exist at all. The critical value $\alpha_d(p)$ contains the well-known condition on δ to be equal or larger than $\frac{(\pi^d - \pi^c)}{(\pi^d - \pi^{nc})}$ for any cartel agreement to be stable. If $\delta < \frac{(\pi^d - \pi^c)}{(\pi^d - \pi^{nc})}$, then $\alpha_d(p)$ is negative implying that deviation becomes the optimal strategy for all values $\alpha \in (0,1)$. The main analytical interest is not, however, aimed at examining the importance of the discount factor for the values of the various strategies under consideration. For that reason, δ is assumed to be equal or larger than $\frac{(\pi^d - \pi^c)}{(\pi^d - \pi^{nc})}$ in the following. With this restriction, $\alpha_d(p)$ is (i) a decreasing function in p, (ii) $\alpha_d(p) \to \infty$ as $p \to 0$ and (iii) $\alpha_d(p) \leqslant 1$ if $\beta\left[\delta(\pi^d - \pi^{nc}) - (\pi^d - \pi^c)\right] \leqslant \delta p \mathcal{F}^m$. As above, the expression exhibits no unexpected characteristics. The level of the detection probability for which the manager becomes indifferent between deviating unilaterally and keeping cartel discipline is increasing in the forgone long-run cartel profit, decreasing in the short-run deviation profit as well as decreasing in the expected fine.

Owners prefer compliance. If $\alpha > \alpha_{cp}(p)$, the manager knows that detection means immediate implementation of the compliance program. Denote the present discounted payoff for the manager after the implementation of the compliance program as $\mathcal{V}_m^{nc} = \frac{(1-\beta)\pi^{nc}}{1-\delta}$. Detection occurs externally with probability α and internally with probability $(1-\theta)$. In the former case, the manager risks additionally the imposition of the monetary fine $\mathcal{F}^m$. Only with probability $(1-\alpha)\theta$, the manager remains completely undetected from one period to the next. The expected outcome of this restricted cartel strategy to the manager is thus given by:

$$\widetilde{\mathcal{V}} = \beta\pi^c + \delta\left\{\alpha\left[\mathcal{V}_m^{nc} - p\mathcal{F}^m\right] + (1-\alpha)\left[\theta\widetilde{\mathcal{V}} + (1-\theta)\mathcal{V}_m^{nc}\right]\right\} \tag{8}$$

The notation $\widetilde{\mathcal{V}}$ is only a temporary notation since the actual value is not of interest at any later point. Solving (8) for $\widetilde{\mathcal{V}}$, equating the solution with $\mathcal{V}_m^d$ and finally solving for α results in:

$$\alpha_d(p,\theta) = \frac{\beta\left[\delta\theta(\pi^d - \pi^{nc}) - (\pi^d - \pi^c)\right]}{\delta\left[\beta\theta(\pi^d - \pi^{nc}) + p\mathcal{F}^m\right]} \tag{9}$$

Comparing (7) with (9), $\alpha_d(p,\theta) < \alpha_d(p)$ for all $(\theta, p) \in (0,1)x(0,1)$. Observe that $\alpha_d(0,\theta) < 1$ for all $\theta \in (0,1)$. Keeping p fixed, $\alpha_d(p,\theta)$ is decreasing in both the internal detection probability $(1-\theta)$ and the personal fine $\mathcal{F}^m$. Thus, the aggregated deterrent is

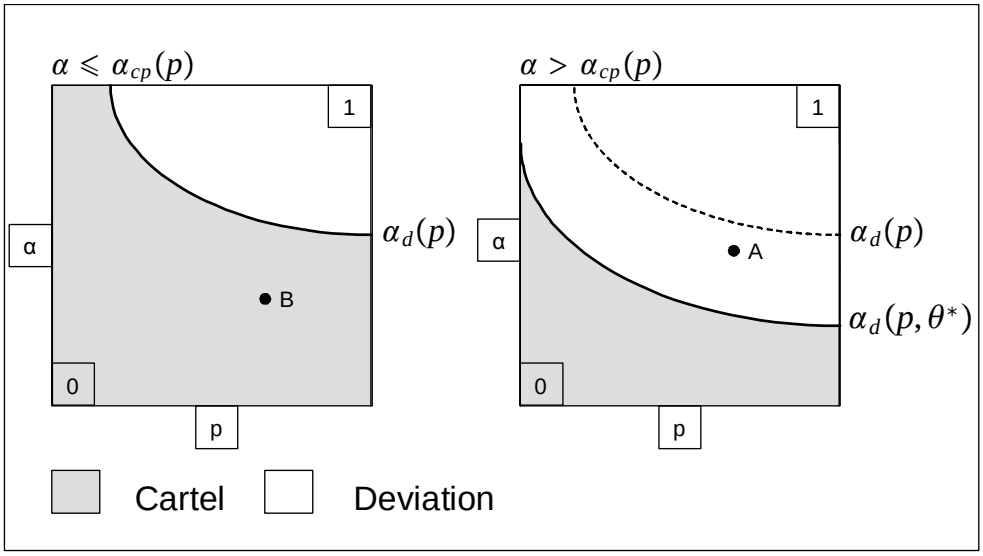

Figure 5: The manager's preferences

larger than before, which is not surprising. In addition to the possible fine, the manager's incentive for deviation increases as the probability for termination of the cartel by the implementation of the compliance program increases. Thus the parameter range for which the manager prefers to deviate is enlarged compared to the case where the owners tolerate the manager's cartel participation.

Figure 5 illustrates both cases. The left panel depicts $\alpha_d(p)$ under the condition that $\alpha \leqslant \alpha_{cp}(p)$ and the right panel depicts $\alpha_d(p, \theta)$ - with an arbitrary fixed θ^* - under the condition that $\alpha > \alpha_{cp}(p)$. The right panel contains also the graph of $\alpha_d(p)$ in order to highlight the enlarged deterrence effect due to the possible implementation of the compliance program. With reference to the example of Figure 4, point B corresponds to the situation where the infinite cartel strategy constitutes a subgame perfect equilibrium. Point A corresponds to a situation where the manager deviates at the beginning of the game.

Proposition 1 summarizes the results of this section.

Proposition 1 ***Benchmark Model.*** *(I) Assume $\alpha \leqslant \alpha_{cp}(p)$. The infinite cartel strategy s^c constitutes a subgame perfect equilibrium of the benchmark model if and only if $\alpha \leqslant \alpha_d(p)$. If $\alpha > \alpha_d(p)$, the manager deviates during the first period. (II) Assume $\alpha > \alpha_{cp}(p)$. The compliance strategy s^{cp} constitutes a subgame perfect equilibrium if and only if $\alpha \leqslant$*

$\alpha_d(p,\theta)$. *If* $\alpha > \alpha_d(p,\theta)$, *the manager deviates during the first period.*

Proof. Follows directly from above. ■

The results of Proposition 1 are subsequently used to illustrate the welfare effects of implementing the leniency program. The economic interpretation of the results for the benchmark model are of little interest as they show no surprising or unexpected characteristics. Both the manager and the owners prefer cartel activity if the expected present discounted value of the infinite cartel strategy exceeds the corresponding values in relation to the compliance strategy as the alternative strategy for the owners, or the deviation strategy as the alternative strategy for the manager. If the owners do not prefer the infinite cartel strategy, the value of the deviation strategy for the manager increases, as the possible termination through the implementation of the compliance program would decrease the expected lifetime of the cartel. For that reason, $\alpha_d(p,\theta)$ depends on the internal detection probability and $\alpha_d(p,\theta) < \alpha_d(p)$.

2.3 Model 2 with leniency program

2.3.1 The assumptions about leniency

Introduction. The following section defines and presents the necessary additional assumptions concerning the procedures in relation to the leniency program as well as the program itself. If the Antitrust Authority has implemented a leniency program, it offers one or more involved agents financial incentives in exchange for relevant information about the cartel. The collected information typically increases the probability of prosecuting all remaining agents who have not cooperated with the Antitrust Authority. In return for cooperation, the agents receive a reduction of their fine. This simple description contains already the main motives for the Antitrust Authority to implement such programs. Involved agents may cooperate because it implies a fine reduction, and the Antitrust Authority cooperates because the it increases its chance for winning the lawsuit against all non-cooperating agents.

Probative evidence. It is reasonable to assume that involved agents possess useful information about the cartel and the other involved agents, which may be used either directly as probative evidence or lead to other relevant information. The managers will typically have the largest amount of information at their disposal as they are the actual wrongdoers.

Assumption 8 Let $\varphi_m \in (0,1)$ be the amount of probative evidence in possession of each manager. Assume that $\varphi_m > p$ stating that each manager possesses strictly more evidence than the Antitrust Authority. In general, $\varphi_m > p$ shall mean that the manager has $\Delta = \varphi_m - p$ additional probative evidence compared to the Antitrust Authority. Probative evidence in the manager's possession incriminates the other group of owners and the other manager with φ_m.

The corporate leniency program $\mathcal{L}^c$. The Antitrust Authority grants leniency in exchange for a confession statement and delivery of all available probative evidence in the applicant's possession. For simplicity, infringement concerning the amount of evidence to be delivered is not possible.

