Hierarchical Firms
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Abstract
This paper presents an agency model that accounts for several key empirical features of the firm, namely the heterogenous morals of its population, its exposition to multiple forms of corrupt activity, and the discriminatory optimal tolerance of these activities. We investigate a principal-supervisor-agent hierarchy where the supervisor may either be honest or dishonest, and where a dishonest supervisor may engage in both collusion and abuse of authority. Among our findings are that the proliferation of corrupt activities in firms: implies that those who control the information are not the only ones who appropriate its rents, makes otherwise costless collusion costly to cope with, results in more corruption being tolerated, does not systematically reduce efficiency, and is advantageous for the supervisor and disadvantageous for the agent. The analysis also reveals that, unlike in models where the population is composed of both honest or dishonest supervisors but only collusion is possible, it may be optimal to tolerate corruption even when it is likely that the supervisor is dishonest.

Keywords: Firm; Organizational design; Abuse of authority; Corruption; Morals.

JEL Classification: D21; D86; L20; M50

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“The best safeguard against abuse of authority and weakness on the part of a higher manager is personal integrity and particularly high moral character of such a manager.” Henri Fayol

1 Introduction

Since Coase’s (1937) influential paper much has been learned on the boundaries of the firm but the theoretical assumptions and results on its internal structure have often been at odds with empirical evidence. Indeed, empirical and experimental studies reveal that key features of the internal structure of the firm are the heterogenous morals of its population, its exposition to multiple forms of corrupt activity, and the discriminatory optimal tolerance of these activities. Yet, amazingly, in the large theoretical literature on multi-level hierarchies pioneered by Antle (1984) and Tirole (1986) the firm is exclusively composed of dishonest members and exposed to a unique form of corrupt activity, namely, collusion.\textsuperscript{1,2} By showing that this form of corruption should be prevented, this literature then implicitly suggests that it is always optimal to deter corrupt activities in firms.

Empirical and experimental analyses show that many people are strongly motivated by honesty and fairness while others behave quite selfishly (e.g., Hornstein, Fisch and Holmes 1968; Murphy 1993; Fehr and Gächter 2000; Evans III et al. 2001).\textsuperscript{3} Many studies argue that acting honestly may be beneficial even though it may in some circumstances cause people to engage in non-selfish behavior (e.g., Akerlof 1983; Granovetter 1985; Sen 1987; LaFollette 2000). A realistic view of firms would therefore acknowledge that they are composed of both honest and dishonest economic agents.

Empirical investigations also reveal that collusion is not the only form of corruption that may take place in firms. Indeed, while an agent may offer a bribe to a supervisor for information concealment, a supervisor may also take undue advantage of her/his position to undermine an agent’s job performance. Empirical analyses find that abuse of authority is one of the most widespread forms of corruption (e.g., Klitgaard 1988; Husbands 1992; Roberts and Mann 1996; Campos and

\textsuperscript{1}See Tirole (1992) for a non-exhaustive survey.

\textsuperscript{2}Other forms of undesired behavior in firms than collusion have been studied by economists. Milgrom (1988), Lazear (1989), Shleifer and Vishny (1989), Silva, Kahn and Zhu (2007), and Che, Dessein and Kartik (2013) consider the implications for the design of an organization of, respectively, influence activities, sabotage, managerial entrenchment, corruption, and pandering. Unlike these authors, we are concerned with unofficial activities taking place in a multi-level hierarchy with hard information in the tradition of Tirole (1986, 1992).

\textsuperscript{3}Hornstein, Fisch and Holmes (1968) found that 40 percent of the wallets that they have intentionally lost in New York City were returned intact. On the psychological and economic drivers of dishonesty, see Mazar and Ariely (2006).
Anecdotal evidence on minor forms of abuse of authority abounds. There is also a great deal of evidence on severe forms of abuse of authority such as sexual harassment.⁴ A comprehensive analysis conducted by the United States Merit Systems Protection Board in 1989 has revealed that 42 percent of women and 15 percent of men have been sexually harassed on their workplace (Flynn 1991). Timmerman and Bajema (1999) provide similar results in their study of sexual harassment in Northwest European countries.⁵

Finally, as proved by these and other empirical studies, while most theoretical models predict that corruption must be optimally deterred, corruption frequently occurs in firms (e.g., Dalton 1959; Johnson and Libecap 1989; Peirce, Smolinski and Rosen 1998; Tanzi 1998).

This paper takes into account these facts, and hence departs from the literature by presenting a phenomenon-driven model of the firm that accounts for its key empirical features. The paper therefore presents a theory of hierarchical firms with both multiple forms of morals and multiple forms of corruption.

In our principal-supervisor-agent hierarchical firm with moral hazard, the supervisor is in charge of obtaining hard, or, equivalently, verifiable, information/evidence about the agent’s output and reporting it to the principal. The supervision technology is not totally efficient, and hence the supervisor obtains hard information about the output only with a certain probability. Given that it is hard evidence, the supervisor’s information can only be concealed but not forged. Upon obtaining hard information about the agent’s output, the supervisor may then conceal his information and produce an inconclusive report. This allows him to engage either in collusion or abuse of authority. When supervision reveals evidence that the agent has produced a low output, the supervisor may collude with the agent and, in exchange for a bribe, conceal his information from the principal. When instead supervision reveals evidence that a high output has been produced by the agent, the supervisor may abuse his authority by asking the agent for a tribute to reveal the information he has obtained. Experiments conducted notably by Evans III et al. (2001) reveal considerably more honest reporting from supervisors than the conventional agency model suggests. In line with this finding, given that in our model the supervisor may be either honest - that is, unwilling to engage in corruption - or dishonest - that is, willing to engage in corruption whenever it is advantageous for him to do so - he will, however, not always engage in collusion and/or abuse of authority but will do so only with a certain probability.

In this more realistic environment, many results of previous models do not longer hold. To

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⁴See also Edwards (1979) and Johnson and Libecap (1989) for evidence on other forms of abuse of authority in organizations.

⁵For an international perspective on sexual harassment, see Aeberhard-Hodges (1996).
analyze the additional modifications that the presence of two forms of corruption introduces in a firm, we characterize the optimal contracts in the cases where only a single form of corruption may occur and in the case where both forms are possible.

We first show that when collusion is the only possible form of corruption, it can be costlessly deterred. We next find that when only abuse of authority is feasible, it is sometimes optimal to tolerate it. Tolerating abuse of authority is optimal whenever the probability of occurrence of this form of corruption is relatively low. This is the case when the probability of a supervisor being dishonest is relatively low or when this probability is relatively high but the production technology is not sufficiently efficient. In these cases, the principal chooses not to destroy the stake of abuse of authority, and hence to leave the door open for this form of corrupt activity. Tolerating abuse of authority, therefore, does not imply that this form of corruption will surely take place.

We then consider both forms of corruption and show that the principal tolerates more often abuse of authority when collusion is feasible than when collusion is not feasible. That is, more corruption is tolerated when both collusion and abuse of authority may take place than in the sole presence of abuse of authority. This is because preventing abuse of authority has a negative effect on preventing collusion. Indeed, deterring abuse of authority has then an extra cost since it makes the deterrence of collusion costly. Collusion is no more costless to prevent. Preventing abuse of authority has also an additional cost when the principal decides to tolerate collusion. This result is in line with both the empirical findings that the possibility of abuse of authority may harm the competitiveness of organizations (e.g., Roberts and Mann 1996; Campos and Pradhan 2007) and that tolerating abuse of authority is sometimes optimal. Indeed, one major difference between collusion and abuse of authority is that the latter may be morally reprehensible since when abusing his authority the supervisor a priori harms the agent. However, as suggested by empirical analyses, due to efficiency considerations, firms often do not adopt preventive solutions against minor and severe forms of abuse of authority (e.g., Klitgaard 1988; Roberts and Mann 1996; Peirce, Smolinski and Rosen 1998).

Similarly, it is optimal to prevent collusion when collusion is the only possible form of corruption whereas it becomes optimal to sometimes tolerate it when both collusion and abuse of authority are feasible.

These findings thus prove that the increase in the forms of corruption: may lead to the breakdown of the collusion-proofness principle, makes otherwise costless collusion costly to deal with,

\[ \text{This principle, established by Tirole (1986), states that we only need to focus on collusion-proof contracts since for any contract that tolerates collusion there exists a collusion-proof contract with an identical payoff.} \]
results in more corruption being tolerated, and does not systematically reduce efficiency. The analysis also reveals that the proliferation of corrupt activities in firms is advantageous for the supervisor and disadvantageous for the agent.

