Managerial effort incentives and market collusion*

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Abstract

We investigate the interactions between managers' incentives to collude or compete, and their incentives to exert effort. A manager privately chooses the competitive strategy of the firm, and his own effort to improve productivity; He may substitute collusion to effort to increase profits. High profit targets — i.e., strong effort incentives — make participating in a cartel more attractive.

To answer this two-tasks moral hazard, owners may have to give the manager information rents, and to choose inefficient effort levels — or profit targets. Because of this reduced internal efficiency, welfare losses may arise even when the industry remains competitive.

Antitrust policy has a novel value, specifically from individual sanctions: They foster internal efficiency in competing firms while worsening it in cartelized firms. This improves both efficiency under competition and cartel deterrence. Individual fines are thus more beneficial than corporate fines; Criminal sanctions are even more effective. All antitrust instruments make competition more attractive, and/or collusion less attractive, except for one: Individual leniency programs. The latter have ambiguous effects, even when not used in equilibrium.

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1 Introduction

The Scandivanian airline company, SAS, has recently been under investigation from the U.S. and E.U. antitrust authorities for participation in a cartel. SAS claimed it had no knowledge of the cartel, and was the victim of its own executive. SAS indicated in the spring of 2008 its intention to sue the decision-making executive — though the latter could not pay for cartel infringement fines even if convicted.[1]. This example highlights the discretion managers and executives may have over a number of decisions relating to market conduct. They may resort to illegal practices, including price-fixing and other collusive behavior; and may find this particularly attractive when under a strong pressure to increase profits.

It is widely recognized that managers, CEOs and other high level executives have objectives that are not perfectly aligned with owners' interests.[2]. Remuneration schemes that are strongly linked with profits (such as stock options or profit targets) are routinely used to improve internal efficiency and provide effort incentives. But we stress that they tend to induce more risky market conduct, and possibly illegal conduct. Owners may see this as a concern, as controlling fraud and illegal behavior often proves difficult[3]; but they may also sometimes wish to induce this illegal behavior (that they cannot request in a formal contract). Remuneration schemes may thus be used both to induce effort and to induce a particular conduct.

We highlight that effort incentives will tend to conflict with incentives to choose some market conduct. This paper focuses on this internal incentive issue: More precisely, managers, and other senior executives, can use collusion as a substitute for their profit-enhancing effort.We stress the role of individual fines and criminal sanctions, and discuss the impact of individual leniency. Despite recent increases, many analysts believe that corporate fines are still too low,

[1]SAS may of course have announced this unusual procedure simply because of reputation issues, but the general public is often not very sensitive to cartel conviction and tends not to boycott convicted firms. Even a firm selling to the general public, such as Danone, did not seem to suffer much from its conviction as repeat offender.

[2]Aviram (2010), among others, details a number of reasons why CEOs may not maximize owners' interests even when given profit incentives.

[3]SAS Airlines claims it was the victim of the disclosed collusive behavior, even though it had an internal compliance program to avoid illegal actions. More generally, Price Waterhouse Coopers (2008) has conducted interviews of over 5,400 companies in 40 countries and finds that over 43 % of the companies interviewed report suffering one or more significant economic crime.

and that sanctions and programs targeted at individuals may help increase deterrence.[4] This paper provides some rationale for this claim, and shows that neglecting internal incentive issues leads to underestimating both the welfare losses due to cartelization, and the value of individual sanctions. We indeed identify a new social welfare cost of the possibility of cartelization, to be added to price inefficiencies: internal inefficiencies in both colluding and competing firms. Even when collusion does not arise, firms may be less efficient than in the absence of the possibility of collusion. This new cost of *potential* collusion goes along a new benefit of antitrust intervention, that fosters internal efficiency.

Our approach and main results We use a simple dynamic model with a multitask moral hazard component. In each firm, in each period, a manager privately chooses, i) market conduct (competing aggressively, colluding, deviating from a collusive agreement), and ii) his own productivity-enhancing effort. The manager can save on effort by choosing an anti-competitive conduct (colluding or deviating).

We show that to prevent a manager from colluding, owners may have to provide him with weak incentives to exert effort, when expected antitrust sanctions are not a sufficient deterrent. Collusion indeed allows saving on effort. With an increasing marginal cost of effort, saving on effort is more attractive for high effort levels. By reducing the requested effort level (or profit target), owners reduce the gain the manager can obtain by colluding. To avoid cartelization, owners may thus have to sacrifice internal efficiency. This implies that the sheer possibility that managers collude may generate social losses (due to inefficient effort levels) even when firms ultimately do not collude.

Asymmetric information adds within-firm, internal, incentive constraints to the standard within-cartel incentive constraint (the 'sustainability condition'). Indeed, owners who favor cartelization also have to request inefficiently low effort levels. This is in order to deter deviations from the cartel agreement: When colluding becomes very attractive, so is deviating (that allows

[4] Cartels indeed still abound (Connor, 2004, Levinstein and Suslow, 2004, Schinkel, 2007). Criminal sanctions are used in the U.S, the U.K., Ireland or Estonia, and are suggested as an efficient deterrent by Klawiter (2001) and Wils (2005). The tapes from the lysine cartel provide anecdotal evidence that colluding executives avoid meeting in the U.S., due to the risk of jail sentences.

saving even more on the cost of effort, especially when the profit target is high). Thus, although managers have a 'natural' incentive to collude to save on effort, once all incentive issues are taken into account, colluding firms will find it difficult to induce effort. Colluding firms actually always request inefficiently low or high effort levels; while competing firms may be able to operate fully efficiently provided individual sanctions exist and are high enough.

In addition to effort distortions, colluding firms always have to pay the manager an information rent; competing firms may have to do so, when expected individual sanctions are too low. Which regime applies depends crucially on the value of managerial sanctions, as a function of the probability of antitrust conviction.

High antitrust individual sanctions allow competition-prone owners to require high profits without inducing cartelization. They also reinforce the incentive to deviate in colluding firms (as the manager then face the threat of a fine only once, in the deviation period). And they even create a new conflict of interest between owners and managers: when they are very high, managers may prefer to compete, exert extra effort and not risk personal liability (while still being paid more by uninformed owners to compensate for this liability). Last, when antitrust sanctions are very large, two-task moral hazard makes cartels less profitable and less sustainable than under full information on at least one moral hazard variable. Antitrust penalties for individuals play a different role from corporate penalties (in previous models, fines on individuals were simply compensated for by owners, so that they played the same role as fines on the corporation). These penalties are more efficient when they encompass jail sentences or managerial disqualification: by terminating the manager's employment, they act as if they were reducing his discount factor. While we cannot estimate whether it is more likely that owners wish to induce collusion, or to compete, we can derive clear-cut results in terms of policy recommendations: Except for individual leniency programs, antitrust instruments all benefit cartel deterrence. Individual leniency programs, however, have an ambiguous impact. They raise the costs of inducing collusion; but they also make it more likely that owners must pay information rents and request inefficient effort levels, in order to induce competition. This holds even though the program is not used in equilibrium.

Related literature The disciplining effect of more intense market competition on managers has been the object of much theoretical and empirical work (see Hart, 1983, Scharfstein, 1988, Schmidt, 1997). Closer to our concern, the impact of managerial incentives on the intensity of competition has been studied in the context of strategic delegation. This literature originates in important papers by Fershtman and Judd (1987), Sklivas (1987), Fershtman, Judd, and Kalai (1991) or Aggarwal and Samwick (1999). They show that committing to a particular incentive scheme allow owners to credibly promise to compete more or less than they would have done without delegation. Adjusting the profits of managers to make them behave more or less aggressively does not raise issues in this literature. Conversely, in our paper, the focus is on the response of managers to incentive schemes, under two-task moral hazard: there is a tension between incentives to reach a degree of competition, and incentives to induce effort.