Assumption 9 Assume a cartel has been active in period $t-1$. The Antitrust Authority grants leniency to the first corporation to come forward at the beginning of period t (Corporate Self-Report). A successful corporate leniency application results in complete fine immunity for both the manager and the group of owners. If no corporate self-report takes place and the Antitrust Authority opens proceedings at the beginning of period t, corporate leniency is still available for the first corporation to come forward (Corporate Report). Corporate leniency applications will only be accepted if (1) the corporation has implemented the compliance program and (2) the owners are able to ensure the manager's cooperation. Damage payments are not covered by the corporate leniency program.

The first condition requires the benefiting corporation to be the first to approach the Antitrust Authority, either before or after an investigation has been opened.[14] For simplicity, the probability of being first is assumed to be equal to $\frac{1}{2}$ throughout the paper. The second condition requires the immediate termination of any participation in cartel activity that shall be translated into the model's language as the immediate implementation of the compliance program before the application takes place.[15] For simplicity, the Antitrust Authority is not able to prove in which period the owners learned about the cartel. The third condition concerns the full and complete cooperation of the manager as the main

[14] U.S. corporate leniency program: (1) "At the time the corporation comes forward [...], the Division has not received information [...] from any other source" (2) "The corporation is the first one...", DoJ (1993).

[15] U.S. corporate leniency program: "The corporation [...] **took** prompt and effective action to terminate its part in the activity", DoJ (1993).

actor and most important source of information.[16] Finally, corporate leniency does not cover damage payments.

The individual leniency program $\mathcal{L}^i$. In contrast to the corporate leniency program, the individual leniency program does not require the implementation of the compliance program *per se*. The distinction does not affect any of the presented results. Applying for individual leniency has an even harsher consequence than unilateral deviations, that is, individual leniency applications trigger the immediate and infinite reversion to the non-cooperative market solution.

Assumption 10 As long as the Antitrust Authority has not opened an investigation against the corporations, the manager may approach the Antitrust Authority on his own behalf. If the owners approach the Antitrust Authority at the same time as the manager, the application is regarded as a corporate leniency application. For simplicity, any individual leniency application at the beginning of period t triggers the infinite reversion to the non-cooperative market solution from the same period on. Individual leniency includes complete fine immunity for the manager.

2.3.2 The solution of the final stage

Introduction. Upon opening an investigation at the beginning of some period t, the owners have to make a decision concerning three different strategies. In the benchmark model, the owners had two options only: they accepted the infinite continuation of the cartel strategy, or they implemented the compliance program. Neither option affected the expected outcome of the investigation or the related lawsuit at the beginning of period t. With the corporate leniency program, however, the owners have an additional third option, which affects the outcome of the present investigation and lawsuit. The strategy where the owners decide to report upon the opening of an investigation is denoted as the corporate report strategy s^{cr}. The individual leniency program does not enter the analysis of the final stage.

[16] "If the corporation is unable to secure the cooperation of one or more individuals, that will not necessarily prevent the Division from granting the amnesty application. However, the number and significance of the individuals who fail to cooperate, and the steps taken by the company to secure their cooperation, are relevant in the Division's determination as to whether the corporations's cooperation is truly 'full, continuing and complete'.", Gary R. Spartling DAAG Antitrust Division, April 1, 1998.

Cooperation of the manager. A necessary condition for acceptance into the corporate leniency program requires the full cooperation of the manager, apart from the implementation of the compliance program. This requirement only applies at the final stage in relation to a (possible) corporate report, but at for the intermediate stage in relation to a (possible) corporate self-report. The following Lemma states a more general result, which subsequently will be referred to occasionally.

Lemma 1 *The manager is willing to cooperate with the Antitrust Authority immediately after the implementation of the compliance program.*

Proof. If the Antitrust Authority has opened an investigation, and the owners decide to implement the compliance program in order to carry out a corporate self-report, the manager receives $0 + \mathcal{V}_m^{nc}$, if he cooperates. If the manager refuses cooperation, the corporation will not be regarded as an eligible applicant, and the manager then expects to receive $-p\mathcal{F}^m + \mathcal{V}_m^{nc}$. If the owners implement the compliance program before the Antitrust Authority possibly opens an investigation, the manager expects to receive $-\alpha p\mathcal{F}^m + \mathcal{V}_m^{nc}$. Immediate cooperation yields again $0 + \mathcal{V}_m^{nc}$. ■

Determining the relevant conditions. Table 1 illustrates all available strategies for the owners at the final stage:

Table 1: The owners' strategies at the final stage		
Strategy		Expected payoff
s^c	Infinite Cartel	$-p(\mathcal{F}^f+\mathcal{T}) + \mathcal{V}_f^c$
s^{cr}	Corporate Report	$-\mathcal{T} + \mathcal{V}_f^{cp}$
s^{cp}	Voluntary Compliance	$-p(\mathcal{F}^f+\mathcal{T}) + \mathcal{V}_f^{cp}$

Note that the present discounted strategy payoff s^{cr} is denoted as a deviation payoff, given that the other corporation has chosen either s^c or s^{cp}. Comparing s^{cr} with s^{cp}, owners prefer to cooperate if and only if:

$$p > \frac{\mathcal{T}}{\mathcal{F}^f+\mathcal{T}} \tag{10}$$

If condition (10) holds, strategy s^{cp} is strictly dominated by s^{cr}, leaving the owners with the choice between s^c and s^{cr}. Equating the corresponding payoffs from the above

table and solving for α yields:

$$\alpha_{cr}(p) = \alpha_{cp}(p) + \frac{1-\delta}{\delta}\left[\frac{\mathcal{T}}{p(\mathcal{F}^f + \mathcal{T})} - 1\right] \tag{11}$$

Observe that $\alpha_{cr}(p) < \alpha_{cp}(p)$ for all p satisfying $p > \frac{\mathcal{T}}{\mathcal{F}^f+\mathcal{T}}$, that is, condition (10). If the given pair (α, p) lies on or below $\alpha_{cr}(p)$, the owners prefer to allow the manager to continue the cartel strategy. Otherwise, the owners prefer to implement the compliance program in order to carry out a corporate report.

If condition (10) does not hold, the solution remains the same as in the benchmark model. The owners then prefer to implement the compliance program voluntarily if the given pair (α, p) lies above $\alpha_{cp}(p)$. Otherwise, the owners prefer to allow the manager to continue with the cartel strategy.

Lemma 2 *Assume the game has reached the final stage. (Case 1) Owners prefer to participate in the corporate leniency program by carrying out a corporate report if and only if* $p > \frac{\mathcal{T}}{\mathcal{F}^f+\mathcal{T}}$ *and the given pair* (α, p) *lies above* $\alpha_{cr}(p)$*. (Case 2) Owners prefer to implement the compliance program voluntarily if and only if* $p \leqslant \frac{\mathcal{T}}{\mathcal{F}^f+\mathcal{T}}$ *and the given pair* (α, p) *lies above* $\alpha_{cp}(p)$*. (Case 3) If the given pair* (α, p) *lies on or below* $\min\{\alpha_{cr}(p), \alpha_{cr}(p)\}$*, the owners prefer the manager to continue with the cartel where* $\alpha_{cr}(p) \leqslant \alpha_{cp}(p)$ *if and only if* $p > \frac{\mathcal{T}}{\mathcal{F}^f+\mathcal{T}}$*.*

Proof. Omitted. ■

Concluding remarks. Condition (10) - although far from spectacular - is the key condition throughout the paper. Most of the results will significantly depend on whether this condition holds. Two observations follow directly from (10). Firstly, condition (10) determines whether the corporate leniency program exhibits any effect at the final stage at all. Secondly, increasing $\mathcal{F}^f$ increases the probability that condition (10) is satisfied. In particular, owners prefer always to cooperate if $\mathcal{T} = 0$, for any given $\mathcal{F}^f$. Increasing the corporate fine therefore does not increase the preference for the corporate leniency program *per se*. Increasing the corporate fine increases the preference for the corporate leniency program since the fraction of components covered by the corporate leniency program increases compared to the fraction of components not covered. In this paper, the former type of components refers to the corporate fine, the latter to damage payments.

The second part of the rhs of (11) refers directly to possible beneficial welfare effects of the corporate leniency program. First, if condition (10) holds, the parameter range for which owners prefer to allow the manager to continue the cartel strategy is reduced, as $\alpha_{cr}(p) \leqslant \alpha_{cp}(p)$ if and only if $p > \frac{\mathcal{T}}{\mathcal{F}^f+\mathcal{T}}$. Secondly, the corporate leniency program induces the corporations to cooperate with the Antitrust Authority at the final stage. The Antitrust Authority's probability for prosecuting the remaining non-cooperating agents increases. The first effect is related to the concept of pro-collusivity.

Definition 1 *A leniency rule $\mathcal{L}$ is said to create a pro-collusive (anti-collusive) effect if the relative value of the cartel strategy increases (decreases) after the implementation of $\mathcal{L}$. If a leniency rule $\mathcal{L}$ is pro- and anti-collusive, then $\mathcal{L}$ is called neutral.*

In this paper, there may be two different sources for pro-collusivity in general. Either the manager is more likely to initiate cartel activity, or the owners are more likely to accept existing cartel activity. In relation to the final stage, only the latter type applies.