Although both the presence of economic agents with different morals and the existence of various forms of corruption are very important empirical features of firms, economists have not developed models where these two features are simultaneously present. There is, however, a small literature that studies the consequences of a population of supervisors with mixed morals on the optimality of tolerating collusion in three-level firms (Tirole 1992, and references therein). The central, and very intuitive, result of this literature is that tolerating collusion is optimal whenever the probability of an honest supervisor is high enough. It is then unlikely that collusion occurs and costly measures to deter it are unnecessary. This literature therefore shows that the collusion-proofness principle does not hold in environments where the organization is exclusively exposed to collusion and where it is likely that a supervisor is honest. In the light of this result, it is tempting to conjecture that preventing all forms of corruption is in general optimal when it is sufficiently likely that the supervisor is dishonest.

Among our findings is that the central result of the literature on collusion with a mixed population of supervisors and its natural conjecture do not systematically hold in a more realistic environment. Indeed, we show that when collusion is the only possible form of corruption, the policy regarding collusion adopted by the principal does not depend on the supervisor’s morals since collusion can then be costlessly deterred. Furthermore, the central result in question no longer systematically holds when the supervisor may also engage in abuse of authority. That is, in the presence of both collusion and abuse of authority it may be optimal to deter collusion even if the probability of an honest supervisor is relatively high. More generally, the analysis reveals that the issue of morals and corruption is much more complex than suggested by the literature on morals and collusion. Indeed, we show that it may be optimal to tolerate corruption (either collusion or abuse of authority) even if it is likely that the supervisor is dishonest, and, as just mentioned, it may be optimal to deter collusion even if it is likely that the supervisor is honest.

To sum up, among the many results derived in this article we offer a new explanation for the optimality of collusion tolerance - or, equivalently, the breakdown of the collusion-proofness principle - based on the exposition of the firm to a second form of corruption, and, furthermore, prove that this result does not systematically hold in a more realistic environment than that considered by the literature on collusion with a mixed population of supervisors.

Contracting in hierarchies in the presence of two forms of corruption has also been seldom
considered. An exception is Vafaï (2002) who introduces the possibility of abuse of authority in a principal-supervisor-agent hierarchy with moral hazard and hard information but assumes that the supervisor is dishonest.\footnote{The model in Vafaï (2010) is also based on this assumption.} Furthermore, owing to the absence of uncertainty in production, in his model collusion and abuse of authority do not interact. Abuse of authority and collusion are both systematically deterred and collusion is harmless. The possibility of abuse of authority thus does not make collusion costly to deter. Expressed differently, though collusion is feasible, the only harmful, and hence relevant, form of corruption is abuse of authority.

Exploring several ways in which the standard agency model can be enriched to better explain empirical evidence, this paper is, to our knowledge, the first that departs from the existing literature on agency relationships by analyzing a multi-level firm where the supervisor may be either honest or dishonest and where two forms of corruption are feasible.

The design of the paper is the following. The model is presented in Section 2. Section 3 characterizes the optimal incentive contracts when corruption is not possible. Sections 4 and 5 characterize the optimal incentive contracts and determine the firm’s optimal policy regarding corruption respectively when a single form of corruption is possible and when two forms of corruption are possible. Section 6 concludes the paper. Proofs are relegated to an Appendix.

2 Model

A firm under moral hazard consisting of three risk neutral players, a principal (it), a supervisor (he) and an agent (she), has the following specifications:

2.1 Production and supervision technologies

The agent decides how much effort, $e \in \{0, 1\}$, to expend in production. If she chooses to work by expending $e = 1$, she produces a high output $x_H > 0$ with probability $\pi \in (0, 1]$ and a low output $x_L \equiv 0$ with probability $1 - \pi$. If instead she chooses to shirk, she produces $x_L$. How much effort the agent expends is known by her only.

The principal can obtain hard information, or, equivalently, hard evidence (i.e., verifiable) about the agent’s output exclusively by employing a supervisor.\footnote{On optimal contracting and monitoring inside multi-tier organizations in other environments, see Demougin and Fluet (2001) and Bental, Deffains and Demougin (2012).} The supervisor makes a verifiable report on the output. The evidence the supervisor obtains on output is his private information, but, once revealed, it is verifiable. That is, evidence is verifiable exclusively by the person(s) to
whom the supervisor reveals it. Evidence is publicly verifiable only when the supervisor produces his report. In accordance with the literature on collusion, and for simplicity, we assume that supervision is costless. Since the supervision technology is imperfect, private evidence about output is obtained only with probability \( p \in (0, 1) \). The supervisor’s report, \( r \), therefore belongs to \( I = \{x_L, \emptyset, x_H\} \), where \( r = \emptyset \) indicates that supervision has not been conclusive. Given that the private information/evidence obtained by the supervisor is hard, it can be concealed but not forged. In other words, when the supervisor obtains hard evidence that the agent has produced \( x_L \) (resp. \( x_H \)) he may report \( r = \emptyset \) but not \( r = x_H \) (resp. \( r = x_L \)).

### 2.2 Preferences and contracts

Preferences of the agent and the supervisor are respectively described by the following utility functions, \( U^A(w, e) = w - \gamma e \) and \( U^S(s) = s \), where \( w \) and \( s \) are the transfers received from the principal and \( \gamma > 0 \) is the agent’s disutility of effort. The agent’s and supervisor’s reservation utilities are normalized to 0.

The output \( x_H \) is assumed to be large enough for it to be in the principal’s interest to engage in production. For the firm to be valuable, the principal must thus elicit the production effort level \( e = 1 \). The principal is then concerned with designing contracts that induce the effort level \( e = 1 \). We will refer to these contracts as incentive contracts.

Since hard information about the output is exclusively obtained through supervision, contracts are contingent on the supervisor’s report. The principal offers a contract \((w_L, w_\emptyset, w_H)\) to the agent, where \( w_L \) and \( w_H \) are the wages she receives when \( r = x_L \) and \( r = x_H \), respectively, and \( w_\emptyset \) is the wage she receives when \( r = \emptyset \). Similarly, the principal offers a contract \((s_L, s_\emptyset, s_H)\) to the supervisor. The agent and the supervisor are protected by limited liability. We simply assume that the principal cannot impose a negative wage on them.\(^9\)

The principal’s problem is hence to design incentive contracts that minimize the expected cost of production and supervision \( C(w, s) \).

### 2.3 Corruption

Like most models of collusion, we are interested in ex-post corruption, that is, corruption taking place after the supervisor has obtained evidence on output. Because supervision is imperfect, the

\(^9\)To be in a position to compare our results to those obtained in the existing literature on collusion with hard information, we have adopted the same assumptions as in this literature. As most models of collusion with hard information, we have assumed that the supervisor and the agent are risk neutral and protected by limited liability.
supervisor has discretion to conceal information from the principal. The supervisor’s discretion allows him to engage in two forms of corruption. In line with Tirole’s (1986, 1992) standard models of collusion and a large part of the existing literature, we assume that when the supervisor engages in corruption, he unofficially shows (but does not give) the private evidence he has obtained to the agent. That is, corruption occurs under symmetric information on evidence between the supervisor and the agent.

When supervision reveals evidence that the agent has produced a low output, the supervisor may collude with the agent and, in exchange for a bribe, make an uninformative report, \( r = \emptyset \), to the principal. The principal then pays \( w_\emptyset \) to the agent and the agent pays the promised bribe to the supervisor. When instead supervision reveals evidence that a high output has been produced, the supervisor may abuse his authority by threatening the agent with an uninformative report in case she refuses to comply and to pay him a tribute. Thus, if the agent refuses to comply, the supervisor reports \( r = \emptyset \). If instead the agent chooses to comply, the supervisor reports \( r = x_H \). The principal then pays \( w_H \) to the agent and the agent pays the promised tribute to the supervisor.

The supervisor will however not systematically engage in corruption. We assume that with probability \( h \in [0,1] \) the supervisor is honest - and hence will never engage in corruption - and with probability \( 1 - h \) he is dishonest.\(^{10}\) Hence, if \( h = 0 \) the supervisor is dishonest whereas if \( h = 1 \), he is not. Clearly, a dishonest supervisor engages in corruption only if the utility of this choice is higher than that of not doing so.

Regarding corruption, we make the following standard assumptions.

**Observability**

Corruption is only observable to the involved parties.

**Side transfer technology**

Following the literature on collusion, we make the assumption that the side transfer technology - that is, the technology used to transfer bribes and tributes - is less efficient than the official transfer technology used by the principal to pay its employees. Formally, unofficial income can be transferred to a dishonest supervisor at a rate \( k \in (0,1) \). That is, the side transfer creates a deadweight loss. A side transfer of size \( t \) is then only worth \( kt \) to a dishonest supervisor. The transaction costs of side contracting reflect the fact that corruption is costly to organize. These transaction costs can also reflect the non-monetary nature of bribes and tributes.\(^{11}\) Observe that the side transfer technology is totally inefficient, and thus corruption does not occur, when \( k = 0 \).

\(^{10}\)Treisman (2000) provides explanations on the historical and cultural determinants of \( 1 - h \).