More recent papers have focused on how delegation may help sustain tacit collusion. Chen (2007) centers on the relative advantages of delegation, relative to centralization, with and without leniency programs. Spagnolo (2000) adopts a different perspective by considering stock-related compensation (as stock options) in the infinitely repeated game framework used to model tacit collusion. He shows that this type of compensation, delayed for one period, can lessen short-run incentives to deviate, provided that stock markets anticipate the decline in future profits after a deviation, and correspondingly reduce the stock price. Full collusion becomes possible for any discount factor. Spagnolo (2005) takes into account the preference of managers for income-smoothing: they have lessened incentives to deviate, as this provides a sudden increase followed by a drop in profits. Collusion is thus more sustainable with a desire for income-smoothing.[5]

By assuming that a cartel requires communication, we allow for antitrust intervention and we can study its impact on internal incentives, and consequently on the efficiency of a firm depending on its market conduct, an aspect neglected in most of the literature on strategic delegation. Aubert (2007) studies a similar setting, but managers are assumed to remain in the firm for a limited time period only, and effort is discrete. Due to both assumptions, incentive problems are particularly stark.

[5]Somewhat relatedly, Bernhardt and Chambers (2006) show how sharing income with employees (in the absence of incentive issues) can reduce incentives to deviate for (decision-making) owners. Their perspective is very different though as employees play a passive role with respect to collusion.

This paper considers the impact of individual leniency programs on managerial incentives. It thus adds to the existing literature, that has focused almost exclusively on corporate leniency programs — as in the theoretical papers by Motta and Polo (2003), Spagnolo (2004), or Harrington (2008). Empirical support in favor of corporate leniency programs has been provided by Miller (2009), for the US, and Brenner (2009) for the EU.[6] Spagnolo (2004) and Aubert, Rey and Kovacic (2006) argue that positive rewards for corporate informants would be much more effective than leniency. Aubert et al. (2006) also suggest offering rewards to individual informants. They consider individual informants who are not in a position to make decisions over market conduct. Conversely, here, managers make decisions about collusion.

On a more technical note, our paper relates to the literature on multitasking with moral hazard (Holmström and Milgrom, 1991). As there are two moral hazard variables that do not simply add up in profits, owners would ideally want to have two performance variables in order to provide adequate incentives. Here, there is only one variable, profits, that is always observed in each period; another performance variable is the intervention by the antitrust authority, that occurs with some probability in colluding firms. The repetition of the relationship between owners and managers however allows providing more incentives than in a static framework.

The paper is organized as follows. Section 2 sets up a model where conflicts of interest may arise between owners and managers. It also provides benchmarks. Section 3 characterizes the equilibrium when owners want to achieve the collusive outcome, while Section 4 considers the case in which they prefer competition. We assess the effects of rewards and jail penalties on remuneration schemes and effort choices. The implications of our results for owners' preference for collusion and for policy are discussed in Section 5. Section 6 briefly considers the case of a quadratic cost of effort, discusses some assumptions and conclude.

[6] Leniency programs induce a much larger number of cartel cases, but this could be due to more cartel formation, if the programs have adverse effects facilitating collusion. Harrington and Chang (2009) build a model of cartel formation and cartel ending and argue that the observed duration of detected cartels can be used to assess the duration of all cartels, using this model. This could be used to compare the length of cartels before and after the introduction of a leniency program.

2 A model of managerial incentives and collusion

2.1 The model

On a given market, N firms play an infinitely repeated game. Each firm is owned by an 'owner'[7] and run by a manager, all being risk neutral.

The timing In each period, the following stages take place:

1. In each firm, the owner privately offers the manager a remuneration scheme w, with recommendations about market strategy.

2. Managers from all firms have an opportunity to communicate before choosing a market strategy for the whole period. This communication allows reaching a cartel agreement.

3. Managers privately choose their effort level, e, and their market conduct, K. If one manager at least has preferred not to communicate, the subsequent market strategy is necessarily competitive. If on the other hand, a collusive agreement has been reached, each manager decides whether to follow it, or to compete (i.e., to 'deviate' from the agreement), and possibly report information to the antitrust authority (applying for a leniency program).

4. If no information has been reported, the antitrust authority intervenes with probability ρ, in which case it always finds evidence when communication did take place[8].

[7] We recognize that owners often have diverging preferences, due, e.g., to different opportunity costs of funds, different cash constraints, different degrees of risk aversion, different abilities to insure and diversify. We however assume that they constitute a homogeneous group.

[8] Assuming that the antitrust authority always finds evidence when it investigates a colluding industry is of little consequence in the remainder. Under the alternate assumption, owners might learn about the existence of a cartel despite the absence of conviction; in that case, they would terminate their relationship with the manager, if they favored competition. This would change some of the incentive constraints to be considered in section 4, but would not alter much our results nor add insight.

The probability of conviction of colluding firms is thus ρ, that is constant over time[9] and independent from profit levels (contrary to Harrington, 2005). In our model, profits may indeed not provide adequate indications as to market conduct, as they also depend on internal effort.

Owners require a return to competition forever after a deviation[10]. Owners obtain the firm's profit, minus the wage paid to the manager, w. All owners have the same discount rate $\delta^o \in]0,1[$, while all managers have a discount rate $\delta \in]0,1[$ (the two groups may have different time preferences).

Owners can only observe their own profits and the outcome of antitrust interventions. In particular, they may not distinguish between high profits obtained thanks to a competitive behavior and a high effort, and the same profits obtained with collusion and a low effort.

Managerial effort and profits In each firm, the manager privately chooses his effort level e, $e \geq 0$, and market conduct, $K \in \{C, M, D\}$, where C refers to competition, M to collusion or 'monopolization', and D to deviation from a collusive agreement (the latter two strategies only being feasible when other managers agree to participate in a cartel agreement).

Effort e is not observable and imposes a non observable cost $\psi(e)$ on the manager, where $\psi(0) = 0$ and $\psi(.)$ is a strictly convex, increasing, function. It increases profits for all possible market strategies.

To highlight the interplay between internal incentives and market conduct, we focus on the case in which the two are technically independent: The marginal impact of effort does not depend on market conduct. This will arise when effort bears on fixed costs, or when its impact is not sensibly different when the firm sells competitive quantities rather than collusive ones. The productivity-improving effort we consider may for instance improve the internal organization of the firm, the functioning of accounting, financial or research departments, some marketing services on a given market, etc. This assumption thus provides a clear benchmark (it is further

[9] In practice, this probability may change along with budgets allocated to the antitrust authority. Harrington (2008) characterizes optimal leniency programs when the probability of being detected by the antitrust authority varies over time.

[10] If misbehavior by a manager was tolerated as an excuse, allowing to resume collusion (possibly with a new manager), incentives to deviate at the level of firms would be strengthened.

discussed in subsection 6.2.).

In our symmetric set-up, if a manager has incentives to choose an effort level and participate in a cartel, then so have other managers in equilibrium. We could attribute to each manager a belief as to the probability that a collusive agreement be reached, but this belief would have no impact on the decision to accept to communicate: whenever a collusive agreement is not reached, the firms compete, and the gains from competition cancel out from the comparison the manager makes between the different market strategies. We can therefore study our game as if each manager was choosing the market conduct of the whole industry, except for the possibility that other managers deviate, as usual in collusive games.[11] To simplify notations, we will therefore simply distinguish between profits when other firms adopt the same strategy as the manager, $\pi^K(e)$, and profits when one other firm deviates, $\underline{\pi}^K(e)$ (the latter only occurring if the manager first accepted to participate in a cartel).

Profits are

$$\pi^K(e) = e + \gamma^K,$$

where $\gamma^C \equiv 0$ represents the benchmark case of competition, and γ^M and γ^D the additional profits obtained by colluding / monopolizing and deviating respectively. $\gamma^D > \gamma^M > \gamma^C = 0$.