Figure 6 illustrates Lemma 2. The left panel shows the beneficial welfare effect of the corporate leniency program, which is related to the reduction of the parameter range for which the owners prefer the infinite cartel strategy. In the figure, this area is highlighted as the hatched area. For $p = p'$, the two graphs of $\alpha_{cr}(p)$ and $\alpha_{cp}(p)$ intersect at height $\frac{\mathcal{X}}{\delta\mathcal{T}}$ where p' solves condition (10) with equality. For all values of $p > p'$, condition (10) strictly holds. Figure 6 shows an example where $\frac{\mathcal{X}}{\delta\mathcal{T}} < 1$. If $\frac{\mathcal{X}}{\delta\mathcal{T}} \geqslant 1$, the point of intersection lies outside the unit square. However, the following result holds regardless of whether the point of intersection lies inside or outside the unit square:

Comparative statics. If one lowers the damage payments while increasing the corporate fine such that $\mathcal{T}^* < \mathcal{T}$ and $\mathcal{F}^{f*} > \mathcal{F}^f$ and $(\mathcal{F}^{f*}+\mathcal{T}^*) = (\mathcal{F}^f+\mathcal{T})$ remains constant, $\alpha_{cp}(p)$ holds its position while $\alpha_{cr}(p)$ moves downwards as indicated by the arrows in the left panel of Figure 6.[17] The point of intersection thus moves to the left and upwards, along $\alpha_{cp}(p)$, since $\frac{\mathcal{X}}{\delta\mathcal{T}^*} > \frac{\mathcal{X}}{\delta\mathcal{T}}$ and $p'(\mathcal{F}^f, \mathcal{T}) > p'(\mathcal{F}^{f*}, \mathcal{T}^*)$. The parameter region for which the owners prefer to participate in the leniency program at the final stage becomes larger since a larger fraction of the sum $(\mathcal{F}^{f*}+\mathcal{T}^*)$ is affected by the corporate leniency program. This result as such is nearly trivial, the reason for pointing it out anyway is related to the graphical

[17] The effect of lowering $\mathcal{T}$ without keeping $(\mathcal{F}^f + \mathcal{T})$ constant is ambiguous as it increases the preference for the corporate leniency program, thus $\alpha_{cr}(p)$ shifts downwards, and it decreases the deterrent, thus $\alpha_{cr}(p)$ shifts upwards.

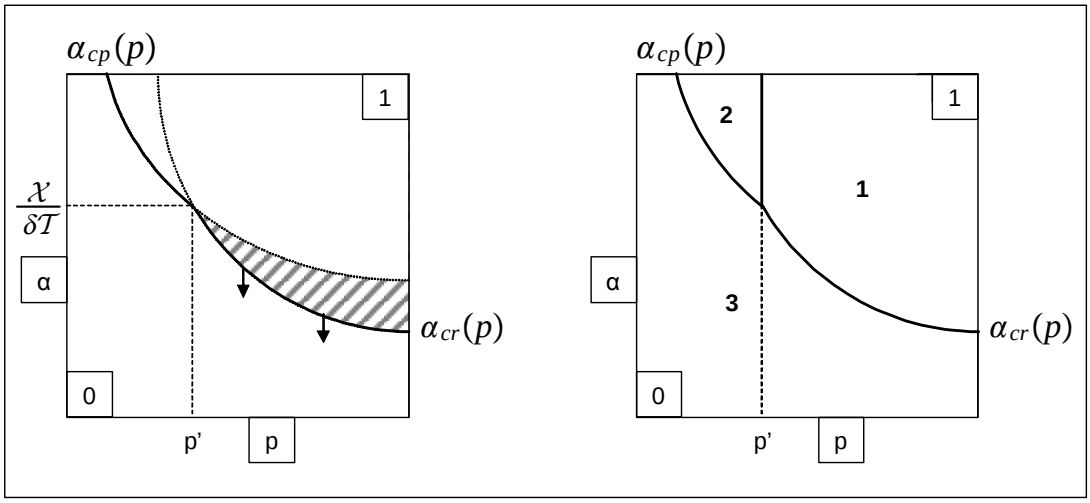

Figure 6: The final stage

representation of Lemma 2. The right panel of Figure 6 shows the division of the (α, p) unit square into the three subcases as defined by Lemma 2 where $\frac{\mathcal{X}}{\delta\mathcal{T}} < 1$ for a given value of $(\mathcal{F}^f + \mathcal{T})$. Lowering the damage payments from $\mathcal{T}$ to $\mathcal{T}^*$ while increasing the corporate fine from $\mathcal{F}^f$ to $\mathcal{F}^{f*}$, increases area 1 and decreases areas 2 and 3. If $\mathcal{X} > \delta\mathcal{T}^*$, there is no area 2 at all.

The division of the parameter space according to Lemma 2 determines the following course of action where all three cases are considered in backward order. In each case, the first step comprises looking at the intermediate stage, given what happens at the final stage and finally, considering the initial stage, given what happens at both the intermediate and final stage.

2.3.3 The solution of the intermediate and initial stage

Case 3: Owners prefer cartel activity Case 3 is the analytically least interesting case, as mentioned in section 1.3. For that reason, the presentation is limited to the following lemma only.

Lemma 3 ***Case 3.*** *Assume the given pair* (α, p) *lies on or below* $\min\{\alpha_{cr}(p), \alpha_{cp}(p)\}$. *The managers enter into a cartel agreement at the initial stage. If and only if* $\alpha \leqslant \alpha_d(p)$, *none of the managers deviate unilaterally, existing cartel activity will not be terminated at*

any later stage of the game, and no leniency application will be observed. If $\alpha > \alpha_d(p)$, the cartel breaks down during the first period of the game.

Proof. See appendix. ■

Case 2: Owners do not cooperate at the final stage The region which defines Case 2 is located above $\alpha_{cp}(p)$ and to the left of p', for some fixed value $\mathcal{T}$ satisfying $\mathcal{X} < \delta\mathcal{T}$, as depicted in Figure 6. If the last requirement does not hold, there is no Case 2.

In general, without individual leniency program, the owners prefer to implement the compliance program immediately, since the given pair (α, p) lies above $\alpha_{cp}(p)$. This result corresponds exactly to the corresponding result for the benchmark model. With the individual leniency program, however, the result changes significantly. With reference to the lower panel of Figure 3, the immediate implementation of the compliance program at the end of the second period generates a strict incentive for the manager to contact the Antitrust Authority in order to carry out an individual self-report. During this infinitesimal period between the end of the second and the beginning of the third period, the manager expects a present discounted payoff equal to $\mathcal{V}_m^{nc} - \alpha p \mathcal{F}^m$. The first part relates to the implementation of the compliance program, and the second part relates to the uncertainty about the occurrence of the investigation at the beginning of the third period. If he chooses an individual self-report, he receives $\mathcal{V}_m^{nc} - \frac{1}{2}\varphi_m \mathcal{F}^m$ instead. The last expression takes into account that also the other manager prefers to contact the Antitrust Authority, and thus there is a probability equal to $\frac{1}{2}$ of being the first one to come forward. The crucial point is, however, that even if $\frac{1}{2}\varphi_m \mathcal{F}^m > \alpha p \mathcal{F}^m$, the manager would try to carry out the individual self-report since any possible agreement with the other manager creates a deviation payoff equal to 0. Even the expected possibility of being the second to come forward cannot keep the manager from trying to be first.

The owners have basically three possible reactions to this threat: (1) The owners could apply for corporate leniency at the same time. By Assumption 10, the application of both the manager and the owners would then be regarded as a corporate self-report. (2) The owners could simply accept the manager's individual self-report. They pay the fine and damages although the Antitrust Authority's chances of winning the lawsuit increase considerably due to the manager's cooperation. The expected present discounted payoff in relation to the first option is given by $\mathcal{V}_f^{cp} - \mathcal{T}$, whereas the latter option results in $\mathcal{V}_f^{cp} - \varphi_m(\mathcal{F}^f + \mathcal{T})$. Both options are, however, less profitable than the third option: (3)

They make an agreement with the manager stating that the owners abstain temporarily from implementing the compliance program as long as the Antitrust Authority does not open an investigation. If and when the Antitrust Authority opens an investigation, the manager's threat stops, the owners implement the compliance program and possibly pay the corporate fine and damage payments. From this period on, the owners' expected present discounted payoff is given by $\mathcal{V}_f^{cp} - p(\mathcal{F}^f + \mathcal{T})$, which is larger than $\mathcal{V}_f^{cp} - \mathcal{T}$ since condition (10) does not hold in Case 2. Until then, however, the owners earn the larger cartel profits. The expected present discounted payoff is therefore larger than the corresponding payoffs in relation to the first two options. The agreement does not exhibit real effects if the Antitrust Authority opens an investigation right at the beginning of the third period. In all other cases, however, the manager continues with the cartel until the Antitrust Authority opens an investigation.