\(^{11}\)See Tirole (1992) for a discussion of different kinds of transaction costs.
Finally, notice that the *technology of the firm* is characterized by the vector \((\pi, p, k)\).

*Unofficial bargaining*

In accordance with Tirole (1992), we assume that a dishonest supervisor has all the bargaining power when engaging in corruption.

*Unofficial threats and promises*

In line with the existing literature on corruption in three-level firms, and especially Tirole (1992) and Vafaï (2002), we do not formalize the mechanism that ensures the credibility of unofficial commitments (that is, a dishonest supervisor’s threat of reporting \(r = \emptyset\) - in case of noncompliance of the agent - when abusing his authority as well as the agent’s promise to pay a bribe or a tribute to him). We consider the findings and evidence put forward by this literature as the starting point of our modeling. As shown by recent studies in experimental economics and evidence derived from case studies of collusion and abuse of authority in firms, reputational as well as various non-monetary mechanisms (e.g., emotions, reciprocity) sustain the credibility of commitments even in one-shot interactions.

2.4 Timing

The game played inside the three-level firm evolves as follows: (1) Contracts \((w_L, w_0, w_H)\) and \((s_L, s_0, s_H)\) are offered to employees. (2) Employees decide whether to accept or reject contracts. If either rejects, the game ends and they both get their reservation utility. If instead contracts are accepted, the game continues as follows. (3) Supervision takes place and the agent chooses her effort level. (4) If the supervisor is honest, he does not engage in collusion or abuse of authority. If instead the supervisor is dishonest and (i) supervision reveals evidence that the agent has produced a low output, the agent and the supervisor decide whether or not to collude; (ii) supervision reveals evidence that a high output has been produced, the supervisor decides whether or not to abuse his authority. (5) The supervisor produces a report. (6) Transfers and, in the case the supervisor is dishonest and engages in corruption, (7) side transfers take place.

3 Corruption-free firm

This section studies the benchmark case where the supervisor is honest, that is, \(h = 1\). The agent’s incentive compatibility constraint is then, \(p[\pi w_H + (1 - \pi)w_L] + (1 - p)w_0 - \gamma \geq pw_L + \gamma\) as explained above, corruption will also not take place if \(k = 0\).
(1 − p)wθ, or equivalently,
\[ w_H - w_L \geq \frac{\gamma}{p\pi}. \]  

This equation makes the agent prefer to exert effort in equilibrium.\(^\text{13}\)

The agent’s contract must also verify her participation constraint, \( p[\pi w_H + (1 - \pi)w_L] + (1 - p)w_\emptyset - \gamma \geq 0 \). However, since the agent’s contract must be incentive compatible and transfers are non-negative, the agent’s participation constraint is systematically redundant and will therefore be disregarded in the rest of the paper.

Given that wages must be non-negative, we have
\[ w_L \geq 0, \quad w_\emptyset \geq 0, \quad w_H \geq 0, \quad s_L \geq 0, \quad s_\emptyset \geq 0, \quad s_H \geq 0. \]  

The supervisor accepts any contract \((s_L, s_\emptyset, s_H) \in \mathbb{R}_+^3\). Since supervision is costless, any contract \((s_L, s_\emptyset, s_H) \in \mathbb{R}_+^3\) is individually rational.

Finally, in order to provide incentives to the supervisor to reveal the information he has obtained, the principal must also set \( s_L \geq s_\emptyset \) and \( s_H \geq s_\emptyset \).\(^\text{14}\) Given that the optimal contract offered to the supervisor in this case and in the subsequent cases satisfies these constraints, we will systematically ignore them.

The program of a corruption-free firm is thus

\[
\begin{array}{ll}
\text{min} & p[\pi(w_H + s_H) + (1 - \pi)(w_L + s_L)] + (1 - p)(w_\emptyset + s_\emptyset) \\
\text{s.t.} & (1) \text{ and } (2).
\end{array}
\]

The solution to this program is given in the next proposition.

**PROPOSITION 1.** The features of a firm unexposed to corruption are such that:

The optimal contracts are \((w_L, w_\emptyset, w_H) = (0, 0, \frac{\gamma}{p\pi})\) and \((s_L, s_\emptyset, s_H) = (0, 0, 0)\). The expected cost of production and supervision is \(C^F = \gamma\).

This proposition reveals that, when corruption is not possible, the principal keeps both the supervisor and the agent at their reservation utility levels. That is, the principal does not need to provide rents to obtain information. This is not anymore systematically true when corruption is possible.

\(^{13}\)We assume that the agent chooses to work when she is indifferent.

\(^{14}\)We assume that the supervisor reports truthfully when he is indifferent.
4 Firm, morals and a single form of corruption

In this section, we investigate a hierarchical firm in which the supervisor is dishonest with some probability $h \in [0, 1)$ and may engage in a single form of corruption. We respectively consider the case where only collusion is possible and the case where the supervisor may only engage in abuse of authority.

4.1 Collusion

In a firm where only collusion is possible, a dishonest supervisor and the agent may collude when supervision reveals evidence that a low output has been produced. This occurs either when the agent shirks or when she works hard but is unlucky. In both of these cases, the agent promises to pay a bribe to the dishonest supervisor if he makes an uninformative report, $r = \emptyset$, instead of $r = x_L$, to the principal. The principal has then the choice between two policies. It can either deter or tolerate collusion.

The deterrence of collusion imposes an extra constraint on the firm to the determination of which we now turn.

If the agent colludes with a dishonest supervisor and pays the promised bribe, her utility is $w_\emptyset - b$ if she has shirked, and $w_\emptyset - b - \gamma$ if she has worked but has been unlucky, where $b$ is the bribe offered to the supervisor. If instead the agent does not collude with a dishonest supervisor, her utility is $w_L$ if she has shirked, and $w_L - \gamma$ if she has worked but has been unlucky. The agent is thus ready to collude with the supervisor if $w_\emptyset - b \geq w_L$, that is, if $b \leq w_\emptyset - w_L$. The maximum bribe, $b^M$, the agent is willing to offer for an uninformative report is therefore $b^M \equiv w_\emptyset - w_L$.

Since a dishonest supervisor has all the bargaining power, he can extract $b^M$ from the agent. We make the standard assumption that a dishonest supervisor does not engage in corruption when he is indifferent. Collusion between a dishonest supervisor and the agent will thus not take place if the supervisor’s utility from revealing the truth, $s_L$, exceeds his utility from providing an inconclusive report, $s_\emptyset + kb^M$, that is, if

$$s_L \geq s_\emptyset + k(w_\emptyset - w_L), \quad (3)$$

where $w_\emptyset - w_L$ is the stake of supervisor/agent collusion. We refer to this constraint as the no-collusion constraint.

When collusion is deterred, we therefore have that the program of the firm is identical to program $\left[P^F\right]$ with the difference that contracts must also satisfy the no-collusion constraint.
We do not need to consider the case where collusion is tolerated since, as it is straightforward to see, the solution to program $[P^F]$ also satisfies the no-collusion constraint. In other words, the collusion-free contracts coincide with the collusion-proof contracts. Moreover, as will become clear, tolerating collusion is more expensive than deterring it. We thus have:

**PROPOSITION 2.**  Compared with the case where it is unexposed to corruption, the firm does not sustain any efficiency loss, that is, collusion prevention is costless in a firm exposed only to this form of corruption.

The proposition states that the sole possibility of collusion does not reduce the efficiency of the firm.\(^{15}\) In the next section we will show that this is not the case anymore when both collusion and abuse of authority may occur.

It should be noted that we are not claiming here that collusion between a dishonest supervisor and an agent is always harmless, but we show that, even in environments where collusion is harmless, this form of corruption becomes costly to deal with when other forms of corruption may also take place. A growing literature proves that the harmfulness of collusion depends crucially on the environment in which collusion may occur, and hence collusion can be costlessly deterred in a broad class of circumstances (e.g., Vafaï 2002; Cont 2004, and references therein). Slightly modifying Tirole’s standard model may result in collusion becoming costless to deter or even beneficial.

In the light of these results the relevance of the literature on collusion has been questioned. In this paper, we identify a cause for collusion harmfulness, namely the presence of other forms of corruption. We show below that while collusion may be costless to deter in the absence of abuse of authority, this is no longer the case when abuse of authority becomes possible. Considering a single form of corruption is thus deceptive. This is all the more the case since we have the following natural corollary of Proposition 2:

**COROLLARY.** The sole presence of honest supervisors in the population does not result in the breakdown of the collusion-proofness principle.