Moreover, profits are lower when the firm engages in collusion and faces deviation by one of its partners in the cartel: profits are then

$$\underline{\pi}^K(e) = e + \underline{\gamma}^K$$

when $K = M, D$, and another firm at least has chosen to deviate (conduct D). To simplify, we assume that the profits obtained when several firms deviate are identical to competitive profits: $\underline{\pi}^D(e) = e + \underline{\gamma}^D = \pi^C(e) = e$. And $\underline{\pi}^D(e) > \underline{\pi}^M(e)$. Note that $\underline{\gamma}^M < \underline{\gamma}^D = 0$.

In this set-up, due to the absence of direct link between effort and market conduct, the optimal level of effort is independent from market conduct, under full information: Maximizing

[11] If a cartel member deviates, other members are better off deviating as well, as we will see. And as communication makes the manager liable to antitrust sanctions, he should not communicate if he anticipates a deviation from other cartel members. There is thus always a symmetric equilibrium in which no manager accepts to communicate, as he correctly anticipates that others would deviate and he would himself deviate.

the firm's profits with respect to effort yields this optimal level, e^*, as characterized by

$$\psi'(e^*) = 1.$$

This feature of the model allows an easier comparison between the effort levels that will be required by owners, under asymmetric information, when they wish the manager to compete or collude.

Managerial compensation The only variable on which wages can be conditioned is the firm's profit (competitors' net profits are not observable).[12] When there is antitrust intervention, an additional variable can serve as a basis for employment termination. Owners may then distinguish between a clearing, a conviction for cartel, or a conviction for cartel together with leniency application from the manager; and accordingly decide whether to fire the manager.

Owners cannot impose penalties on the manager in case of misbehavior.[13] The manager can quit the firm at any time, in which case he gets a zero reservation wage from exerting his best outside option. There are thus limited liability constraints: $w \geq 0$.

The incentive scheme received by the manager is assumed to be soft private information, that cannot be credibly communicated to competing firms. We abstract from coordination issues between the managers of the different firms, in order to focus on the interplay between internal incentives and market conduct.[14]

Implicit contracts can theoretically depend on the production of hard evidence of a collusive agreement, when owners want to induce collusion. This does not change the contracts relative to the situation in which such evidence is not requested by managers (implicit contracts are identical, so that incentive issues are not modified, and we assume that the latter can always

[12] We will use notations for wages that do not refer to the complete history of the game, as this will not be necessary here.

[13] We could allow for the possibility that an antitrust investigation provides evidence about a misconduct from the manager that was not required by owners. The manager would suffer costs following private litigation from owners. The corresponding penalties would simply add to the antitrust individual sanction, when managers collude.

[14] We do not consider complex cheap talk games between managers about their own compensation package, and assume that communication between managers only bear on the particular collusive agreement to be adopted.

make copies, duplicate evidence, so that owners cannot confiscate it).[15]

Antitrust penalties The antitrust authority can impose (fixed) fines F on colluding firms if it obtains evidence about current collusion. The evidence used for convicting cartel members is generated by communication between firms. Thus a firm and its manager remain liable even if they deviate from the cartel agreement, as they first communicated with other cartel members.[16]

The antitrust authority can also impose sanctions J on managers (if it operates under a regime of individual liability). We abstract from reputation issues for managers whose collusive behavior has been exposed in an antitrust case; reputation costs can indeed simply be incorporated in J. Penalty J may be simply monetary, or may be the monetary equivalent in terms of instantaneous utility loss from a jail sentence, or from some monetary liability plus managerial disqualification. The latter two cases, jail sentences and disqualification, will be referred to as 'criminal sanctions'. Jail sentences and managerial disqualification share an interesting feature: the manager cannot retain its position after a cartel conviction, even when owners would have wished them to stay in office.[17]

Leniency Under a corporate leniency program, evidence can be brought forward by each firm to the antitrust authority. Informed individuals, such as managers and senior executives,

[15] Assume that owners require that evidence of an agreement be shown to them when they want to induce collusion. A formal contract providing for a higher wage in case such evidence is shown could of course not be enforced by courts. A collusion-prone owner can only use implicit contracts, and would thus simply terminate the manager's employment if the latter failed to produce the required evidence. The promised wage would have to be paid for the current period, due to legal constraints. The implicit contract would thus be identical to the one we describe in the remainder of the paper, as the owners would anyway terminate the manager's employment when observing that profits are below the collusive level and that competitors play the competitive strategies afterwards. We return to this point when the contracts are characterized, in the next sections.

[16] This assumption is in line with decisions ruling that price parallelism constitutes no ground for conviction, while memos and other evidence of meeting and information exchange about prices do. Purely tacit collusion cannot be punished by antitrust authorities since firms act non-cooperatively (see Werden, 2004, and the well-known woodpulp case).

[17] Admittedly, retaining a manager convicted of collusive behavior may constitute a signal that owners were not opposed to collusion. Changing managers may thus appear necessary in any case. Yet there may be ways of providing another, less visible, employment to the manager in some subsidiary or other.

also have access to this evidence and may use it to apply to an individual leniency program. Reports to the antitrust authority become public after the manager has been paid for the current period.[18] If a report occurs within the leniency program, the industry is better known by the antitrust authority and kept under close scrutiny afterwards, so that subsequent collusion is deterred. When a manager is the first to report evidence as to collusive behavior, and does so before any audit has been launched, he obtains full amnesty.

2.2 Some benchmarks

The best collusive firm strategies are simple: when collusion is sustainable and profitable, the best strategy consists in colluding in every period, even after a successful audit. Whether collusion is sustainable and/or profitable will depend on incentives at the level of the cartel, but also at the level of the firm.

Full information Assume first that the owners are perfectly informed on both effort e and market conduct K. They will impose choices on their manager, including the optimal effort level e^*. The manager will not quit the firm provided his wage w covers his cost of effort and potential liability in case of collusive behavior.

Under competition, the manager's wage exactly equals his cost of effort, $\psi(e^*)$.

Under collusion, the wage covers the manager for his liability and is $\psi(e) + \rho J$.

A cartel is thus profitable for owners if and only if

$$\frac{1}{1-\delta^o}[e^* - \psi(e^*)] < \frac{1}{1-\delta^o}[e^* + \gamma^M - \rho F - (\psi(e^*) + \rho J)], \quad i.e., \;\; \gamma^M > \rho(F+J). \tag{1}$$

Frequent investigations and corporate and individual liability have the obvious advantage of reducing the profitability of the cartel.

A cartel is sustainable if and only if $\gamma^D - \gamma^M < \frac{\delta^o}{1-\delta^o}[(e^* + \gamma^M - \rho F - (\psi(e^*) + \rho J)) - (e^* - \psi(e^*))]$, i.e.,

$$\gamma^D - \gamma^M < \frac{\delta^o}{1-\delta^o}[\gamma^M - \rho(F+J)], \quad i.e., \;\; \gamma^M > (1-\delta^o)\gamma^D + \gamma^s \rho(F+J). \tag{2}$$

[18] We abstract from the usual credibility issue related to audit in such a context. If the antitrust authority cannot credibly commit to a probability of investigation, the equilibrium is in mixed strategies (Khalil, 1997). Rey (2003) contrasts corporate leniency with public and with secret reports.

Managerial liability does not affect the gain from deviating in the short run, but it reduces the profitability of the cartel, thereby negatively affecting its sustainability. As for profitability, this impact is identical, under full information, to the impact of corporate sanctions F. An individual sanction has thus no particular value for deterrence compared to corporate fines; it may simply help when antitrust authorities cannot raise corporate fines above some level. As we will see, this equivalence between the two types of sanctions will no longer hold under asymmetric information.

Last, note that a corporate leniency program is unambiguously good for deterrence, and its benefits are reinforced by managerial liability, as owners do not have to compensate the manager for his liability when using the program.[19] In the remainder of the paper, we will consider individual leniency programs, as they affect managerial incentives.

Moral hazard on market conduct Assume now that owners cannot observe market conduct. They can deduce it from the joint observation of effort and profits, as there is no uncertainty. No incentive issue arises as the manager would not benefit by adopting a different market conduct than the one required[20].