At the initial stage in the benchmark model, the manager took into account that detection immediately led to termination by the owners. With the leniency program, the manager knows that one of the two types of detection implies temporary continuation of the cartel. This result increases the preference for keeping cartel discipline, or alternatively decreases unilateral deviation incentives, as the prospect for long-run cartel profits is enhanced. The new critical level for the initial stage, indicating the level of indifference between cartel discipline and unilateral deviation incentives thus increases compared to the critical level of the benchmark model, which was given by $\alpha_d(p, \theta)$.

The result for Case 2 is summarized in the following lemma.

Lemma 4 ***Case 2. (1) Intermediate stage.*** *Upon internal detection by the owners, the owners allow the manager to continue with the cartel. As soon as the Antitrust Authority opens an investigation, the owners implement the compliance program. Without individual leniency program $\mathcal{L}^i$, owners would immediately implement the compliance program. (2)* ***Initial stage.*** *The manager keeps cartel discipline if and only if $\alpha \leqslant \alpha_d(p, 1)$ where $\alpha_d(p, 1) > \alpha_d(p, \theta)$ for all $\theta \in (0, 1)$. Without individual leniency program $\mathcal{L}^i$, the corresponding critical value would be given by $\alpha_d(p, \theta)$.*

Proof. See appendix. ■

Compared to the result for the benchmark model, the manager profits considerably by the leniency program. It is a combination of three decisive factors that generates this result: (1) The owners prefer cartel termination over cartel activity, (2) the owners prefer lawsuit over participation in the corporate leniency program, and (3) the existence of the

individual leniency program. In Case 2, the parameter range for which the managers keep cartel discipline at the initial stage has obviously increased, since the individual leniency program has eliminated one possible cause for termination by the owners.

The concluding proposition presents the first of a total of three cases considering how the individual leniency program affects the market outcome without the individual leniency application actually taking place at the same time. The pressure arises merely due to the threat of carrying out an application.

Proposition 2 *The manager may threaten the owners to apply for individual leniency if the owners prefer to terminate undetected cartel activity ($\alpha > \alpha_{cp}(p)$) while the corporate leniency program is sufficiently unattractive for the owners at the same time ($p < p'$ for given $\mathcal{T}$ satisfying $\mathcal{X} < \delta\mathcal{T}$). This threat makes the owners willing to allow the manager to continue with the cartel.*

Proof. Follows directly from the above explanations. ■

One interesting implication of Proposition 2 is the increased willingness of the manager to keep cartel discipline. The economic literature on leniency programs has focused on exactly this effect, which is generally related to the concept of pro-collusivity, in accordance with Definition 1. The reason this effect occurs has typically been attributed to leniency programs, which have changed the corporations' expectations about the profitability of cartel activity in the "wrong" direction by increasing this expectation, compared to the situation without leniency program. Here, the opposite is true. Pro-collusivity arises since the corporate leniency program is sufficiently unattractive for the owners. The damage payments are sufficiently larg, and the detection probability is sufficiently low, as expressed by the phrase "$p < p'$ for given $\mathcal{T}$ satisfying $\mathcal{X} < \delta\mathcal{T}$" in Proposition 2. This dislike may then be exploited by the manager in order to maintain the opportunity to continue cartel activity. Damage payments thus have two effects: They obviously increase the general deterrence effect. On the other hand, sufficiently large damage payments give the manager an opportunity to exploit the individual leniency program as the damage payments drive a wedge between the corporate and the individual leniency program.

Case 1: Owners cooperate at the final stage Case 1 corresponds to the situation where the owners prefer to participate in the corporate leniency program at the final stage by carrying out a corporate report since $V_f^c - p(\mathcal{F}^f + \mathcal{T}) < V_f^{cp} - \mathcal{T}$. In Figure 6, this region corresponds to all points (α, p) lying above $\alpha_{cr}(p)$ and to the right of p'. The latter

condition refers to the prosecution probability in relation to the lawsuit, which is sufficiently high, implying that the owners benefit by the fine reduction in return for cooperation even though this definitely also implies payment of damages. The owners' generally positive attitude towards the corporate leniency program at the final stage constitutes the principle difference to the situation of Case 2. At the beginning of the intermediate stage, the owners thus know what they prefer to do, given the game has reached the final stage. As in the case before, the owners may prefer to do something already at the beginning of the intermediate stage, which might affect the probability whether the final stage occurs at all. The owners may also prefer to do nothing at the beginning of the intermediate stage, implying that the manager temporarily continues with the cartel, while they act only then, if the final stage actually has occurred.

As in Case 2, also the result for Case 1 is decisively determined by the individual leniency program. In the first place, the case $\mathcal{X} < \delta\mathcal{T}$ is considered. The case $\mathcal{X} \geqslant \delta\mathcal{T}$ will be considered after the results for the former case have been presented, by carrying out comparative statics, showing how the results change as the relationship between $\mathcal{X}$ and $\delta\mathcal{T}$ changes.

Before presenting the relevant strategic considerations at the intermediate stage, however, it is necessary to point out an important change in the viewing angle. So far, all relevant conditions indicating the level of indifference between any two options have been expressed in terms of the detection probability α as a function of the prosecution probability p. In Case 1 however, the occurrence of the final stage would lead to the owners' cooperation with the Antitrust Authority. Since the two cooperations are identical, each group of owners prefers cooperation, which implies that there is a probability of not being the first one to come forward. The *ex ante* expectation about the litigation payoff at the final stage is thus given by $\frac{1}{2}\left[\mathcal{T} + \varphi_m(\mathcal{F}^f + \mathcal{T})\right]$. The first part refers to the payoff in case the corporation wins the "run to the courthouse", whereas the second part refers to the payoff in case the corporation loses the race. As it can be seen, the prosecution probability p does not enter this expression. The payoffs of all available options at the intermediate stage are, however, compared with this particular outcome at the final stage. The following critical values are therefore expressed in terms of the detection probability α as a function of the probative evidence φ. The assumption $\varphi_m > p$ simplifies the graphical representation as the relevant areas in the (α, φ) and (α, p) unit square seemingly coincide. To every point (α^*, p^*) in the relevant area of the (α, p) unit square corresponds an open interval $(\varphi^*, 1)$ at height α^* in the (α, φ) unit square, as shown in Figure 7. The relevant

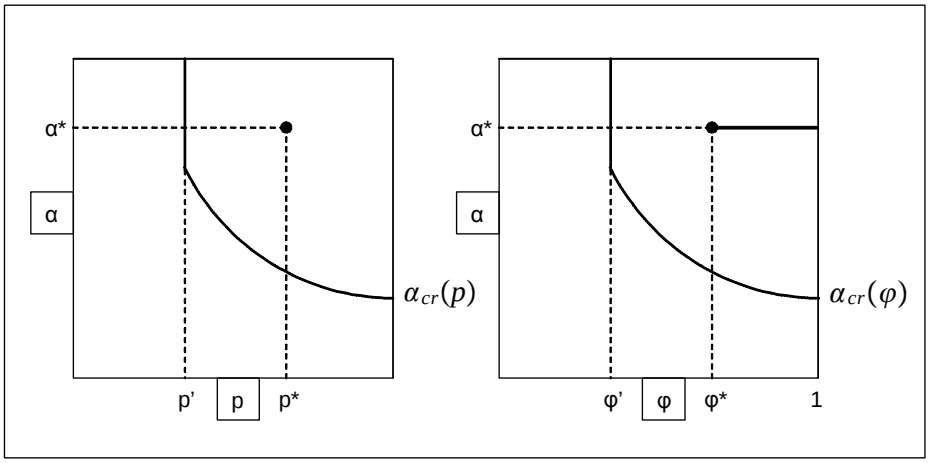

Figure 7: The transition from the (α, p) to the (α, φ) space.

area which defines Case 1 is bounded by p' from the left and by $\alpha_{cr}(p)$ from below. Thus, the relevant area in the (α, φ) unit square is bounded by $\alpha_{cr}(\varphi)$ and φ' where $\varphi' = p'$. It would require considerable effort to transfer all results from the (α, φ) unit square back to the (α, p) unit square, if one should prefer to remain within the two-dimensional world, for which reason this is not done here.

According to the comments from section 1.3, there are three strategic options available for the owners, if the individual leniency program is not in effect. The owners prefer corporate self-reports for high values of $\alpha(\varphi)$, the implementation of the compliance program for medium values of $\alpha(\varphi)$, and finally, the temporary continuation of the cartel for low values of $\alpha(\varphi)$. If the Antitrust Authority opens an investigation, the owners apply for a corporate report. The individual leniency program eliminates, however, the possibility for the owners to pursue the particular strategy for medium values of $\alpha(\varphi)$. As a consequence, the parameter ranges, supporting the strategies for high and low values of α, respectively, extend towards the middle until the parameter range for the infeasible strategy is completely covered. This result is summarized in the following lemma.