As noted in the introduction, a central result of the literature on collusion is that the collusion-proofness principle does not hold - or, equivalently, tolerating collusion is optimal - in environments\(^{15}\) A similar result as that of Proposition 2 is proven in Vafaï (2002). However, the reason behind Vafaï’s (2002) result is different from the one here. Indeed, collusion is harmless in Vafaï (2002) because $\pi = 1$, and hence the supervisor’s wage $s_L$ does not enter the objective function. This wage can then be set so large as to deter collusion without affecting the efficiency of the firm.
where the firm is exclusively exposed to collusion and where it is likely that a supervisor is honest. The above corollary proves that this may not be the case. We prove below that while the collusion-proofness principle may remain valid in an environment with both honest and dishonest supervisors and where only collusion is possible, this is not always the case anymore when the firm is also exposed to abuse of authority.

### 4.2 Abuse of authority

In a firm where abuse of authority is the only possible form of corruption, a dishonest supervisor may abuse his authority when supervision reveals evidence that the agent has produced a high output. A dishonest supervisor then threatens the agent with an uninformative report, \( r = \emptyset \), if she refuses to comply and to pay him a tribute. The agent’s utility is \( w_H - t - \gamma \) if she complies to the supervisor’s abuse of authority and pays the demanded tribute, denoted \( t \), and \( w_\emptyset - \gamma \) if she does not comply. The agent therefore complies and pays a tribute for information revelation if \( w_H - t - \gamma \geq w_\emptyset - \gamma \), that is, if \( t \leq w_H - w_\emptyset \). Since a dishonest supervisor can extract the maximum amount of \( t^M \equiv w_H - w_\emptyset \) from the agent, his utilities corresponding respectively to abusing and not his authority are \( s_H + kt^M \) and \( s_H \). A dishonest supervisor therefore engages in abuse of authority whenever he has a stake in it, that is, whenever \( t^M > 0 \).

Consequently, when the firm is exposed to abuse of authority, the agent’s incentive compatibility constraint is, 

\[
p \left[ \pi \left[ hw_H + (1 - h)(w_H - t^M) \right] + (1 - \pi)w_L \right] + (1 - p)w_\emptyset - \gamma \geq pw_L + (1 - p)w_\emptyset,
\]

or equivalently,

\[
hw_H + (1 - h)w_\emptyset - w_L \geq \frac{\gamma}{p\pi}.
\]

Since abuse of authority occurs as long as \( t^M > 0 \), the principal also faces the following constraint, 

\[
w_H - w_\emptyset \geq 0.
\]

Constraint (5) says that the principal may either tolerate or deter abuse of authority. To

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\[ ^{16} \text{The model does not consider the possibility of the agent appealing to the principal or lodging a complaint after being victim of abuse of authority. This is because abuse of authority is unobservable and the information transmitted by the supervisor is the only available information. Empirical evidence show that lodging a complaint is often ineffective. For example, in the case of sexual harassment, Husbands (1992, p. 556) writes: "A complaint may encounter a number of practical obstacles in litigating a sexual harassment case. In pursuing any type of civil case in the countries surveyed, the burden of proofs falls on the complainant alleging the harassment... the proposition asserted by the complainant may be difficult to prove in a sexual harassment case. Most propositions for tangible job benefits in exchange for sexual favours are not made with witnesses present, so it may often be the complainant’s word against the alleged harasser’s." He then observes: “There is evidence that a great deal of sexual harassment goes unreported” (p. 538). As noted by Roberts and Mann (1996, p. 270): “...most cases of sexual harassment still go unreported: as many as ninety-five percent of all such incidents may not be brought to light.”.}
tolerate abuse of authority, the principal has to keep the stake of this form of corruption, and hence set the agent’s wages \( w_H \) and \( w_0 \) such that \( t^M = w_H - w_0 > 0 \). To deter abuse of authority, the principal has instead to destroy the stake of this form of corruption, and thus set \( w_H \) and \( w_0 \) such that \( t^M = 0 \). Expressed differently, constraint (5) says that if \( w_H - w_0 > 0 \) abuse of authority may take place, whereas if \( w_H - w_0 = 0 \) it may not.

The program of a firm where only abuse of authority may occur is therefore

\[
\begin{align*}
[PA] \quad \min_{w_L, w_0, w_H, s_L, s_0, s_H} & \quad p[\pi(w_H + s_H) + (1 - \pi)(w_L + s_L)] + (1 - p)(w_0 + s_0) \\
& \text{s.t. (2), (4) and (5)}. 
\end{align*}
\]

Define \( \hat{h} \equiv p \) and \( \hat{\pi} \equiv \frac{h(1-p)}{p(1-h)} \). We then have.

**Proposition 3.** The features of a firm exposed only to abuse of authority are such that:

1. The optimal contracts are \((w_L, w_0, w_H) = (0, 0, \frac{\gamma}{p\gamma h})\) and \((s_L, s_0, s_H) = (0, 0, 0)\) if \( h \leq \hat{h} \) and \( \pi \leq \hat{\pi} \), or \( h > \hat{h} \). Abuse of authority is tolerated. The expected cost of production and supervision is \( C^A_1 = \frac{\gamma}{\pi} \).

2. The optimal contracts are \((w_L, w_0, w_H) = (0, \frac{\gamma}{p\pi}, \frac{\gamma}{p\pi})\) and \((s_L, s_0, s_H) = (0, 0, 0)\) if \( h \leq \hat{h} \) and \( \pi > \hat{\pi} \). Abuse of authority is deterred. The expected cost of production and supervision is \( C^A_2 = \frac{(1-p)(1-\pi)}{p\pi} \frac{\gamma}{\pi} \).

3. Either the supervisor or the agent captures an informational rent. Tolerating abuse of authority benefits a dishonest supervisor (the instigator), whereas deterring abuse of authority benefits the agent (the potential victim).

4. Compared with the cases where it is unexposed to corruption or exposed only to collusion, the firm systematically sustains an efficiency loss, that is, abuse of authority is costly to deal with (to deter or to tolerate).

As noted above, the principal has the choice between deterring and tolerating the supervisor’s abuse of authority. If it decides to deter abuse of authority, it has to destroy its stake by setting \( w_0 = w_H \). If instead the principal decides to tolerate abuse of authority, it sets \( w_H > w_0 \).

Proposition 3 states that in the extreme case where the supervisor is always dishonest (i.e., case 2 since then \( h = 0 \), and thus \( \hat{\pi} = 0 \)), it is always optimal to deter abuse of authority. This can be explained in the following way. Compared with the case where corruption is not feasible or
where only collusion may occur, the possibility of abuse of authority reduces the agent’s incentive to work. The agent’s incentive compatibility constraint then becomes $w_0 - w_L \geq \frac{\gamma}{p\pi}$. Since it is optimal to set $w_L = 0$, this means that the principal must offer $w_0 = \frac{\gamma}{p\pi}$ in place of $w_H = \frac{\gamma}{p\pi}$ to motivate the agent to work hard. Given that the expected cost of production and supervision is increasing in wages paid, it is then clearly preferable for the principal to prevent abuse of authority by offering $w_H = w_0 = \frac{\gamma}{p\pi}$ rather than tolerate it by setting $w_H > w_0$. The principal then offers a flat wage to the agent whenever $r \neq x_L$. Thus, in the case where the supervisor is always dishonest, the agent receives a rent $(1 - p)\frac{\gamma}{p\pi}$. The supervisor is kept at his reservation utility level.

Unlike in the case where $h = 0$, when $h \in (0, 1)$ it may become optimal to tolerate abuse of authority. Indeed, in the case where the supervisor is dishonest with probability $h \in (0, 1)$, the optimal policy trades off a contract with a higher wage $w_0 = \frac{\gamma}{p\pi}$ and a lower wage $w_H = \frac{\gamma}{p\pi}$ in the case where abuse of authority is deterred against a contract with a lower wage $w_0 = 0$ and a higher wage $w_H = \frac{\gamma}{p\pi h}$ in the case where abuse of authority is tolerated.

When $h > \hat{h}$, the probability that the supervisor is honest, and thus abuse of authority will not take place, is high enough. Clearly, it is then optimal to tolerate abuse of authority. In this case, a rent $p\pi t^M \equiv p\pi(w_H - w_0)$ or, equivalently, $\frac{\gamma}{p\pi}$, is left to a dishonest supervisor (i.e., a dishonest supervisor only receives $p\pi t^M = \frac{k\gamma}{\pi}$) while the agent is kept at her reservation utility level.

When instead the probability of the supervisor being honest is sufficiently low (i.e., $h \leq \hat{h}$), the principal’s policy will depend on the quality of the production technology.

If $\pi \leq \hat{\pi}$, the principal will tolerate abuse of authority, and hence a rent will be left to a dishonest supervisor. This is because the probability that a low output will be produced, and thus $w_H$ will not be paid to the agent, is then high enough.

If $\pi > \hat{\pi}$, the probability that a high output will be produced, and hence $w_H$ will be paid to the agent, is large enough. It is therefore optimal to deter abuse of authority and offer a lower wage $w_H = \frac{\gamma}{p\pi}$. As noted earlier, in this case only the agent receives a rent.