Moral hazard on effort Assume now that market conduct is observable to owners, but not effort. As above, the joint observation of market conduct and profits provides information. However, when required to join a cartel, a manager could under-exert effort and pretend that the low profit levels obtained are due to deviation from another cartel member. Owners can easily prevent such behavior by paying the manager only when the desired level of profit is reached. We will assume that this is done in the remainder of the paper. If this assumption did not hold, owners would have to leave an information rent to the manager when inducing collusion, giving him a stake in collusive profits.[21]

[19] If a deviating firm can use a corporate leniency program, and if this program is attractive and removes individual liability for firm employees, a cartel is now sustainable only if $\gamma^D - (\gamma^M - \rho F - \rho J) < \frac{\delta^o}{1-\delta^o}[\gamma^M - \rho F - \rho J]$.

[20] This result may not hold with whistle-blowing programs as the manager would then have incentives to join a cartel in order to denounce it.

[21] For completeness, let us assume here that owners cannot so drastically reduce wages for the manager without attracting attention. Then the strategy described becomes attractive to the manager: he would exert effort

3 Managers' incentives when owners prefer collusion

In the remainder of the paper, owners can observe neither managerial effort nor market conduct. Let us first consider the case in which owners want to induce collusion.[22] This will allow us to compute the net profits of owners under collusion, taking into account possible information rents and inefficiencies. The next section will perform the same analysis when owners want to induce competition. Section 5 will then characterize the optimal choice from the point of view of owners between these two options. More precisely, it will assess the profitability and sustainability of collusion.

The manager has 'natural' incentives to collude as this reduces the effort level needed to reach a particular profit target. He may however still prefer deviating or competing. We denote by $PC(K)$ the participation constraint of the manager for market conduct K; and by $IC(K_1 \prec K_2)$ the incentive constraint ensuring that the manager prefers to choose conduct K_2 to K_1 (omitting effort from notations).

An important element of the the analysis is whether the manager remains in office after a cartel conviction (as possible under purely monetary individual sanctions). When the manager faces jail sentences or disqualification, a cartel conviction also ends his relationship with owners. We consider each case below, before turning to the impact of individual leniency programs.

$\underline{e} = e^* + \underline{\gamma}^M - \gamma^M$, where $\underline{\gamma}^M < 0$, to reach the profit corresponding to a competitor's deviation together with the required effort, $\underline{\pi}^M(e^*)$. The manager saves $\psi(e^*) - \psi(e^* + \underline{\gamma}^M - \gamma^M)$. This would be followed by competition forever after (and possibly a dismissal of the manager). If the manager gets no share in the higher profits obtained under collusion, the strategy provides him with a short-term gain but no long-term losses (he gains zero after either a return to competition or a dismissal). Owners must pay him a wage w above the compensation of costs $\psi(e^*) + \rho J$, as long as they require a collusive conduct; While the wage under competition remains at its minimal level, $\psi(e^*)$. The information rent must be such that the long-term losses for the manager due to return to competition off-set the gain obtained by shirking in one period: $\psi(e^*) + \rho J - \psi(e^* + \underline{\gamma}^M - \gamma^M) \leq \frac{\delta}{1-\delta}[w - \psi(e^*)]$. This yields $w = (\psi(e^*) + \rho J) + \frac{1-\delta}{\delta}\psi(e^* + \underline{\gamma}^M - \gamma^M)$, where the information rent is the term in excess of the full information wage.

[22] Inducing the manager to deviate rather than collude is easy, as deviating saves on effort and limits the risk of antitrust penalties to a single period.

3.1 Monetary sanctions

First assume that there is no criminal liability: the manager remains in the firm even after a successful investigation when he obeys the instructions of the owners: colluding and exerting some effort e such that $e+\gamma^M = \pi^M$, where π^M is the required profit target. When disregarding owners' recommendations, the manager either competes or deviates, and optimally adjusts his effort level. Two effort levels may potentially be optimal for both conducts.[23]

- The manager may exert no effort, in which case he will receive no wage;

- Or he may exert the effort level needed to reach the profit target imposed by owners, $\pi^M(e)$; this requires extra effort $(e+\gamma^M)$ when competing, and less effort $(e+(\gamma^D-\gamma^M)$ when deviating, to compensate for the impact of market conduct on profits.

Deviation only comes after a communication stage, so that evidence has been created and the manager remains liable. Deviating without exerting effort thus provides the manager with a utility of $0-\rho J$, which is lower than the participation level, making this choice a dominated one.

Owners will not keep the manager in office, both after a low profit or a deviation.[24] But they will not be able to distinguish competition with extra effort, from collusion with effort e.

The constraints faced by owners are thus

$$\begin{aligned}
PC(M): &\quad \tfrac{1}{1-\delta}[w(\pi^M(e))-\psi(e)-\rho J] \geq \quad 0 \\
IC(C \prec M): &\quad \tfrac{1}{1-\delta}[w(\pi^M(e))-\psi(e)-\rho J] \geq \quad \max\{0, \frac{1}{1-\delta}[w(\pi^M(e))-\psi(e+\gamma^M)]\} \\
IC(D \prec M): &\quad \tfrac{1}{1-\delta}[w(\pi^M(e))-\psi(e)-\rho J] \geq \quad w^M(\pi^M(e))-\psi(e-(\gamma^D-\gamma^M))-\rho J.
\end{aligned}$$

The participation constraint simplifies in $w(\pi^M(e)) \geq \psi(e)+\rho J$, as under full information, and is clearly encompassed by the incentive constraint with respect to competition. Due to this constraint, when deviating the manager gets at least his reservation wage plus a gain from exerting less effort. Hence the participation constraint cannot bind[25], and $IC(C \prec M)$ can only

[23] If a choice is preferred at some period, then it is so at any other period.

[24] We are assuming that the break-down of collusion generates sufficient discontent from other cartel members to become known to (or guessed by) majority owners.

[25] Provided the participation constraint is satisfied, $w(\pi^M(e)) \geq \psi(e)+\rho J$ so that the right-hand side from $IC(D \prec M)$ must be larger than $\psi(e)-\psi(e-(\gamma^D-\gamma^M))$ — which is strictly positive.

matter when it differs from participation, i.e. if $w(\pi^M(e)) - \psi(e+\gamma^M) > 0$. This happens when the manager prefers to exert extra effort to reach the profit target. As he then receives the same wage in each period as if he were colluding, the wage cancels out from the incentive constraint; the only remaining adjustment variable for owners is effort.

The constraints thus simplify into two constraints, i) one that determines a minimum level of the wage, $IC(D \prec M)$, and ii) another, derived from $IC(C \prec M)$ and denoted $IC(C \prec M)'$, that only applies when $w(\pi^M(e)) - \psi(e+\gamma^M) > 0$ and may determine effort e:

$$\begin{aligned} IC(D \prec M): \quad & w(\pi^M(e)) && \geq \psi(e) + \rho J + \frac{1-\delta}{\delta}[\psi(e) - \psi(e - (\gamma^D - \gamma^M))] \\ IC(C \prec M)': \quad & \rho J && \leq \psi(e+\gamma^M) - \psi(e) \quad \Big(\text{if } w^M(\pi^M(e)) \geq \psi(e+\gamma^M) \Big). \end{aligned}$$

Incentives to deviate First consider the constraint $IC(D \prec M)$. Owners are better off having it bind, so as to reduce as much as possible the manager's wage: $w(\pi^M(e)) = \psi(e) + \rho J + \frac{1-\delta}{\delta}[\psi(e) - \psi(e - (\gamma^D - \gamma^M))]$. The manager receives an extra payment relative to the full information wage $\psi(e) + \rho J$, i.e., an information rent that is increasing in e (from the convexity of $\psi(.)$).