Lemma 5 ***Case 1.*** *Assume $\mathcal{X} < \delta\mathcal{T}$.* ***(1) Intermediate stage without individual leniency program.*** *(I) The owners prefer to carry out a corporate self-report if the given pair (α, φ_m) lies above $\widetilde{\alpha}_{sr}(\varphi)$ where $\widetilde{\alpha}_{sr}(\varphi) = \frac{\mathcal{T}}{\frac{1}{2}\left[\mathcal{T}+\varphi(\mathcal{F}^f+\mathcal{T})\right]}$.(II) The owners prefer to implement the compliance program if the given pair (α, φ_m) lies on or below $\widetilde{\alpha}_{sr}(\varphi)$ and above*

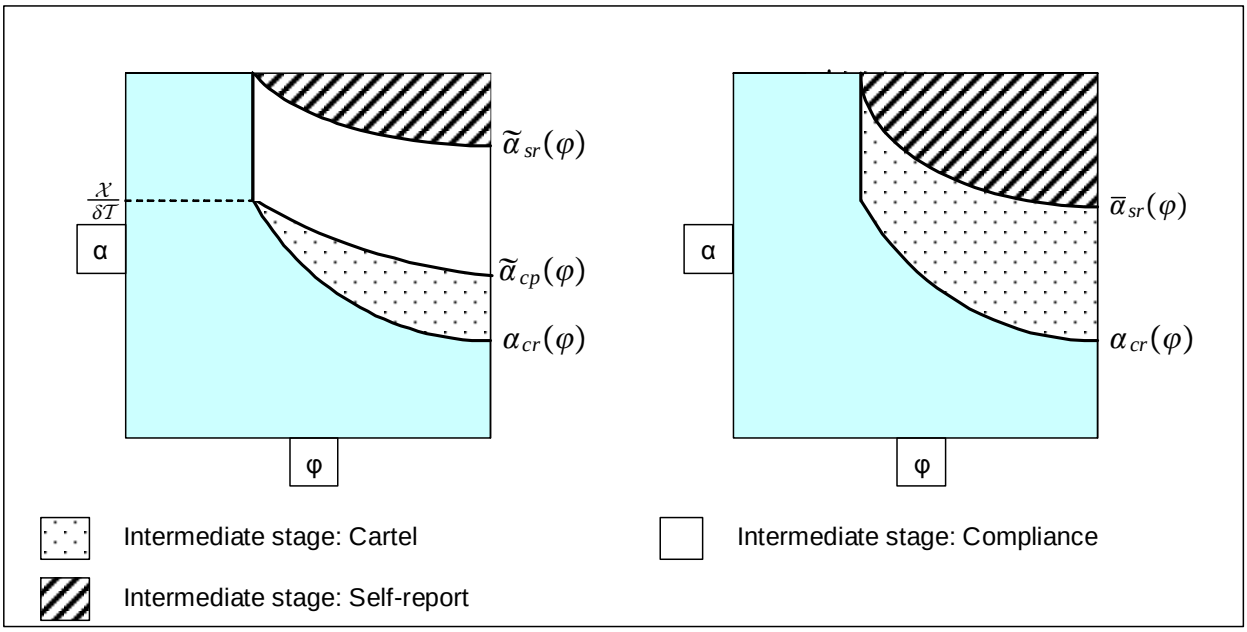

Figure 8: Case 1: The intermediate stage

$\widetilde{\alpha}_{cp}(\varphi)$ *where* $\widetilde{\alpha}_{cp}(\varphi) = \frac{\mathcal{X}}{\delta\frac{1}{2}\left[\mathcal{T}+\varphi(\mathcal{F}^f+\mathcal{T})\right]}$. *(III) The owners prefer to allow the manager the continuation of the cartel otherwise.* ***(2) Intermediate stage with individual leniency program.*** *The owners prefer to carry out a corporate self-report if the given pair* (α, φ_m) *lies above* $\overline{\alpha}_{sr}(\varphi)$ *where* $\overline{\alpha}_{sr}(\varphi) = \frac{\mathcal{X}-\delta\mathcal{T}+\mathcal{T}}{\mathcal{X}-\delta\mathcal{T}+\frac{1}{2}\left[\mathcal{T}+\varphi(\mathcal{F}^f+\mathcal{T})\right]}$. *Otherwise, the owners prefer to allow the manager to continue the cartel.*

Proof. See appendix. ■

Figure 8 illustrates the results of the preceding lemma. Since $\mathcal{X} < \delta\mathcal{T}$, $\widetilde{\alpha}_{sr}(\varphi) > \widetilde{\alpha}_{cp}(\varphi)$ and both $\widetilde{\alpha}_{sr}(\varphi')$ and $\overline{\alpha}_{sr}(\varphi')$ are equal to 1, whereas $\widetilde{\alpha}_{cp}(\varphi') = \frac{\mathcal{X}}{\delta\mathcal{T}}$. The left panel of Figure 8 depicts the case without individual leniency program, and the right panel depicts the case with individual leniency program. As seen, both parameter regions, which support a corporate self-report and the temporary cartel continuation, respectively, extend in the case with individual leniency program covering the middle region totally.

Proposition 3 *The parameter ranges for which owners prefer to carry out a corporate self-report at the intermediate stage and for which the owners prefer to allow the manager the continuation of the cartel increase if the individual leniency program* $\mathcal{L}^i$ *is in place.*

Proof. Follows directly from above. ■

Comparative statics. Take the value of $\mathcal{Z} = (\mathcal{F}^f + \mathcal{T})$ as given satisfying $\mathcal{X} < \delta\mathcal{T}$ and the requirement (4). Consider a decrease of the fraction of damage payments from $\frac{\mathcal{T}}{\mathcal{Z}}$ to $\frac{\mathcal{T}^*}{\mathcal{Z}}$ while increasing the fraction of the corporate fine from $\frac{\mathcal{F}^f}{\mathcal{Z}}$ to $\frac{\mathcal{F}^{f*}}{\mathcal{Z}}$ such that $\mathcal{F}^{f*} + \mathcal{T}^* = \mathcal{Z}$ and $\mathcal{X} \geqslant \delta\mathcal{T}^*$. Consider then the left panel of Figure 8 and assume the individual leniency program is not in effect. As already shown at the final stage, the parameter region that defines Case 1 extends since the lower boundary $\alpha_{cr}(\varphi)$ moves downwards, and the left boundary φ' moves leftward if the fraction of damage payments declines. With respect to the levels of indifference $\widetilde{\alpha}_{sr}(\varphi)$ and $\widetilde{\alpha}_{cp}(\varphi)$, the following effects occur: (1) The present discounted payoff in relation to both the corporate self-report strategy $\mathcal{V}_f^{cp} - \mathcal{T}$ as well as the compliance strategy $\mathcal{V}_f^{cp} - \frac{1}{2}\left[\mathcal{T} + \varphi_m(\mathcal{F}^f + \mathcal{T})\right]$ increases as $\mathcal{T}$ decreases. The value increase in relation to the former strategy, however, is obviously larger since it changes by $\Delta\mathcal{T}$, whereas the latter value changes by $\frac{\Delta\mathcal{T}}{2}$ only. Thus, the level of indifference $\widetilde{\alpha}_{sr}(\varphi)$ moves downwards. (2) Similarly, the present discounted value in relation to the cartel strategy increases by more than the corresponding value of the compliance strategy, which implies that $\widetilde{\alpha}_{cp}(\varphi)$ moves upwards. This can also be seen by fixing $\mathcal{Z} = (\mathcal{F}^f + \mathcal{T})$ in the expression $\widetilde{\alpha}_{cp}(\varphi)$, while decreasing the isolated $\mathcal{T}$ in the denominator. If $\mathcal{X} = \delta\mathcal{T}^*$, the location of $\widetilde{\alpha}_{sr}(\varphi)$, coming from above, coincides with the location of $\widetilde{\alpha}_{cp}(\varphi)$, coming from below, implying that the preference for the compliance strategy drops out. In addition, $\widetilde{\alpha}_{sr}(\varphi) = \widetilde{\alpha}_{cp}(\varphi) = \overline{\alpha}_{sr}(\varphi)$ and thus, the solutions for both cases, with and without individual leniency program, become identical. If $\mathcal{X} > \delta\mathcal{T}^*$, the relation between the critical values changes to $\widetilde{\alpha}_{sr}(\varphi) < \overline{\alpha}_{sr}(\varphi) < \widetilde{\alpha}_{cp}(\varphi)$. This, however, does not change the result that both solutions remain identical. The reason is the following: For $\widetilde{\alpha}_{sr}(\varphi) < \alpha(\varphi_m) < \overline{\alpha}_{sr}(\varphi)$, the owners prefer self-report over compliance, since $\widetilde{\alpha}_{sr}(\varphi) < \alpha(\varphi_m)$. On the other side, the owners prefer cartel over self-report, since $\alpha(\varphi) < \overline{\alpha}_{sr}(\varphi)$. Thus, the cartel strategy is the most profitable strategy, whether the individual leniency program is in place or not. The analogous reasoning applies for values of $\alpha(\varphi_m)$ satisfying $\overline{\alpha}_{sr}(\varphi) < \alpha(\varphi_m)$, coming to the conclusion that corporate self-reports turn out to be the most profitable strategy.

If the individual leniency program is not in place, decreasing the fraction of damage payments let $\overline{\alpha}_{sr}(\varphi)$ move downwards, which is not surprising since the value increase in relation to the self-report strategy is frictionless. Consequently, $\frac{\partial\overline{\alpha}_{sr}(\varphi)}{\partial T}\Big|_{\mathcal{Z}=\overline{\mathcal{Z}}} > 0$.