Straightforward comparative statics show that tolerating abuse of authority becomes more attractive as the probability of an honest supervisor increases (i.e., $\frac{\partial \hat{\pi}}{\partial h} > 0$).

To sum up the results on rent extraction, we thus have that the supervisor captures the informational rent generated by the tolerance of abuse of authority, whereas the agent captures the informational rent generated by the deterrence of this form of corruption.

Finally, as easy to check, compared with the cases where the firm is not exposed to corruption or exposed only to collusion, the possibility of abuse of authority increases the expected cost of the firm. In other words, unlike the possibility of collusion, the possibility of abuse of authority
systematically reduces the efficiency of the firm. This result is in line with the empirical finding that the possibility of abuse of authority harms the competitiveness of organizations (e.g., Campos and Pradhan 2007).

5 Firm, morals and multiple forms of corruption

We now turn to the case of a firm where the supervisor may have heterogeneous morals (i.e., $h \in [0, 1)$) and may engage in both collusion and abuse of authority.

As above, the principal has the choice between deterring and tolerating collusion.

5.1 Prevention

If the principal decides to deter collusion, constraint (3) must be added into program $[P^A]$ when looking for the optimal contracts in a firm where both collusion and abuse of authority are possible and collusion is deterred. Let $[P^{CA}]$ denote this new program and define $\pi \equiv \frac{h(1-p(1-k))}{p(1-h(1-k))}$. The next proposition then summarizes the solution to $[P^{CA}]$.

**PROPOSITION 4.** The features of a firm exposed to both collusion and abuse of authority where collusion is deterred are such that:

1. The optimal contracts are $(w_L, w_0, w_H) = (0, 0, \frac{\tilde{\gamma}}{p\pi h})$ and $(s_L, s_0, s_H) = (0, 0, 0)$ if $h \leq \hat{h}$ and $\pi \leq \tilde{\pi}$, or $h > \hat{h}$. Abuse of authority is tolerated. The expected cost of production and supervision is $C^{CA}_1$.

2. The optimal contracts are $(w_L, w_0, w_H) = (0, \frac{\tilde{\gamma}}{p\pi}, \frac{\tilde{\gamma}}{p\pi})$ and $(s_L, s_0, s_H) = (\frac{k\gamma}{p\pi}, 0, 0)$ if $h \leq \hat{h}$ and $\pi > \tilde{\pi}$. Abuse of authority is deterred. The expected cost of production and supervision is $C^{CA}_1 = \frac{1-p(1-\pi)(1-k)}{p\pi}$.

By the same argument as that given for Proposition 3, when the supervisor is always dishonest (i.e., case 2 of Proposition 4 since then $h = 0$, and thus $\pi = 0$) it is optimal to prevent abuse of authority. Clearly, to deter collusion the principal then sets $s_L = \frac{k\gamma}{p\pi}$. Compared with the cases where only one form of corruption may occur, the expected cost of the firm is larger. This is due to the (negative) interaction of the two forms of corruption. The possibility of abuse of authority now makes collusion costly to prevent.

In contrast to the case where $h = 0$, when $h \in (0, 1)$ abuse of authority is sometimes optimally tolerated. Comparing the results of Proposition 4 to that of Proposition 3 when $h \in (0, 1)$ reveals that the possibility of collusion expands the range of parameter values for which abuse of authority
is tolerated. In other words, given that \( \hat{\pi} \leq \pi \) when \( h \leq \hat{h} \), the principal tolerates more often abuse of authority when collusion is possible than when it is not. The intuition behind this is that when the probability of an honest supervisor is sufficiently low (i.e., \( h \leq \hat{h} \)) and it is hence likely that corruption occurs, deterring abuse of authority by setting \( w_\emptyset = \frac{\gamma}{p\pi} ( = w_H) \) is more costly here than in the case where only abuse of authority is possible. This is because deterring abuse of authority has now an extra cost since it makes the deterrence of collusion costly (i.e., \( s_L = \frac{k}{p\pi} \)).

By contrast, collusion is costless to deter when abuse of authority is tolerated. In this case, the two forms of corruption do not interact. Therefore, in contrast to the case where \( h = 0 \), when \( h \in (0,1) \) collusion and abuse of authority do not always interact. Given that collusion is harmless when abuse of authority is tolerated, this policy has now an additional advantage compared with the case where only abuse of authority is possible.

Unlike when only abuse of authority is possible, there is a case where both the supervisor and the agent receive rents. Indeed, the supervisor now also receives a rent when abuse of authority is deterred. In this case, the agent’s rent is \((1 - p)\frac{\gamma}{p\pi}\) (as in the case where the firm is exposed only to abuse of authority and this form of corruption is deterred) and the supervisor’s rent is \((1 - \pi)\frac{k}{p\pi}\). As just explained, this is because preventing abuse of authority makes collusion deterrence costly. Thus, when abuse of authority is optimally prevented, the supervisor captures the informational rent generated by the deterrence of collusion and the agent captures the informational rent generated by the deterrence of abuse of authority. As in the above subsection, when abuse of authority is instead tolerated, only the supervisor receives a rent, \( \frac{k}{p\pi} \). Since \( \hat{\pi} \leq \pi \) when \( h \leq \hat{h} \), the agent now less often receives a rent.

To summarize, unlike in the case where only abuse of authority is possible, the supervisor now systematically receives a rent, whereas the agent less often captures a rent. The supervisor is hence the one who benefits from the proliferation of corrupt activities.

Finally, note that, as in the case where only abuse of authority is possible, \( \frac{\partial (\pi)}{\partial h} > 0 \).

### 5.2 Tolerance

If the principal decides to tolerate collusion - that is, if it decides to offer contracts which do not satisfy the no-collusion constraint \( s_L \geq s_\emptyset + k(w_\emptyset - w_L) \) - collusion occurs. Indeed, as explained in subsection 4.1, since for the bribe \( b^M \equiv w_\emptyset - w_L \) both a dishonest supervisor and the agent are then willing to collude, collusion takes place. Hence, when collusion is tolerated, a dishonest supervisor reports \( r = \emptyset \) in the case where the technology of supervision reveals \( x_L \). The agent then receives a wage \( w_\emptyset \) from the principal and pays a bribe \( b^M \equiv w_\emptyset - w_L \) to the supervisor.
The agent’s incentive compatibility constraint is however identical to that in the case where only abuse of authority is possible. Indeed, the agent’s incentive compatibility constraint is now
\[ p \left[ \pi \left[ hw_H + (1 - h)(w_H - t^M) \right] + (1 - \pi) \left[ hw_L + (1 - h)(w_\emptyset - b^M) \right] \right] + (1 - p)w_\emptyset - \gamma \geq 0. \]

The principal’s objective function writes
\[
\min_{w_L, w_\emptyset, w_H, s_L, s_\emptyset, s_H} \left[ P^{CA}_2 \right] \quad \text{s.t. (2), (4) and (5).}
\]

Define \( \bar{\pi} = \frac{\hat{h}(1 - \hat{h})}{\hat{h}(1 - \hat{h})} \). We then have.

**PROPOSITION 5.** The features of a firm exposed to both collusion and abuse of authority where collusion is tolerated are such that:

1. The optimal contracts are \( (w_L, w_\emptyset, w_H) = (0, 0, \hat{h}) \) and \( (s_L, s_\emptyset, s_H) = (0, 0, 0) \) if \( h \leq \hat{h} \) and \( \pi \leq \bar{\pi} \), or \( h > \hat{h} \). Abuse of authority is tolerated. The expected cost of production and supervision is \( C^A_1 \).

2. The optimal contracts are \( (w_L, w_\emptyset, w_H) = (0, \hat{h}, \hat{h}) \) and \( (s_L, s_\emptyset, s_H) = (0, 0, 0) \) if \( h \leq \hat{h} \) and \( \pi > \bar{\pi} \). Abuse of authority is deterred. The expected cost of production and supervision is \( C^{CA}_2 = \frac{1 - p(1 - \pi)\hat{h}}{p} \).

Before providing intuition for Proposition 5, note that in the first case of this proposition we have simplified the analysis by setting \( w_\emptyset = 0 \) instead of \( w_\emptyset = \epsilon > 0 \) (with \( \epsilon \rightarrow 0 \)). We have made the standard assumption that the supervisor does not engage in collusion when indifferent. Hence, if the principal decides to allow collusion, it must set \( b^M = w_\emptyset - w_L \) such that the supervisor receives a strictly positive (though, clearly, as small as possible) bribe from the agent, that is, the principal must set \( w_\emptyset - w_L \geq \epsilon \). For the supervisor to engage in collusion the optimal contracts must also satisfy \( s_L < s_\emptyset + k(w_\emptyset - w_L) \) or \( s_L \leq s_\emptyset + k(w_\emptyset - w_L - \epsilon) \). Since optimally \( w_L = s_L = s_\emptyset = 0 \), we must then have \( w_\emptyset = \epsilon \). However, as explained in the Appendix, setting \( w_\emptyset = 0 \) instead of \( w_\emptyset = \epsilon \) is inconsequential.
For the same reason as that given for Proposition 3, when the supervisor is always dishonest (i.e., case 2 of Proposition 5 given that then $h = 0$, and hence $\tilde{\pi} = 0$) the principal optimally deters abuse of authority. As explained above, since collusion is tolerated, a dishonest supervisor reports $r = \emptyset$ when the technology of supervision reveals $x_L$. The agent then receives $w_\emptyset$.