Lemma 1 *When owners want to induce collusion, they must pay the manager an information rent, $\frac{1-\delta}{\delta}[\psi(e) - \psi(e - (\gamma^D - \gamma^M))]$, increasing in the required effort level e — or equivalently in the profit target — to avoid deviations.*

In order to further reduce managerial pay, owners should pick an effort level that maximizes their profits, $\frac{1}{1-\delta}[(e+\gamma^M) - w^M(\pi^M(e))]$. The solution to this program is e^M such that

$$\psi'(e^M) = 1 - \frac{1-\delta}{\delta}[\psi'(e^M) - \psi'(e^M - (\gamma^D - \gamma^M))].$$

As $\psi'(e^M - (\gamma^D - \gamma^M)) < \psi'(e^M)$, one has $\psi'(e^M) < \psi'(e^*) = 1$ and $e^M < e^*$.

The gain for a manager from deviating stems from the fact that deviating allows saving on effort. As effort is increasingly costly at the margin ($\psi(.)$ is convex), this savings marginally increases with the effort level required to reach the profit target π^M. By reducing this profit target, owners reduce the necessary effort level under collusion, and make deviations less attractive. They find it profitable to induce some internal inefficiency as the effort level undertaken in equilibrium differs from the first-best one.

The incentive to deviate exists in the absence of antitrust intervention, as it stems from profit targets. Both the effort level e^M and the information rent are independent from individual sanctions. The latter however play a role, as the following shows.

Incentives to compete Reducing the required effort level is only possible if it does not make competition too attractive. Indeed, the gain of competing rather than colluding comes from the existence of antitrust sanctions: competing saves on the expected penalty ρJ but at the cost of increased effort ($e + \gamma^M$ instead of e) to reach the profit target. Again due to the convexity of the cost of effort, this cost of competing increases with e. A reduction in effort (down to e^M) to lessen incentives to deviate makes incentives to compete more stringent. $IC(C \prec M)'$ then applies: the wage paid to the manager becomes large enough to make competing while exerting extra effort (to reach the profit target) more attractive than competing and shirking (and not being paid). In that case, owners will be forced to choose a higher effort level to avoid competition (compared with e^M), and the information rent arising from incentives to deviate will increase.

More precisely, consider the case in which $IC(C \prec M)'$ applies at e^M; that is: $\psi(e^M) + \rho J + \frac{1-\delta}{\delta}[\psi(e^M) - \psi(e^M - (\gamma^D - \gamma^M))] - \psi(e^M + \gamma^M) > 0$, or equivalently,

$$J > \widehat{J}^M(\rho, e^M) \equiv \frac{1}{\rho}\Big[\psi(e^M + \gamma^M) - \psi(e^M) - \frac{1-\delta}{\delta}[\psi(e^M) - \psi(e^M - (\gamma^D - \gamma^M))]\Big].$$

Then $IC(C \prec M)'$ cannot be satisfied. $IC(C \prec M)$ can only be satisfied when it boils down to the participation constraint (so that $IC(C \prec M)'$ does not apply). To ensure this, owners must choose an effort level, $\hat{e}^M$, higher[26] than e^M. As this increases the information rent of the manager, owners will pick the lowest effort level compatible with this constraint: the equilibrium effort level, $\hat{e}^M$, is characterized by

$$J = \widehat{J}^M(\rho, \hat{e}^M) \quad \Big(\Leftrightarrow \quad w^M(\pi^M(\hat{e}^M)) = \psi(\hat{e}^M + \gamma^M)\Big).$$

Proposition 1 *Due to moral hazard on both effort and market conduct, owners always have to pay an information rent to managers when they want to induce monopolization of the industry.*

[26] As $\psi(.)$ is a convex function, $\psi'(e) > \psi'(e - (\gamma^D - \gamma^M))$ and $\frac{\partial \widehat{J}^M(\rho,e)}{\partial e} = \frac{\delta}{\rho}[\delta\psi'(e^M + \gamma^M) - \psi(e^M) + (1 - \delta)\psi'(e^M - (\gamma^D - \gamma^M))] > \frac{\delta}{\rho}[\delta\psi'(e^M + \gamma^M) - \delta\psi(e^M)] > 0$.

- *Assume* $J \leq \widehat{J}^M(\rho, e^M) \equiv \frac{1}{\rho}\Big[\psi(e^M+\gamma^M)-\psi(e^M)-\frac{1-\delta}{\delta}[\psi(e^M)-\psi(e^M-(\gamma^D-\gamma^M))]\Big]$. *Then owners will implement a 'second best'*[27] *outcome, from their point of view; they require lower profit target and effort than when effort or market conduct are known:* $e^M < e^*$.

- *Assume* $J > \widehat{J}^M(\rho, e^M)$. *Then owners will require higher profit target and effort than their 'second best' levels:* $\hat{e}^M > e^M$. *The information rent will be higher than in the 'second best' outcome described above.*

Moral hazard on both effort and market conduct reduces the profitability of collusion to owners: collusion requires higher managerial wages and a lower internal efficiency than when either effort or market conduct is known. Managerial liability not only directly raises the compensation a manager must get in order to participate; It also increases information rents, and it tends to reduce managerial efficiency. And a sufficiently large individual fine makes a new incentive constraint relevant, compelling owners to implement not a 'second best', but a 'third best' allocation.

Corollary 1 *Under two-task moral hazard on the manager's side, individual fines reduce the profitability of cartel agreements more than corporate fines, and via a different mechanism.*

3.2 Criminal sanctions

Let us now consider criminal sanctions, managerial disqualification or jail. The net present value of his compensation is thus weighted by $\frac{1}{1-\delta(1-\rho)}$, instead of $\frac{1}{1-\delta}$ for monetary sanctions. This is because his prospects of obtaining wages in the industry end with a conviction, so that he behaves as if he was discounting the future more.

Due to the shortening of the manager's time horizon, internal incentives constraints become more costly: The benefits of colluding are reduced, while those of competing or deviating are

[27] The term 'second best' is left in quotes as it applies only from the point of view of owners, not from the point of view of social welfare, contrary to the first-best effort level, that is also socially efficient.

not. The constraints faced by owners are

$$\begin{aligned}
PC(M): &\quad \tfrac{1}{1-\delta(1-\rho)}[w(\pi^M(e)) - \psi(e) - \rho J] \geq \quad 0 \\
IC(C \prec M): &\quad \tfrac{1}{1-\delta(1-\rho)}[w(\pi^M(e)) - \psi(e) - \rho J] \geq \quad \max\{0, \frac{1}{1-\delta}[w(\pi^M(e)) - \psi(e+\gamma^M)]\} \\
IC(D \prec M): &\quad \tfrac{1}{1-\delta(1-\rho)}[w(\pi^M(e)) - \psi(e) - \rho J] \geq \quad w^M(\pi^M(e)) - \psi(e - (\gamma^D - \gamma^M)) - \rho J.
\end{aligned}$$

The incentive constraint with respect to deviation simplifies into

$$IC(D \prec M): \, w(\pi^M(e)) \geq \psi(e) + \rho J + \frac{1-\delta(1-\rho)}{\delta(1-\rho)}[\psi(e) - \psi(e - (\gamma^D - \gamma^M))].$$

This constraint translates into a higher information rent, for a given effort level, than under monetary sanctions — even though we consider a criminal sanction identical in terms of utility loss to the monetary sanction of the previous subsection. This is because a deviation ensures that the manager will continue obtaining positive profits provided his initial collusive behavior remains undetected by the antitrust authority (while collusion entails a higher risk of termination of one's employment and opportunities).

But when the wage becomes too large, remaining in office has much value for the manager. And competing is a way of avoiding contractual termination due to criminal sanctions after an antitrust intervention. Formally, if one has $w(\pi^M(e)) > \psi(e+\gamma^M)$, then $IC(C \prec M)$ writes as $w(\pi^M(e)) \leq \frac{1-\delta(1-\rho)}{\delta\rho}\psi(e+\gamma^M) - \frac{1-\delta}{\delta\rho}(\psi(e) + \rho J)$. This condition is only compatible with the initial assumption on $w(\pi^M(e))$ when $\psi(e) + \rho J < \psi(e+\gamma^M)$, or equivalently $J < \widetilde{J}^{crim}(\rho) \equiv \frac{1}{\rho}[\psi(e+\gamma^M) - \psi(e)]$. This may require an increase in e above the first best level e^*. Following the same logic as in the previous subsection, this may further increase the cost of the information rent the manager obtains.[28]

Lemma 2 *Criminal sanctions are more effective at reducing the profitability of collusion for owners than their monetary equivalent:*

- *They increase the manager's information rent for a given effort level,*
- *and they add tension between preventing competition and preventing deviation, so that effort will more often be distorted above the 'second best' level.*

[28] We do not provide a full characterization here as the logic is the same as with monetary sanctions.