Proposition 4 *For any given $\mathcal{Z}$, satisfying requirement (4), one can always find a division of $\mathcal{Z}$ where the solutions with and without individual leniency program $\mathcal{L}^i$ coincide if the fraction of damage payments $\frac{\mathcal{T}}{\mathcal{Z}}$ is sufficiently low and vice versa.*

Proof. Follows from above. ■

At the initial stage, the manager takes into account the possible outcomes at the intermediate and final stage. The concluding Lemma 6 presents the corresponding values.

Lemma 6 ***Case 1. (1) Initial stage without individual leniency program.*** *(I) If the given pair (α, φ_m) lies above $\widetilde{\alpha}_{sr}(\varphi)$, the manager deviates at the initial stage if and only if $\alpha > \widetilde{\alpha}_d(\varphi, \theta)$ where $\widetilde{\alpha}_d(\varphi, \theta) = \frac{\beta\left[\delta\theta(\pi^d - \pi^{nc}) - (\pi^d - \pi^c)\right] - \delta\frac{1}{2}\varphi\mathcal{F}^m(1-\theta)}{\delta\theta\left[\beta(\pi^d - \pi^{nc}) + \frac{1}{2}\varphi\mathcal{F}^m\right]}$. Otherwise, the manager keeps cartel discipline. (II) If the given pair (α, φ_m) lies above $\widetilde{\alpha}_{cp}(\varphi)$ and on or below $\widetilde{\alpha}_{sr}(\varphi)$, the manager deviates if and only if $\alpha > \widetilde{\alpha}_d(\varphi, \theta)\,|_{cp}$ where $\widetilde{\alpha}_d(\varphi, \theta)\,|_{cp} = \frac{\beta\left[\delta\theta(\pi^d - \pi^{nc}) - (\pi^d - \pi^c)\right]}{\delta\theta\left[\beta(\pi^d - \pi^{nc}) + \frac{1}{2}\varphi\mathcal{F}^m\right]}$. (III) If the given pair (α, φ_m) lies on or below $\widetilde{\alpha}_{cp}(\varphi)$, the manager deviates if and only if $\alpha > \widetilde{\alpha}_d(\varphi)$ where $\widetilde{\alpha}_d(\varphi) = \widetilde{\alpha}_d(\varphi, 1)\,|_{cp} = \widetilde{\alpha}_d(\varphi, 1)$ and where $\widetilde{\alpha}_d(\varphi) > \widetilde{\alpha}_d(\varphi, \theta)\,|_{cp} > \widetilde{\alpha}_d(\varphi, \theta)$ for all $\theta \in (0, 1)$.* ***(2) Initial stage with individual leniency program.*** *(I) If the given pair (α, φ_m) lies above $\overline{\alpha}_{sr}(\varphi)$, the manager deviates at the initial stage if and only if $\alpha > \overline{\alpha}_d(\varphi, \theta)$ where $\overline{\alpha}_d(\varphi, \theta) = \widetilde{\alpha}_d(\varphi, \theta)$. (II) If the given pair (α, φ_m) lies on or below $\overline{\alpha}_{sr}(\varphi)$, the manager deviates at the initial stage if and only if $\alpha > \overline{\alpha}_d(\varphi)$ where $\overline{\alpha}_d(\varphi) = \widetilde{\alpha}_d(\varphi)$.*

Proof. See appendix. ■

In Case 1, however, it becomes nearly impossible to compare the critical values of the benchmark model with those of Lemma 6. This depends mainly on the change in relation to the parameter spaces. The critical values of the benchmark model are expressed in terms of $\alpha(p)$, whereas the critical values of Lemma 6 are expressed in terms of $\alpha(\varphi)$. In addition, the number of variables and parameters would make it necessary to formulate any precise statement as an almost endless chain of if-then conditions. For this reason, the paper abstains from a more detailed comparison. Both cases may occur, where the parameter region for which managers prefer to keep cartel discipline has either increased or decreased. In general, if the corporate leniency program $\mathcal{L}^c$ increases the parameter region where the owners prefer to terminate existing cartel activity, then the parameter region where the manager prefers to keep cartel discipline is likely to be decreased. Ceteris paribus, a larger amount of probative evidence in the manager's possession decreases the expected benefit of

participating in the leniency program, which also decreases the parameter region for which the manager prefers to keep cartel discipline. The former statement refers to a positive dependence of the critical values of Lemma 6 on θ, whereas the latter statement refers to a negative dependence on φ.

2.3.4 Summary of the results

The concluding comments summarize the main findings of the model.

Anti-collusive effect at the final stage. The corporate leniency program exhibits a strict anti-collusive effect at the final stage (Lemma 2). The individual leniency program does not affect this outcome, since individual leniency is not allowed at the final stage. The anti-collusive effect occurs since there always exists a prosecution probability p and a detection probability α for which the benefits for the owners accruing from cooperating with the Antitrust Authority exceed the expected present discounted payoff of the infinite cartel strategy, even though cooperation with the Antitrust Authority requires the implementation of the compliance program which cannot be abandoned again. The size of this beneficial welfare effect depends on the relation between corporate fine and damage payments. The effect becomes larger the lower the fraction of damage payments is.

Pro-collusive effect at the intermediate stage (Case 2). The combination of the corporate and individual leniency program may create a strict pro-collusive effect at the intermediate stage (Proposition 2). The effect occurs if and only if the fraction of damage payments is sufficiently large, implying that the owners do not prefer to apply for corporate leniency. In this case, the owners allow the manager the continuation of the cartel. Without leniency program, they would have implemented the compliance program.

Individual leniency enhances self-reports and cartel activity (Case 1). The result for Case 1 has shown that the individual leniency program may also enhance corporate self-reports. In addition, Case 1 has presented another example where owners allow the temporary continuation of cartel activity, even though the motivation for this behaviour differs from that of Case 2 (Proposition 3). The result depends, however, on the fraction of damage payments in relation to the sum of damage payments and the corporate fine. Comparative statics show that a sufficiently low fraction of damage payments lets the solutions for Case 1 with and without individual leniency program converge (Proposition 4).

Initial stage. The results for the initial stage correspond to the results for the intermediate stage. Pro-collusive effects in terms of owner-accepted cartels pass frictionless into an increased parameter region supporting cartel discipline. In general, the managers' main concern is related to the probability for any kind of elimination of their possibilities to continue with cartel activity. If this probability becomes sufficiently large, each manager has a sufficiently large incentive to deviate unilaterally at the beginning of the game. For Case 3, the corresponding parameter region has not increased, compared to the benchmark model, since the corporate and individual leniency programs exhibit no real effect. In Case 2, the parameter region, supporting cartel discipline, has strictly increased, since the owners allow the manager the cartel continuation at the intermediate stage, where they otherwise would have implemented the compliance program. In Case 1, the result is ambiguous.

General comments. The results show that the option to carry out an individual leniency application becomes relevant for the manager if and only if the owners prefer to terminate ongoing cartel activity. This incentive may then create such a serious threat against the owners that the owners in some cases even allow the manager to continue the cartel. Alternatively, they carry out a corporate self-report. An actual application by the manager never occurs. The manager, however, simply tries to maximize his expected payoff by all means, which also include the possibility to apply for leniency individually. From that point of view, it may even be illegitimate to call his behaviour abuse of the individual leniency program, even though most of the results obviously cannot be in the interest of the Antitrust Authority. It is true that the results would be different if the individual leniency program was not in place at all. The main reason for the conflict between the corporate and individual leniency program is, however, conditioned on a sufficiently large fraction of damage payments. This result would even be true in a very general setup. The crucial point is that some agents prefer to apply for leniency, whereas other agents within the same corporation do not. Damage payments are then just one example that may cause these diverging preferences.

3 Discussion

3.1 The significance of the assumptions

The results of this paper are quite robust with respect to the assumptions. This may surprise, as the number of assumptions, in general, and the number of simplifying assumptions, in particular, is large. The robustness, however, is mainly caused by one simple observation. Owners and managers may have diverging preferences with respect to the leniency program. One type of agent may prefer to apply in appropriate situations, while others do not. This conflict is the driving force for most of the paper's results.

Changing the assumptions, particularly those used in a very simplified way, may either enhance or moderate the dynamics of the model. The structure of the model has made it necessary, however, to simplify many relevant aspects that could have been included if the model was not so complex. This trade-off holds for most of the assumptions, as the following comments may illustrate:

3.1.1 Manager-owner relation

Payment scheme. The type of payment scheme, as defined by Assumption 1, does not allow for the option that the owners in some cases might prefer to adjust the bonus rate β in order to influence and control the manager's performance. The problem is, however, that the closed form of the model without any connection to the outside world implies missing some reference point. Without this reference point, the owners set $\beta = 0$. The assumption about the identical discount factor for owners and managers was not necessary. In all relevant expressions derived, one could substitute δ^m and δ^f for δ, which would have made it possible, to consider different time horizons.