As in the case where collusion is deterred, given that $\tilde{\pi} \leq \tilde{\pi}$ when $h \leq \hat{h}$, if $h \in (0, 1)$ the principal tolerates more often abuse of authority when collusion is feasible than when it is not. Again, this is because deterring abuse of authority has now an additional cost. Indeed, when the principal offers a contract that deters abuse of authority, a dishonest supervisor colludes with the agent when the supervision technology reveals a low output and the principal must then also offer $w_\emptyset = \frac{1}{p\pi}$ to the agent in this case since the supervisor reports $r = \emptyset$. Collusion is costless when abuse of authority is instead tolerated. In this case, collusion and abuse of authority do not interact. As in the previous subsection, when $h \in (0, 1)$ the two forms of corruption do not systematically interact. Compared with the case where only abuse of authority is feasible, tolerating abuse of authority has thus now an extra advantage.

As in the preceding subsection, unlike when the firm is exposed only to abuse of authority, there is a case where both a dishonest supervisor and the agent capture rents. Indeed, a dishonest supervisor now also captures a rent when abuse of authority is prevented. In this case, the agent’s rent is $(1 - p)\frac{1}{p\pi}$ (again as in the case where the firm is exposed only to abuse of authority and this form of corruption is deterred) and the supervisor’s rent is $(1 - \pi)(1 - h)\frac{k\gamma}{\pi}$. We have just explained that this is due to the existence of a negative interaction between the two forms of corruption. Notice that, unlike in the above case where collusion were deterred, only a dishonest supervisor receives a rent in the case where abuse of authority is deterred. When abuse of authority is optimally prevented, a dishonest supervisor thus captures the informational rent generated by the tolerance of collusion and the agent captures the informational rent generated by the deterrence of abuse of authority. As above, when abuse of authority is instead tolerated only the supervisor receives a rent, $\frac{k\gamma}{\pi}$. Since $\tilde{\pi} \leq \tilde{\pi}$ when $h \leq \hat{h}$, the agent now less often captures a rent.

To sum up, unlike in the case where only abuse of authority is possible, a dishonest supervisor now always captures a rent, whereas the agent less often receives a rent. A dishonest supervisor is therefore the member of the firm who benefits from the proliferation of corrupt activities.

### 5.3 Morals and hierarchy

Comparing the firm’s expected costs in Propositions 4 and 5, we may now determine the optimal policy regarding collusion, and hence regarding corruption, and also sum up the above discussions.
Define $\xi \equiv 1 - h$, and note that $\tilde{\pi} \geq \pi$ if $h \leq \tilde{h}$ and $k \leq \xi$ whereas $\tilde{\pi} \leq \pi$ if $h \leq \tilde{h}$ and $k > \xi$. Then:

**THEOREM.** The features of a firm exposed to both collusion and abuse of authority are such that:

1. The optimal policy is: (a) to tolerate abuse of authority and deter collusion if (i) $h \leq \tilde{h}$, $\pi \leq \tilde{\pi}$ and $k \leq \xi$; (ii) $h \leq \tilde{h}$, $\pi \leq \tilde{\pi}$ and $k > \xi$; (iii) $h > \tilde{h}$; (b) to deter both abuse of authority and collusion if $h \leq \tilde{h}$, $\pi > \tilde{\pi}$ and $k \leq \xi$; (c) to deter abuse of authority and tolerate collusion if $h \leq \tilde{h}$, $\pi > \tilde{\pi}$ and $k > \xi$.

2. When abuse of authority is optimally deterred: (a) the two forms of corruption interact, and hence the possibility of abuse of authority makes collusion costly to deal with (that is, to deter or to tolerate); (b) both the supervisor and the agent capture informational rents. The supervisor captures the rent generated by the tolerance or the deterrence of collusion, whereas the agent captures the rent generated by the deterrence of abuse of authority; (c) the supervisor captures a higher rent when collusion is deterred than when it is tolerated; (d) the efficiency loss sustained by the firm is higher compared with the case where it is exposed only to abuse of authority.

3. When abuse of authority is optimally tolerated: (a) the two forms of corruption do not interact, and hence collusion remains costless; (b) only a dishonest supervisor captures an informational rent. This rent - generated by the tolerance of abuse of authority - is identical to that extracted by the supervisor in the case where the firm is exposed only to abuse of authority; (c) the efficiency loss sustained by the firm is identical to that sustained in the case where only abuse of authority is possible.

Several results are summarized in the Theorem.

First, given that it may be optimal to tolerate collusion, the collusion-proofness principle may not hold. As noted in the introduction, there is a small literature that explains the breakdown of the collusion-proofness principle by the presence of enough honest supervisors in the population. Our explanation of the breakdown of this principle is instead based on the exposition of the firm to more than a single form of corruption. Moreover, as noted in the introduction and explained below, the central result of this small literature does not hold in a more realistic environment where multiple forms of corruption are possible. Indeed, the Theorem shows that in the presence of both collusion and abuse of authority it is optimal to deter collusion even if the probability of an honest supervisor is relatively high. More generally, the analysis reveals that the issue of morals and corruption is much more complex than suggested by the literature on morals and collusion.
Next, the Theorem expresses that when both the probabilities of the supervisor being honest and the agent producing a high output are relatively low (cases 1ai and 1aii of the Theorem), that is, when it is likely that corruption occurs but not in the form of abuse of authority, it is optimal to tolerate abuse of authority and deter collusion. The reason why tolerating abuse of authority is optimal is that provided after Proposition 3. As for collusion, the principal is better off deterring it since deterrence is costless in this case (i.e., \( w_\emptyset = 0 \), and hence \( s_L = 0 \)) while, as explained above and shown in the Appendix, tolerance is costly (i.e., \( w_\emptyset = \varepsilon > 0 \)). Clearly, this policy is also optimal when the probability of an honest supervisor is sufficiently high (case 1aiii of the Theorem), and hence it is unlikely that corruption takes place.

Third, when \( k \leq \overline{k} \) and the probability of the supervisor being honest is relatively low while the probability of the agent producing a high output is in an intermediate range (subcase \( \pi \in (\overline{\pi}, \overline{\pi}] \) of case 1b of the Theorem), the principal has the choice between tolerating and deterring both forms of corruption. As explained after Proposition 3, the probability that a high output will be produced, and hence \( w_H \) will be paid to the agent, is then relatively high. It is thus optimal to deter abuse of authority by offering a lower wage \( w_H = \frac{\overline{\gamma}}{p\pi} \) (plus the extra wage cost of collusion deterrence, \( s_L = \frac{k\overline{\gamma}}{p\pi} \)) rather than to tolerate abuse of authority by offering a higher wage \( w_H = \frac{\gamma}{p\pi h} \).

Fourth, when \( k > \overline{k} \) and the probability of the supervisor being honest is relatively low while the probability of the agent producing a high output is in an intermediate range (subcase \( \pi \in (\overline{\pi},\pi] \) of case 1c of the Theorem), the principal has the choice between deterring abuse of authority while tolerating collusion and tolerating abuse of authority while deterring collusion. Again, as explained after Proposition 3, it is then likely that a high output will be produced, and hence \( w_H \) will be paid to the agent. It is therefore optimal to deter abuse of authority by offering a lower wage \( w_H = \frac{\overline{\gamma}}{p\pi} \) rather than to tolerate abuse of authority by offering a higher wage \( w_H = \frac{\gamma}{p\pi h} \). The principal then chooses to deter abuse of authority and tolerate collusion.

Finally, when the probability of the supervisor being honest is relatively low while the probability of the agent producing a high output is relatively high, that is, when it is likely that corruption in the form of abuse of authority occurs (subcases \( \pi > \overline{\pi} \) and \( \pi > \pi \) respectively of cases 1b and 1c of the Theorem), it is optimal to deter this type of corruption. The reason why this policy is then optimal is that provided after Proposition 3. As explained in the previous subsections, unlike tolerating abuse of authority, deterring abuse of authority makes collusion costly to deal with. To decide whether to tolerate or deter collusion, the principal must then compare the additional costs associated with these two options. The extra costs of collusion deterrence and collusion tolerance are respectively \( \frac{k\overline{\gamma}}{p\pi} \) and \( \frac{(1-h)\overline{\gamma}}{p\pi} \). One has \( \frac{k\overline{\gamma}}{p\pi} \leq \frac{(1-h)\overline{\gamma}}{p\pi} \) if \( k \leq \overline{k} \). The optimal policy now depends
on the efficiency of the side transfer technology. Collusion should therefore be deterred when it is difficult, and hence relatively inexpensive to prevent. That is, collusion should be deterred when the side transfer technology is sufficiently inefficient \((k \leq \bar{k})\).