To write general expressions, one can use a proxy $\mathbb{1}_j$, where $\mathbb{1}_j = 1$ when there are jail sentences or disqualification, and $\mathbb{1}_j = 0$ otherwise. Participation then writes as $PC(M)$: $\frac{1}{1-\delta(1-\rho\mathbb{1}_j)}[w(\pi^M(e)) - \psi(e) - \rho J] \geq 0$, for instance.

3.3 Individual leniency

Let us assume now that the manager can apply to an individual leniency program (ILP) and get full amnesty when doing so (and that the application becomes public only after the manager has been paid). The program makes deviating more attractive: As deviating implies the termination of the manager's contract, he should also always use the individual leniency program to be shielded from individual sanctions (for which he will receive an extra payment from owners anyway). To ensure that the manager will not not deviate (and simultaneously use the individual leniency program), one must have

$$IC(D \prec M)^{ILP}: \quad \frac{1}{1-\delta(1-\mathbb{1}_j\rho)}[w(\pi^M(e)) - \psi(e) - \rho J] \geq w(\pi^M(e)) - \psi(e - (\gamma^D - \gamma^M)),$$

or equivalently

$$IC(D \prec M)^{ILP}: \quad w(\pi^M(e)) \geq \psi(e) + \rho J + \frac{1-\delta(1-\mathbb{1}_j\rho)}{\delta(1-\mathbb{1}_j\rho)}[\psi(e) + \rho J - \psi(e - (\gamma^D - \gamma^M))].$$

The logic of the argument used in the absence of an individual leniency program applies, with an effort distortion optimally computed to reduce the information rent obtained by the manager. This information rent is higher with individual leniency programs than without them, for a given effort level. An individual leniency program thus reduces the profitability of the cartel.[29]

[29] If the manager is rewarded for his information, as in a whistle-blowing program (instead of being simply amnestied), the incentive constraint above becomes more difficult to ensure: the reward adds to the avoided cost of individual sanctions, ρJ. As in Aubert, Rey and Kovacic (2006), colluding owners must bribe their employee into silence; this impact is reinforced by the one we identify on internal efficiency, when this employee privately chooses both market conduct and effort.

4 Managers' incentives when owners prefer competition

Let us now assume that owners want to induce competition. Characterizing the stream of profits they obtain with competition, together with the results of the previous section, will allow us to assess the sustainability and profitability of collusion.

The difference between monetary and criminal sanctions has here no impact on incentives. Indeed, owners will always fire a manager after an antitrust investigation leading to conviction, or a deviation generating upheaval among firms. The time horizon of a colluding manager is thus determined by the probability of antitrust intervention, not by the type of individual sanctions imposed.

4.1 Equilibrium effort levels

For an effort level e, the participation constraint and incentive compatibility constraints ensuring that the manager prefers competition are

$$\begin{aligned}
PC(C): &\quad \frac{1}{1-\delta}[w(\pi^C(e)) - \psi(e)] \geq 0 \\
IC(M \prec C): &\quad \frac{1}{1-\delta}[w(\pi^C(e)) - \psi(e)] \geq \frac{1}{1-\delta(1-\rho)}[w(\pi^C(e)) - \psi(e-\gamma^M) - \rho J] \\
IC(D \prec C): &\quad \frac{1}{1-\delta}[w(\pi^C(e)) - \psi(e)] \geq w(\pi^C(e)) - \psi(e-\gamma^D) - \rho J.
\end{aligned}$$

Assuming that the participation constraint is satisfied, the incentive constraint with respect to deviation simplifies, and the constraints can be rewritten as:

$$\begin{aligned}
PC(C): &\quad w(\pi^C(e)) \geq \quad \psi(e) \\
IC(M \prec C): &\quad w(\pi^C(e)) \geq \quad \psi(e) + \frac{1-\delta}{\delta\rho}[\psi(e) - \psi(e-\gamma^M) - \rho J] \\
IC(D \prec C): &\quad w(\pi^C(e)) \geq \quad \psi(e) + \frac{1-\delta}{\delta}[\psi(e) - \psi(e-\gamma^D) - \rho J].
\end{aligned}$$

Binding participation constraint The participation constraint is more stringent than the incentive constraints whenever $J \geq \widehat{J}^C(\rho, e) \equiv \frac{1}{\rho}[\psi(e) - \psi(e-\gamma^M)](> 0)$. Assume $J \geq \widehat{J}^C(\rho, e^*)$.

Then incentives play no role, and the owners require the efficient effort e^* for the minimum wage $w^C = \psi(e^*)$. This is more likely for a large probability of intervention ρ, a large individual penalty J and a small gain from cartelization γ^M.

For $0 < J < \widehat{J}^C(\rho, e^*)$, owners may either reduce effort to some level e^C such that $J = \widehat{J}^C(\rho, e^C)$ (where e^C is increasing in J, from the convexity of effort costs $\psi(.)$); or they may choose to have the most stringent of the two incentive constraints binding, and pick the best effort level in that case.

If the owners decide to reduce effort to avoid having incentive constraints bind, they gain $e^C - \psi(e^C)$. If on the other hand they choose a higher effort level than e^C, an incentive constraint will bind, so that they will pay an information rent and choose some distorted effort level to optimally reduce this information rent. As the information rent is a function of the expected fine in case of collusion, ρJ, the comparison between the two options provides a threshold $\overline{J}^C(\rho)$ below which owners are better off having an incentive constraint bind. The remainder of this section studies this choice.

Binding incentive constraint Assume $J < \overline{J}^C(\rho)$. The incentive constraint with respect to monopolization is more stringent than the one with respect to deviation whenever the penalty J is lower than $\widehat{\widehat{J}}^C(\rho, e) \equiv \frac{1-\rho}{\rho}[\psi(e) - \psi(e - \gamma^M)] + [\psi(e - \gamma^M) - \psi(e - \gamma^D)]$ (that is increasing in e and decreasing in ρ). When the penalty is higher, a deviation becomes attractive as it exposes the manager to this penalty only once, in the deviation period. We will assume that $\overline{J}^C(\rho) < \widehat{\widehat{J}}^C(\rho, e)$ (the reverse case is treated in a footnote below) so that the incentive constraint with respect to deviations never binds.

Assume $J < \widehat{\widehat{J}}^C(\rho, e)$. Then $IC(M \prec C)$ binds and the manager obtains an information rent on top of effort compensation $\psi(e)$. This rent is increasing in effort and equals $\frac{1-\delta}{\delta\rho}[\psi(e) - \psi(e - \gamma^M) - \rho J]$. Owners will optimally choose effort e to maximize profits minus the manager's wage. The solution to their program is $\hat{e}^C$ characterized by[30]

$$\psi'(\hat{e}^C) = 1 - \frac{1-\delta}{\delta\rho}[\psi'(\hat{e}^C) - \psi'(\hat{e}^C - \gamma^M)].$$

[30] One should check that this effort level $\hat{e}^C$ is compatible with the initial assumption, $J < \widehat{\widehat{J}}^C(\rho, \hat{e}^C)$. If it is not, owners may further reduce the required effort level to ensure that the manager has incentives to compete.

As the cost of effort $\psi(.)$ is strictly convex, reducing the effort required also reduces the gain from colluding and shirking on this effort $(\psi(e) - \psi(e - \gamma^M))$.[31] The equilibrium effort level increases with the frequency of antitrust intervention (and conviction) ρ.