Damage payments. Managers do not have to pay damage payments. This assumption ignores the fact that many manager payment schemes are directly linked to future profit evolutions. From this point of view, the manager may also suffer indirectly from damage payments, and the restriction seems unjustified. On the contrary, damage payments are a result of a claim against the corporation and not against the manager. In addition, damage payments - as well as fines - have to be paid on short notice, which puts pressure on the financial structure of the corporation, and the group of owners probably suffers more than the manager. In addition, even if one would allow for damage payments

also for the manager, this would not change the results qualitatively. It is not the assumption about damage payments on the owners' side only that drives the results. It is the difference in the relative benefits accruing from participation in the leniency program that explain the results.

Hiring and firing. Assumption 5 eliminates the possibility of a quite natural conflict solution in relation to possible disagreements between the owners and the manager. In some cases, the manager would simply be fired if he does not behave in accordance with the owners' preferences. In other cases, the manager would simply quit if he can find a better job. The simplification is, however, necessary in order to avoid model explosion, since allowing for this possibility would require a considerable number of additional assumptions. These additional assumptions would involve, for instance, a specification about how the owners, in given case, might find a new manager and how the manager finds a new job. Moreover, one would have to allow for different types of managers since replacing one manager with another manager who shows the same characteristics may not solve the original conflict. However, the possibility for the owners to implement the compliance program countervails the strong implication of the assumption, at least partly. In addition, the results show that situations where the manager might have strictly preferred to resign rather than follow the model's suggestion without this possibility do not occur.

Future research. The complexity of the model would have made it difficult to consider two competing leniency programs under the additional inclusion of a design problem with respect to an optimal payment scheme between owners and managers. According to the results, however, the particular problem in connection with the payment scheme may motivate interesting future research. Assume that the manager's payment consists of a combination of a fraction $1-\gamma$ non-stock-related payments and a fraction γ stock-related payments where $\gamma \in (0,1)$. If managers do not have to pay damages, one would expect an optimal reaction to be adjusting the fraction γ downwards in order to decrease the expected benefits of illegal cartel activity. On the other hand, if managers face the risk of paying damages, it may be optimal to adjust γ upwards in order to increase the possible financial consequences for illegal cartel activity. In addition, the more the manager's payment can be linked to the corporation's possible damage payments, the more the wedge between the corporate and individual leniency program decreases.

3.1.2 Detection and prosecution

Detection probability α. Assumption 2 employs the implicit assumption that the life-time of evidence is restricted to exactly one period. This simplification ignores the possibility that the detection probability may increase as the duration of the cartel increases, where the term *cartel* refers to a stochastic sequence of consecutive periods with undetected cartel activity. Calculations during the writing of this paper have shown that the presented results survive if one employs longer life-times. The results for life-times of two and three periods differ only quantitatively from those above. This may suggest that the qualitative results for any finite life-time would be similar. There are other reasons why the detection probability may vary: The detection probability may depend on the Antitrust Authorities' capacities and capabilities, which constantly grow over time, or the detection probability may depend on the managers' cautiousness.

Prosecution probability p and fines. The prosecution probability p may depend on the length of the investigation. Another form of dependence may be explained through the relation between the prosecution probability and the length of the cartel. One would naturally require that the prosecution probability decreases as the duration of the cartel increases. With respect to the fines, this relation is turned around, however. From this point of view, a constant prosecution probability in combination with a constant fine may be considered an appropriate approximation. Alternatively, a constant fine, and thus also a constant prosecution probability, may be justified by fine levels implemented in many jurisdictions.[18] The disadvantage of this interpretation is related to the additionally necessary assumption that the fines under consideration reach this fine limit on average. For this reason, the former interpretation seems preferable as practical experiences show that the fines only seldom have reached this level. A constant prosecution probability contradicts, however, one important observation. It lacks realism to assume that the Antitrust Authority would not become better at prosecuting repeat offenders. This is an important aspect, which is neglected in the model due to the simplification need.

[18] Fine levels may be employed as absolute fine levels or relative fine levels. An example of the former one is the fine ceiling of the U.S. Sherman Act, which recently has been raised to $ 100 mio. Examples of the latter are the fine ceilings of the U.S. Sentencing Guidelines or of the EC Commission. Roughly spoken, the fines are bounded by a certain percentage of the revenues in both cases.

Increasing detection and prosecution probabilities. It seems reasonable to assume that even constantly growing detection and prosecution probabilities converge in the long run towards some upper levels $\overline{\alpha}$ and $\overline{p}$, respectively. The majority of the presented results, however, is embedded in the (α, p) unit square. The point $(\overline{\alpha}, \overline{p})$ corresponds then to one particular point in this unit square. It is obvious that the larger $\overline{\alpha}$ and $\overline{p}$, respectively, are, the more $(\overline{\alpha}, \overline{p})$ approaches $(1, 1)$. This should not, however, affect the robustness of the presented results in general.

Prison sentences. The exclusion of prison sentences from the model is not only related to the above-mentioned need for simplicity. The explicit inclusion of prison sentences may make it difficult to distinguish prison sentences from monetary fines sufficiently. Without changing the model principally, a particular type of identification problem may arise in relation to the utility loss accruing from a prison sentence compared to the utility loss accruing from a monetary fine. In both cases, one has to attach a number to each event. The temporary loss of income, the loss of reputation, and so forth, can always be expressed by some number. But then there exists a monetary fine which yields the same loss in terms of the utility function. This equivalence does not hold in general if monetary fines are bounded by some upper level and prison sentences are supposed to reach a high level of utility losses in general. This, however, creates other technical problems since non-continuous indifference curves may occur. In addition, an obvious reason to include prison sentences would be given if prison sentences would affect the wedge between the corporate and individual leniency program. In most cases, however, prison sentences are also covered by the leniency program, and thus additional insights through the explicit inclusion of prison sentences are possibly limited only.

Duopoly. The restriction on a duopoly is harmless. In all expressions with $\frac{1}{2}$, one may read $\frac{1}{n}$ instead.

Deviation. The assumption that deviation does not create evidence is not regarded as a problem. The two main reasons for this simplifying assumption are that the market conditions do not change over time and the expected present discounted payoffs of all cartel strategies under consideration never increase during the game's progression. These two reasons "push" any deviation incentive back to the first period. If deviation becomes an option, then only at the initial stage. This may contradict legal principles regarding

the pure existence of cartel contracts as an offence. However, it seems questionable that a cartel that actually never has existed will be detected .

3.2 Damage payments

The following discussion is related to the question of whether the concept of leniency should be extended in a way that also covers damage payments. In fact, the proposed modification could be interpreted as a practical application of Spagnolo's (2004) proposal to let the non-cooperating firms pay the fine reduction for the first cooperating firm. Consider the model of section 2.4 with following modification:

Corporate leniency program $\mathcal{L}^{c*}$ Damage payments $\mathcal{T}$ are covered by the leniency program. The non-cooperating corporation has to pay $2\mathcal{T}$ if it is prosecuted successfully upon the cooperating corporation's leniency application. If no corporation applies, each corporation has to pay $\mathcal{T}$ in case of a successful prosecution.

The modification implies that the compliance strategy s^{cp} becomes strictly dominated by the corporate report strategy s^{cr} at the final stage. Condition (10) drops out, thereby constituting the first benefit of $\mathcal{L}^{c*}$: The parameter range for which owners prefer to apply for corporate leniency at the final stage increases. Those who have not applied before - because of condition (10) - apply now. Moreover, the new corresponding critical value is necessarily lower than $\alpha_{cr}(p)$ since the benefit for cooperation has increased. This constitutes the second benefit of $\mathcal{L}^{c*}$. Equating the expected present discounted payoff of the infinite cartel strategy s^c with the corresponding value for the corporate report strategy s^{cr} and solving for α yields:

$$\alpha^*_{cr}(p) = \alpha_{cp}(p) - \frac{(1-\delta)}{\delta} < \alpha_{cr}(p) \tag{12}$$

implying that the parameter range supporting the infinite cartel strategy decreases.

Consider the case $\alpha > \alpha^*_{cr}(p)$ at the intermediate stage.[19] The owners - upon internal detection - recognize that they are going to implement the compliance program and apply for corporate leniency, as soon as the Antitrust Authority opens an investigation. Their choice at the intermediate stage consists in balancing the values for allowing the temporary continuation of the cartel with carrying out a corporate self-report. The former value is

[19] The case $\alpha \leqslant \alpha^*_{cr}(p)$ is not further affected by $\mathcal{L}^{c*}$. It basically corresponds to Case 3 from section 2.4.

given by:

$$\widetilde{\mathcal{V}} = \alpha \left[\mathcal{V}_f^{cp} - \frac{\varphi_m(\mathcal{F}^f + 2\mathcal{T})}{2} \right] + (1-\alpha) \left[(1-\beta)\pi^c + \delta \widetilde{\mathcal{V}} \right] \tag{13}$$

Equating $\mathcal{V}_f^{cp} - \mathcal{T}$ with (13) and solving for α yields:

$$\overline{\alpha}_{sr}^*(\varphi) = \frac{\mathcal{X}}{\mathcal{X} + \frac{1}{2}\left[\varphi_m(\mathcal{F}^f + 2\mathcal{T})\right]} < \overline{\alpha}_{sr}(\varphi) \tag{14}$$

The fact that $\overline{\alpha}_{sr}^*(\varphi) < \overline{\alpha}_{sr}(\varphi)$ constitutes the third benefit of $\mathcal{L}^{c*}$: The parameter region supporting corporate self-reports at the intermediate stage has increased. The fourth benefit of $\mathcal{L}^*$ is indirectly related to condition (10) again. As Case 2 has shown, the individual leniency program creates an adverse effect. Case 2 does not exist any longer with $\mathcal{L}^{c*}$.