In the extreme case where the supervisor is always dishonest (i.e., case 1b of the Theorem since then \(h = 0\), and thus \(\pi = 0\) and \(\bar{\pi} = 1\)), both forms of corruption are prevented. Indeed, as just explained, in this case abuse of authority is optimally prevented, and the extra costs of collusion deterrence and collusion tolerance are respectively \(\frac{k}{\bar{\pi}^2}\) and \(\frac{\pi}{\bar{\pi}}\). It is then also optimal to prevent collusion.

Combining these cases, one has the results of case 1 of the Theorem.

Concerning the interaction between the two forms of corruption, we therefore have that, except for the special case where \(\pi = 1\), when \(h = 0\) there always exists an interaction. It is then optimal to deter both forms of corruption and the possibility of abuse of authority makes collusion deterrence costly. In the special case just mentioned, abuse of authority is optimally prevented and since \(\pi = 1\), and hence \(s_L\) does not anymore enter the objective function, collusion can be costlessly dealt with. Therefore, when \(h = 0\) and \(\pi = 1\) abuse of authority and collusion do not interact. When \(h \in (0, 1)\) there does not always exist an interaction between the two forms of corruption. Indeed, when it is optimal to tolerate abuse of authority, the deterrence of collusion remains costless, and hence the two forms of corruption do not interact. The two forms of corruption only interact when abuse of authority is optimally prevented. As explained, deterring abuse of authority then makes collusion costly to deal with (to prevent or to tolerate).

As discussed above, when abuse of authority is optimally tolerated only a dishonest supervisor captures an informational rent. It is then straightforward to verify that the efficiency loss sustained by the firm is identical to that sustained in the case where the firm is exposed only to abuse of authority and this form of corruption is tolerated. We have also explained above that when abuse of authority is optimally prevented both the supervisor and the agent capture informational rents. As shown in the Appendix, the efficiency loss sustained by the firm is then higher compared with the case where only abuse of authority is possible. It is straightforward to verify that the supervisor then captures a higher rent when collusion is prevented than when it is tolerated. The analysis has also revealed that the increase in the forms of corruption is advantageous for the supervisor and disadvantageous for the agent. These findings prove that the common belief among economists of organizations that those who control the information inside hierarchies appropriate its rents is only partially true. Indeed, although the supervisor (the one who controls the information and is the instigator of abuse of authority) is the member of the firm who benefits from the proliferation
of corrupt activities, the agent (the potential victim of abuse of authority) also captures a rent.

Our results stress the importance of considering the possibility of multiple forms of corruption in firms. Indeed, the results show how radically different the firm’s policy is when exposed to several forms of corruption rather than to a single one. These results challenge the received theory of corruption in three-level firms. Indeed, as previously noted, a major and central finding of the literature that studies collusion in hierarchical firms in the presence of both honest and dishonest supervisors is that tolerating collusion is optimal whenever the probability of an honest supervisor is high enough.\(^\text{17}\) The intuition for this result is that in the presence of enough honest supervisors in the economy, costly measures to deter collusion are unnecessary, and hence collusion may be optimally allowed in equilibrium.

The above Theorem shows that this is no longer true when the supervisor may also engage in abuse of authority. More importantly, in the light of the just mentioned central result of the literature on collusion, it is tempting to conjecture that deterring corruption is in general optimal when the probability of a dishonest supervisor is sufficiently high. The Theorem proves that this is not the case. Indeed, it is sometimes optimal to tolerate corruption (either collusion or abuse of authority) even if the probability of a dishonest supervisor is relatively high (i.e., \(h \leq \hat{h}\)). These findings show that considering a single form of corruption may be deceptive.

As emphasized in the introduction, while most theoretical models show that corruption should be optimally prevented, empirical studies and news reports reveal that corruption frequently takes place in firms. We have offered a new explanation for this fact based on the proliferation of corrupt activities in firms.

As already noted, the literature on collusion also shows that in many environments collusion is costless to deter. Our investigation reveals that while collusion may be harmless in the absence of abuse of authority, it may become harmful when abuse of authority becomes possible.

As discussed, if the supervisor is always dishonest (i.e., \(h = 0\)), the optimal policy is obviously to deter both forms of corruption (i.e., the relevant case is then case 1b of the Theorem). Therefore, when \(h = 0\), the increase in the forms of corruption inside hierarchical firms does not result in more corruption being tolerated since in this case the firm’s optimal policy is to deter corruption whether exposed to one or to two forms of corruption. As explained earlier, this result does not hold when \(h \in (0,1)\). The principal tolerates more often abuse of authority when collusion is possible than when it is not. Similarly, while it is optimal to deter collusion when collusion is the only feasible form of corruption, it sometimes becomes optimal to tolerate it when abuse of authority is also

\(^{17}\) That is, tolerating collusion is optimal whenever \(h\) is above a certain threshold, and deterring collusion is optimal whenever \(h\) is below this threshold.
feasible.

These findings and those explained in our discussion are summarized in the following corollary.

COROLLARY. The proliferation of corrupt activities in firms:

1. Makes otherwise costless collusion costly to deal with.

2. May result in the breakdown of the collusion-proofness principle.

3. Results in more corruption being tolerated.

4. Makes sometimes optimal the (a) deterrence of collusion even when it is likely that the supervisor is honest; (b) tolerance of corruption even when it is likely that the supervisor is dishonest.

5. Does not systematically reduce efficiency.

6. Is advantageous for the supervisor and disadvantageous for the agent.

7. Implies that those who control the information are not the only ones who appropriate its rents.

6 Conclusion

Although much has been learned on multi-level firms employing a dishonest supervisor and exposed to a single form of corrupt activity, such an environment is not very realistic in view of empirical evidence. This paper has extended the analysis of multi-level firms by accounting for morals considerations and by considering more than a single form of corruption. We have notably shown that, in this more realistic environment, many results of previous models do not longer hold.
Appendix

PROOF OF PROPOSITION 1

Before turning to the derivation of the optimal incentive contracts in the different scenarios, it is easy to verify that, in each of these scenarios, the principal sets $s_\emptyset$ as low as allowed by the limited liability constraints, that is, $s_\emptyset = 0$. This is because an uninformative report is undesirable from the principal’s point of view.

Since the expected cost of production and supervision is increasing in wages paid and reducing wages does not make constraints more severe, the principal sets the agent’s and the supervisor’s wages as low as allowed by the constraints. When corruption is not possible, the principal thus sets $w_L, w_\emptyset, s_L, s_H$ as low as allowed by the limited liability constraints, that is, $w_L = w_\emptyset = s_L = s_H = 0$. Similarly, it sets $w_H$ as low as allowed by the agent’s incentive compatibility constraint, that is, $w_H = \frac{\gamma}{p\pi}$ (since optimally $w_L = 0$).

PROOF OF PROPOSITION 3

Given that the objective function of program $[P^A]$ is increasing in $w_L, s_L, s_H$, and reducing these wages does not make constraints more severe, the principal sets these wages as low as allowed by the limited liability constraints, that is, $w_L = s_L = s_H = 0$. Rewriting the agent’s incentive compatibility constraint in program $[P^A]$ as $w_H \geq \frac{\gamma - p\pi(1-h)w_\emptyset}{p\pi h}$, one has two constraints on $w_H$ (plus the limited liability constraints). Note that since $w_H \geq w_\emptyset$, the limited liability constraint $w_H \geq 0$ is redundant. To find which of the agent’s incentive compatibility constraint and constraint $w_H \geq w_\emptyset$ is more restrictive, one must compare $\frac{\gamma - p\pi(1-h)w_\emptyset}{p\pi h}$ with $w_\emptyset$. One has that the agent’s incentive compatibility constraint is more restrictive if $\frac{\gamma - p\pi(1-h)w_\emptyset}{p\pi h} \geq w_\emptyset$, that is, if $w_\emptyset \leq \frac{\gamma}{p\pi}$. The converse is true if $w_\emptyset \geq \frac{\gamma}{p\pi}$. Two cases must thus be distinguished.