The threshold $\overline{J}^C(\rho)$ is defined by comparing firm profits for this outcome with the one for a binding participation constraint (at the equilibrium effort levels in each case): $\overline{J}^C(\rho) = \frac{\delta}{1-\delta}[(e^C - \psi(e^C)) - (\hat{e}^C - \psi(\hat{e}^C))] + \frac{1}{\rho}[\psi(\hat{e}^C) - \psi(\hat{e}^C - \gamma^M)]$. This threshold is decreasing in the probability of conviction ρ: more frequent conviction makes it less likely that competing firms will pay information rents to their managers in equilibrium.

The size of the penalty J imposed on the manager does not directly affect the efficiency of competitive firms (as it does not enter the characterization of optimal effort levels) but it does so indirectly by affecting which constraint binds in equilibrium, and also which effort level can be chosen to lower information rents.

Proposition 2 *In the absence of individual liability, competing firms cannot implement full internal efficiency, and must request inefficiently low profit targets.*

- *Assume* $0 \leq J < \widehat{J}^C(\rho, e^*) = \frac{1}{\rho}[\psi(e^*) - \psi(e^* - \gamma^M)]$. *Then the competitive effort level is always lower than the first best one:* $e^C < e^*$. *The manager may obtain an information rent, if* J *is low (below* $\overline{J}^C(\rho)$*).*

- *Assume* $J \geq \widehat{J}^C(\rho, e^*)$. *Then moral hazard imposes no additional cost on owners when they want to induce competition. The managerial wage and the effort level are both the first best, full information, ones.*

Corollary 2 *More frequent antitrust intervention and larger individual penalties improve internal efficiency in competing firms. They also reduce both the likelihood that competing firms pay information rents, and the size of those rents.*

[31] Assume now that $\overline{J}^C(\rho) < \widehat{\widehat{J}}^C(\rho, e)$. The above analysis remains valid for $J < \widehat{\widehat{J}}^C(\rho, e)$. And the same logic applies, when incentives to deviate are stronger than incentives to collude. This happens for larger expected penalties: when $\widehat{\widehat{J}}^C(\rho, e) \leq J < \overline{J}^C(\rho)$, the information rent obtained by the manager is $\frac{1-\delta}{\delta}[\psi(e) - \psi(e - \gamma^D) - \rho J]$. The optimal effort level is then $\widetilde{e}^C$ characterized by $\psi'(\widetilde{e}^C) = 1 - \frac{1-\delta}{\delta\rho}[\psi'(\widetilde{e}^C) - \psi'(\widetilde{e}^C - \gamma^D)]$.

The inefficiency result in the absence of individual sanctions may appear too stark. In practice, individual sanctions may exist, particularly because of reputation effects. If those are insufficient, owners may have to invest in a monitoring technology, so as to better control their managers and high executives and reduce their discretion (compliance programs may serve this purpose to some extent, but may not be always sufficient). This comes at a cost.

4.2 Individual leniency

Individual leniency has mixed effects. We have seen in the previous section that it can make it more costly for owners to induce collusion. Unfortunately, it may also make it more costly for them to induce competition: Indeed, by using an individual leniency program, a manager can escape sanction J (and possibly also escape sanctions imposed after a private litigation initiated by owners). When choosing to deviate, a manager may also use the individual leniency program to avoid the expected cost ρJ, even though this means the termination of his relationship with owners.

More precisely, a manager prefers to use the individual leniency program when deviating if

$$J \geq \frac{1-\rho}{\rho}\frac{\delta}{1-\delta}[w(\pi^C(e)) - \psi(e)].$$

The incentive constraint $IC(D \prec C)$ becomes (weakly) more difficult to satisfy. Under the condition above, it writes as

$$IC(D \prec C)^{ILP}: \quad w(\pi^C(e)) \geq \psi(e) + \frac{1-\delta}{\delta}[\psi(e) - \psi(e-\gamma^D)].$$

It is more likely that this constraint will be binding. The program will not be used in equilibrium. Yet its existence will increase the set of parameters for which the manager must be paid an information rent, and exerts an inefficient level of effort, when owners induce competition.

In other words, when an individual leniency program is set up, owners find it more difficult to induce competition as the individual penalty no longer plays a disciplining role on managers.

Lemma 3 *While an individual leniency program increases the costs of inducing collusion, it also increases the costs associated with inducing competition. This holds even though the program is ultimately not used.*

To summarize, individual leniency programs make collusion less costly for the manager. The latter is induced more to substitute effort with collusion, and the incentives to contrast this choice — to induce competition — are harder to meet. Competition becomes a less appealing option for owners. As we have seen however, the program makes deviations even more attractive so that inducing cartelization rather than deviation becomes more difficult. Hence the ambiguous result above. This result raises some doubts as to the desirability of individual leniency programs. One should assess whether their positive impact offsets their negative effect. In practice, such programs have not been much used, probably as individual leniency is included in corporate leniency. But they may have an impact on incentives even if they are not used.

5 Profitability and sustainability of collusion

The previous sections have characterized the wage and effort corresponding to respectively collusion and competition, depending on the characteristics of antitrust intervention. These values determine whether owners prefer competition, and, more interestingly, whether this is more or less likely than in the absence of two-task moral hazard.

The condition under which collusion is profitable is now

$$\frac{1}{1-\delta^o}[e^C - w(\pi^C(e^C))] < \frac{1}{1-\delta^o}[e^M + \gamma^M - \rho F - w(\pi^M(e^M))],$$

where $w(\pi^C(e^C)) \geq \psi(e^C)$ and $w(\pi^M(e^M)) > \psi(e^M) + \rho J$. As the manager must be paid an information rent when colluding, his wage increases and collusion tends to become less profitable. But an information rent may also be necessary in competing firms for low expected individual sanctions.

Moral hazard also affects profitability via the effort levels requested. The effort level compatible with incentives to compete, e^C, may or may not equal the efficient level e^*, as we have seen. And the effort level compatible with incentives to collude, e^M, generically differs from e^*. We have seen that the impact of moral hazard will depend strongly on the strength of antitrust intervention. Corporate fines clearly play no different role with and without two-task moral hazard. But with a larger penalty J and larger probability of being caught ρ, as well as with criminal sanctions, competition is more attractive (e^C gets closer to e^*, while e^M is more likely

to be distorted away from the level that minimizes the manager's information rent).

Similar effects play on the condition under which collusion is sustainable:

$$\gamma^D - \gamma^M < \frac{\delta^o}{1-\delta^o}\Big[\Big(e^M + \gamma^M - \rho F - w(\pi^M(e^M)) - (e^C - w(\pi^C(e^C))\Big)\Big].$$

The left-hand side is unchanged compared with full information (or moral hazard on effort solely, or market conduct solely). The right-hand side must be compared with the full information corresponding value, $\frac{\delta^o}{1-\delta^o}[\gamma^M - \rho F - \rho J]$. It is thus increased, or reduced, by $e^M - w(\pi^M(e^M)) + \rho J - e^C + w(\pi^C(e^C))$.

Assume first that competition is incentive-compatible for the manager for the first-best level of effort, $e^C = e^*$ (which holds for $\rho J \geq \rho \widehat{J}^C(\rho, e^*)$). Then competition is as profitable as under full information while collusion is less so, due to the information rent and inefficient effort level. A deviation then becomes more attractive than under full information as it implies a departure from a less attractive option, to return to competition.

Assume now that individual penalties are low and antitrust intervention unfrequent. Then competition also entails a loss in efficiency ($e^C < e^*$); collusion may be more or less attractive relative to competition than under full information. Depending on parameters, cartel sustainability may or not be easier to obtain than under full information.

Corollary 3 *When expected individual sanctions are sufficiently large, managerial discretion on both effort and market conduct makes cartels less profitable and less sustainable.*
It may otherwise either lessen or improve cartel profitability and sustainability depending on parameter values for the gains from colluding and deviating, probability of antitrust intervention and size of individual sanctions.