Lemma 7 *In a model with the modified corporate leniency program $\mathcal{L}^{c*}$: (I) The parameter region supporting corporate leniency applications increases. (II) The parameter region supporting cartel activity decreases.*

Proof. Omitted. ■

The crucial point of Lemma 7 concerns the increased effectiveness of the corporate leniency program without increasing the attractiveness for cartel activity at the same time. It is not surprising at all that increased expected benefits for cooperation increase the incentives for participation in such programs. With $\mathcal{L}^{c*}$, however, the degree of pro-collusivity has also been decreased.

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4 Appendix

Proof of Lemma 3. Assume that the conditions defining Case 3 hold. For all points (α, p) on or below $\min\{\alpha_{cp}(p), \alpha_{cr}(p)\}$ holds that $V_f^c \geqslant V_f^{cp}$ and $V_f^c - p(\mathcal{F}^f + \mathcal{T}) \geqslant V_f^{cp} - \mathcal{T}$. The first relation proves that the owners prefer cartel activity over voluntary compliance. The second relation implies that $V_f^c - \alpha p(\mathcal{F}^f + \mathcal{T}) > V_f^{cp} - \mathcal{T}$, which proves that the owners prefer allowing the manager to continue with the cartel over carrying out a corporate self-report at the intermediate stage. Other options are not available. Thus, the owners support the manager's cartel activity generally, which implies that the critical value at the initial stage remains the same as in the corresponding case of the benchmark model, which in this case is given by $\alpha_d(p)$. ■

Proof of Lemma 4. The first statement follows directly from the explanations presented in the text. Assume that the conditions that define Case 2 hold. At the beginning of the game, the manager's expected present discounted payoff is then given by:

$$\widetilde{\mathcal{V}} = \beta\pi^c + \delta\left\{\alpha\left[\mathcal{V}_m^{nc} - p\mathcal{F}^m\right] + (1-\alpha)\widetilde{\mathcal{V}}\right\} \tag{A1}$$

Equating (A1) with $\mathcal{V}_m^d$ and solving for α yields:

$$\alpha_d(p,1) = \frac{\beta\left[\delta(\pi^d - \pi^{nc}) - (\pi^d - \pi^c)\right]}{\delta\left[\beta(\pi^d - \pi^{nc}) + p\mathcal{F}^m\right]} \tag{A2}$$

which is strictly larger than $\alpha_d(p,\theta)$ for all $\theta \in (0,1)$, which proves the second statement. ■

Proof of Lemma 5. Without individual leniency program. The present discounted payoff to the owners of carrying out a corporate self-report is given by $\mathcal{V}_f^{cp} - \mathcal{T}$, whereas implementing the compliance program yields $\mathcal{V}_f^{cp} - \frac{1}{2}\left[\mathcal{T} + \varphi_m(\mathcal{F}^f + \mathcal{T})\right]$, where the last term refers to the expected litigation payoff, given the Antitrust Authority opens an investigation at the beginning of the period directly following the implementation of the compliance program and both groups of owners are going to carry out a corporate report. Equating both values and solving for α yields:

$$\widetilde{\alpha}_{sr}(\varphi) = \frac{\mathcal{T}}{\frac{1}{2}\left[\mathcal{T} + \varphi(\mathcal{F}^f + \mathcal{T})\right]} \tag{A3}$$

The expected present discounted payoff for allowing the manager to continue the cartel

under the assumption that both groups of owners are going to carry out a corporate report as soon as the Antitrust Authority opens an investigation is given by:

$$\widetilde{\mathcal{V}} = \alpha \left[\mathcal{V}_f^{cp} - \frac{1}{2} \left[\mathcal{T} + \varphi_m (\mathcal{F}^f + \mathcal{T}) \right] \right] + (1 - \alpha) \left[(1 - \beta) \pi^c + \delta \widetilde{\mathcal{V}} \right] \tag{A4}$$

Equating (A4) with the value of the compliance strategy $\mathcal{V}_f^{cp} - \frac{1}{2} \left[\mathcal{T} + \varphi_m (\mathcal{F}^f + \mathcal{T}) \right]$, and finally solving for α yields:

$$\widetilde{\alpha}_{cp}(\varphi) = \frac{\mathcal{X}}{\delta \frac{1}{2} \left[\mathcal{T} + \varphi (\mathcal{F}^f + \mathcal{T}) \right]} \tag{A5}$$

Since $\mathcal{X} < \delta \mathcal{T}$, $\widetilde{\alpha}_{sr}(\varphi) > \widetilde{\alpha}_{cp}(\varphi)$ for all $\varphi \in (0, 1)$, which proves (1) (I) to (III). **With individual leniency program.** Equating the corresponding values for the strategies involving a corporate self-report and allowing the continuation of the cartel, and finally solving for α yields:

$$\overline{\alpha}_{sr}(\varphi) = \frac{\mathcal{X} - \delta \mathcal{T} + \mathcal{T}}{\mathcal{X} - \delta \mathcal{T} + \frac{1}{2} \left[\mathcal{T} + \varphi (\mathcal{F}^f + \mathcal{T}) \right]} \tag{A6}$$

which is the relevant critical value if the individual leniency program is in effect. Other options are not available for the owners, which proves (2). ■

Proof of Lemma 6. Without individual leniency program. If $\alpha > \widetilde{\alpha}_{sr}(\varphi)$, the manager's expected present discounted payoff of the cartel strategy is given by:

$$\widetilde{\mathcal{V}} = \beta \pi^c + \delta \left\{ [1 - (1 - \alpha)\theta] \left[\mathcal{V}_m^{nc} - \frac{1}{2} \varphi_m \mathcal{F}^m \right] + (1 - \alpha) \theta \widetilde{\mathcal{V}} \right\} \tag{A7}$$

Equating (A7) with $\mathcal{V}_m^d$ and solving for α yields:

$$\widetilde{\alpha}_d(\varphi, \theta) = \frac{\beta \left[\delta \theta (\pi^d - \pi^{nc}) - (\pi^d - \pi^c) \right] - \delta \frac{1}{2} \varphi_m \mathcal{F}^m (1 - \theta)}{\delta \theta \left[\beta (\pi^d - \pi^{nc}) + \frac{1}{2} \varphi_m \mathcal{F}^m \right]} \tag{A8}$$

If $\widetilde{\alpha}_{cp}(\varphi) < \alpha \leqslant \widetilde{\alpha}_{sr}(\varphi)$, the manager's expected present discounted payoff of the cartel strategy is given by:

$$\widetilde{\mathcal{V}} = \beta \pi^c + \delta \left\{ \alpha \left[\mathcal{V}_m^{nc} - \frac{1}{2} \varphi_m \mathcal{F}^m \right] + (1 - \alpha) \left[\theta \widetilde{\mathcal{V}} + (1 - \theta) \mathcal{V}_m^{nc} \right] \right\} \tag{A9}$$

Equating (A7) with $\mathcal{V}_m^d$ and solving for α yields:

$$\widetilde{\alpha}_d(\varphi,\theta)\,|_{cp} = \frac{\beta\left[\delta\theta(\pi^d-\pi^{nc})-(\pi^d-\pi^c)\right]}{\delta\left[\beta\theta(\pi^d-\pi^{nc})+\frac{1}{2}\varphi_m\mathcal{F}^m\right]} \tag{A10}$$

If $\alpha \leqslant \widetilde{\alpha}_{cp}(\varphi)$, the manager's expected present discounted payoff of the cartel strategy is given by:

$$\widetilde{\mathcal{V}} = \beta\pi^c + \delta\left\{\alpha\left[\mathcal{V}_m^{nc}-\frac{1}{2}\varphi_m\mathcal{F}^m\right]+(1-\alpha)\widetilde{\mathcal{V}}\right\} \tag{A11}$$

Equating (A11) with $\mathcal{V}_m^d$ and solving for α yields:

$$\widetilde{\alpha}_d(\varphi) = \frac{\beta\left[\delta(\pi^d-\pi^{nc})-(\pi^d-\pi^c)\right]}{\delta\left[\beta(\pi^d-\pi^{nc})+\frac{1}{2}\varphi_m\mathcal{F}^m\right]} \tag{A12}$$

where $\widetilde{\alpha}_d(\varphi) = \widetilde{\alpha}_d(\varphi,\theta)\,|_{cp} = \widetilde{\alpha}_d(\varphi,1)$ and $\widetilde{\alpha}_d(\varphi) > \widetilde{\alpha}_d(\varphi,\theta)\,|_{cp} > \widetilde{\alpha}_d(\varphi,\theta)$ for all $\theta \in (0,1)$.
With individual leniency program. The critical values of (A8) and (A12) are also the corresponding critical values for the case with individual leniency program. Since the compliance program is not going to be implemented by the owners, the value (A10) drops simply out. ■

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