One can summarize the results of the previous sections as follows. Due to the interplay between incentives to choose market conduct and incentives to exert effort, internal efficiency may be lower in equilibrium, both when owners want to induce collusion, and when they prefer to induce competition.

- In colluding firms, managerial effort will be too low if individual penalties are weak, and too high if individual penalties are high; in the later case, the information rent will not be at its second-best level.

- In competing firms, managerial effort will be efficient for high individual penalties (and frequent antitrust intervention); for intermediate penalties, effort will be too low but managers will still be paid at their reservation levels; and for low penalties, effort will be too low and the manager will obtain an information rent.

- Information rents are decreasing in individual penalties for competing firms, but increasing in them for colluding firms.

- The existence of two-task moral hazard makes it more likely that owners prefer competition, if individual sanctions are large. The reverse holds for small individual sanctions.

Corollary 4 *When owners cannot observe market conduct and managerial effort, the possibility of cartelization generates additional welfare costs: Inefficient effort levels may be exerted in colluding firms, but also in competing firms.*

6 Discussions and concluding comments

6.1 An analytical illustration

Let us assume here that the cost of effort takes a simple quadratic form: $\psi(e) = \frac{1}{2}e^2$. Then the optimal effort level is $e^* = 1$.

- If owners wish to collude, they will require their 'second best' effort level

$$e^M = 1 - \frac{1-\delta}{\delta}(\gamma^D - \gamma^M),$$

whenever the most stringent incentive issue is preventing a deviation. As the manager can obtain an information rent from the possibility of deviating, and as effort is distorted to reduce it, the parameters measuring the temptation to deviate play an important role: The more the manager can save by deviating instead of colluding (i.e., the larger $\gamma^D - \gamma^M$), the lower e^M.

If J is large enough, colluding owners will have instead to require effort level

$$\hat{e}^M = \frac{1}{2(\gamma^M - \delta\gamma^D)}\Big[(1-\delta)\rho J - (\gamma^M)^2 + \delta(2\gamma^M - \gamma^D)\Big].$$

This larger effort level prevents owners from reducing the manager's information rent as they would for lower penalties. As effort e^M is increasing in the expected fine ρJ, so is the information rent.

- If owners wish to compete, they will require effort level

$$e^* = 1$$

provided that the individual sanction is larger than $\widehat{J}(\rho, e^*) = \frac{\gamma^M(2-\gamma^M)}{\rho}$ — which is more likely with a higher probability of sanction and a lower gain from colluding.

If the individual sanction takes an intermediate value, competing owners will require the lower effort level necessary for incentive constraints not to bind:

$$e^C = \frac{1}{2\gamma^M}[\rho J + (\gamma^M)^2],$$

that equals e^* at $J = \widehat{J}(\rho, e^*)$. And for larger individual sanctions, owners will require effort level

$$\hat{e}^C = 1 - \frac{1-\delta}{\delta\rho}\gamma^M.$$

A comparison between all possible effort levels would be cumbersome. One can note that the competitive effort weakly decreases with the gain from colluding, γ^M, while the collusive effort increases with it, in accordance with the need to respectively counter or reinforce the manager's incentive to collude. When effort levels have to be distorted to reduce information rents, e^C is larger than e^M whenever the temptation to deviate is important, and antitrust intervention is frequent: $\gamma^D - \gamma^M \geq \frac{(1-\delta)^2}{\delta\rho}\gamma^M$. This condition favors competition relatively more from the point of view of owners.

6.2 Assumptions on effort and market conduct

Our analysis assumes that the value of effort does not depend on market conduct. This isolates the interdependency that arises from asymmetric information and incentives. Assume instead that effort increases profits more, the larger the quantity sold. Then higher effort levels should be expected with either competing or deviating firms. Requiring a high managerial effort would make competing or deviating more attractive to the manager, as these strategies would allow

getting more marginal profit from each additional unit of effort. Incentives to induce a high effort together with collusion would become even more costly than in the set-up considered in the paper.[32]

With technical independence between effort and market conduct, the effort of a given manager has no impact on profits in other firms and is 'private' from the point of view of the cartel. We have considered a 'productivity-oriented' effort. This type of effort would typically improve margins and internal organization without much affecting market shares, as long as price decisions (that belong to 'market conduct' decisions) are not modified. To the contrary, the type of 'sales-oriented' effort likely to affect market shares might sometimes be encompassed in what we labeled 'market conduct'. Cartel members indeed take pains to detail the conditions under which a product will be delivered (as documented by tapes from the lysine cartel), the quality of service (since the 'sandwich war' in airlines), etc. Productivity-oriented effort is likely to be much less observable, since it is not freely observable even for owners.

6.3 Policy implications

Our results have a number of implications.

First, the benefits of antitrust intervention go beyond the disruption of anticompetitive practices, but also beyond deterrence. We identify a specific benefit of individual, and criminal, sanctions: In addition from improving deterrence, they also improve internal efficiency in competing firms. Our results also reinforce the case for more frequent antitrust intervention[33]. As 'effort' from managers and senior executives is not observable, an antitrust authority cannot directly target internal efficiency. But more frequent intervention complements individual sanctions in fostering internally efficient competition: with a higher probability of conviction, lower individual sanctions are needed to impose costs on colluding firms and reduce those on competing ones — which is desirable whenever innocents may be wrongly convicted, however

[32]Note that the efficient effort level would depend on market conduct, which would make comparisons between efficient and equilibrium levels more difficult.

[33]If the stock market had perfect foresight, antitrust authorities should be able to obtain information from its activity. This is not so in our setting: The manager can adjust her effort to the conduct she chooses, and that will potentially mask collusive behavior. Stock market prices are thus quite imperfect indicators of market conduct.

unfrequent this might be in cartel cases. The benefit from improved internal efficiency is clearly not much visible, as it accrues mostly in industries in which firms are not colluding. It might however be taken into account in debates over the size of antitrust budgets and antitrust efficiency. Basing estimates of antitrust efficiency solely on completed cases leads to ignore not only deterrence but also internal incentive effects.

Second, our results highlight the importance of particular antitrust tools, to facilitate efficient competition and make collusion as internally costly as possible — including in terms of information rents and effort. Individual penalties are more effective than corporate ones: They directly reduce the profitability of colluding firms, as corporate sanctions do, since managers must be protected from these sanctions; and they also make colluding firms less efficient while helping competing firms be more so. Jail sentences and managerial disqualifications are even more effective at deterrence, by reducing the manager's expected employment duration (recall however that they do not improve the efficiency of competing firms more than monetary sanctions). Individual sanctions are necessary for competing firms to achieve full internal efficiency (as high profit targets would otherwise induce illegal behavior). Clearly, an increased liability should go along more controls on the authority deciding on this liability, and more expertise on liability within this authority. For instance, particular attention should be given to possible coercion by hierarchical superiors, when subordinates are in a situation of economic dependence. In a criminal system, judges are accustomed to assessing the extent of liability of individuals and usually operate under proper qualifications and control.

The likelihood that owners prefer inducing collusion than inducing competition is difficult to assess empirically. We prefer not to discuss the relative frequency of the two cases. However, our analysis yields the same policy implications regarding the desirability of antitrust instruments for all but individual leniency programs: The latter are the only instrument whose impact may be positive in one case (when owners want collusion) and not in the other. This result calls for more work on the desirability of individual leniency programs. As these programs have not been successful, there is some debate as to whether they should be re-designed to make them more attractive than always using corporate leniency (that encompasses protection for individuals). A new design should be carefully crafted to avoid ambiguous impacts.

Last, note that the above results provide additional rationale for not presuming cartel behavior on the basis of high profits. Colluding firms may not have significantly higher profits than competing ones (as has been observed in a number of instances), due to weaker efficiency. Our results indeed highlight internal disciplining issues for colluding (and to a lesser extent, for competing) firms. This particularly holds in markets in which antitrust intervention is severe with respect to individuals and managers have much discretion.

7 References

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