(1) $w_\emptyset \in \left[0, \frac{\gamma}{p\pi}\right]

In this case, the relevant constraint on $w_H$ is the agent’s incentive compatibility constraint. Since the objective function is increasing in $w_H$, and reducing this wage does not make constraints more severe, one then has $w_H = \frac{\gamma - p\pi(1-h)w_\emptyset}{p\pi h}$. To obtain the optimal wage $w_\emptyset$, one must proceed in the following way. One must substitute $w_H = \frac{\gamma - p\pi(1-h)w_\emptyset}{p\pi h}$ into the principal’s objective function and express this function with respect to $w_\emptyset$. The optimal wage $w_\emptyset$ therefore solves

$$
\min_{w_\emptyset} \frac{\gamma}{h} + \frac{h(1-p)-(1-h)p\pi}{h}w_\emptyset
$$

s.t. $w_\emptyset \in \left[0, \frac{\gamma}{p\pi}\right]$. 

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Again, two cases must be considered. Let \( \Delta \equiv h(1 - p) - (1 - h)p\pi \). Then if \( \Delta \geq 0 \), that is, if \( \pi \leq \hat{\pi} \equiv \frac{h(1 - p)}{p(1 - h)} \), the objective function is increasing in \( w_\emptyset \), and it is thus optimal to set \( w_\emptyset = 0 \) and tolerate abuse of authority. This implies that \( w_H = \frac{\gamma}{p\pi} \). The expected cost of production and supervision is then \( C_1^A = \frac{\gamma}{\pi} \). If instead \( \Delta < 0 \), that is, if \( \pi > \hat{\pi} \), the objective function is decreasing with \( w_\emptyset \) and it is hence optimal to set \( w_\emptyset \) as high as possible. The principal then sets \( w_\emptyset = \frac{\gamma}{p\pi} \), and hence prevents abuse of authority. This implies that \( w_H = \frac{\gamma}{p\pi} \). The expected cost of production and supervision is then \( C_2^A = \frac{1 - p(1 - \pi)}{p\pi} \).

(2) \( w_\emptyset \geq \frac{\gamma}{p\pi} \)

In this case, the relevant constraint on \( w_H \) is \( w_H \geq w_\emptyset \). Given that reducing \( w_H \) lowers the expected cost of production and supervision without making constraints more severe, one has \( w_H = w_\emptyset \). Substituting this equation into the principal’s objective function and expressing this function with respect to \( w_\emptyset \), one has that the optimal wage \( w_\emptyset \) solves

\[
\min w_\emptyset \quad \left[ 1 - p(1 - \pi) \right] w_\emptyset
\]

s.t. \( w_\emptyset \geq \frac{\gamma}{p\pi} \).

The objective function of this program is increasing in \( w_\emptyset \). It is then optimal to set \( w_\emptyset = \frac{\gamma}{p\pi} \), and thus the expected cost of the firm is \( C_2^A \). The difference between cases (1) and (2) is that when \( \pi \leq \hat{\pi} \) the principal sets \( w_\emptyset = 0 \) in case (1) and \( w_\emptyset = \frac{\gamma}{p\pi} \) in case (2). Since one has \( C_1^A \leq C_2^A \) when \( \pi \leq \hat{\pi} \), the optimal policy is to set \( w_\emptyset = 0 \).

Finally, given that \( \hat{\pi} > 1 \) if \( h > \hat{h} \equiv p \), one obtains the different cases of Proposition 3.

PROOF OF PROPOSITION 4

To relax the no-collusion constraint \( s_L \geq k(w_\emptyset - w_L) \) (recall that \( s_0 = 0 \)), the principal may increase \( w_L \). However, given that setting \( w_L > w_\emptyset \) instead of \( w_L \in [0, w_\emptyset] \) both increases the expected cost of the firm (because this cost is increasing in \( w_L \)) and makes the agent’s incentive compatibility constraint more severe without allowing to reduce \( s_L \) below 0 (because of the limited liability constraint \( s_L \geq 0 \)), one has \( w_L \in [0, w_\emptyset] \). The relevant constraint on \( s_L \) is then \( s_L \geq k(w_\emptyset - w_L) \), that is, the limited liability constraint \( s_L \geq 0 \) is redundant.

Since the objective function of program \( [P_1^{CA}] \) is increasing in \( s_L, s_H \), and reducing these wages does not make constraints more severe, the principal sets these wages respectively as low as allowed by the no-collusion and limited liability constraints, that is, \( s_L = k(w_\emptyset - w_L) \) and \( s_H = 0 \).
Substituting $s_L = k(w_0 - w_L)$ into the objective function, one has that this function is increasing in $w_L$. Given that reducing $w_L$ does not make constraints more severe, $w_L = 0$.

Following the lines of the proof of Proposition 3 and, again, observing that since one has $w_H \geq w_0$ the limited liability constraint $w_H \geq 0$ is redundant, two cases must be considered.

(1) $w_0 \in \left[0, \frac{\gamma}{p\pi}\right]$ 

The relevant constraint on $w_H$ is the agent’s incentive compatibility constraint. Recalling that the equation $s_L = k(w_0 - w_L)$ has been substituted into the objective function and $w_L = 0$, to obtain the optimal wage $w_0$ one must then also substitute $w_H = \frac{\gamma - p\pi(1-h)w_0}{p\pi h}$ into the objective function and express this function with respect to $w_0$. The optimal wage $w_0$ therefore solves

$$\min_{w_0} \frac{\gamma}{h} + \frac{h(1-p)(1-(1-k)\pi) - (1-h)p\pi}{p(1-h(1-k))} w_0$$

s.t. $w_0 \in \left[0, \frac{\gamma}{p\pi}\right]$.

Two cases have then to be distinguished. Let $\Xi \equiv h[1 - p(1 - (1 - \pi)k)] - (1-h)p\pi$. Then if $\Xi \geq 0$, that is, if $\pi \leq \overline{\pi} \equiv \frac{h(1-p)(1-k)}{p[1-h(1-k)]}$, the objective function is increasing in $w_0$, and it is thus optimal to set $w_0 = 0$ and tolerate abuse of authority. This implies that $w_H = \frac{\gamma}{p\pi}$ and $s_L = 0$. The expected cost of production and supervision is then $C_1^A$. If instead $\Xi < 0$, that is, if $\pi > \overline{\pi}$, the objective function is decreasing with $w_0$ and it is hence optimal to set $w_0 = \frac{\gamma}{p\pi}$ as high as possible. The principal then sets $w_0 = \frac{\gamma}{p\pi}$, and thus prevents abuse of authority. This implies that $w_H = \frac{\gamma}{p\pi}$ and $s_L = \frac{h\gamma}{p\pi}$. In this case, one has $C_1^{CA} = \frac{(1-p(1-\pi)(1-k))\gamma}{p\pi}$.

(2) $w_0 \geq \frac{\gamma}{p\pi}$

In this case, the relevant constraint on $w_H$ is $w_H \geq w_0$ and, as in the previous proof, $w_H = w_0$. Substituting this equation into the principal’s objective function and expressing this function with respect to $w_0$, one has that the optimal wage $w_0$ solves

$$\min_{w_0} \left[1 - p(1 - \pi)(1 - k)\right] w_0$$

s.t. $w_0 \geq \frac{\gamma}{p\pi}$.

The objective function of this program is increasing in $w_0$. The principal then sets $w_0 = \frac{\gamma}{p\pi}$, and hence the expected cost of the firm is $C_1^{CA}$.

The difference between cases (1) and (2) is that when $\pi \leq \overline{\pi}$ the principal sets $w_0 = 0$ in case (1) and $w_0 = \frac{\gamma}{p\pi}$ in case (2). Since $C_1^A \leq C_1^{CA}$ when $\pi \leq \overline{\pi}$, the optimal policy is to set $w_0 = 0$.

Finally, since $\overline{\pi} > 1$ if $h > \hat{h}$, one has the different cases of Proposition 4.
PROOF OF PROPOSITION 5

As in the proof of Proposition 3, one has \( w_L = s_L = s_H = 0 \) and two cases must be distinguished.

(1) \( w_\emptyset \in \left[ 0, \frac{\gamma}{p\pi} \right] \)

To obtain the optimal wage \( w_\emptyset \), one must then follow the lines of the previous proofs. That is, one must substitute \( w_H = \frac{\gamma - p\pi(1-h)w_\emptyset}{p\pi h} \) into the objective function and express this function with respect to \( w_\emptyset \). The optimal wage \( w_\emptyset \) therefore solves

\[
\min_{w_\emptyset} \left[ \frac{\gamma}{p\pi} + \frac{h[1-p(1-\pi)h] - (1-h)p\pi}{h} w_\emptyset \right]
\]

s.t. \( w_\emptyset \in \left[ 0, \frac{\gamma}{p\pi} \right] \).

Again, two cases must be considered. Let \( \Phi \equiv h[1-p(1-\pi)h] - (1-h)p\pi \). Then if \( \Phi \geq 0 \), that is, if \( \pi \leq \pi - \tilde{\pi} = \frac{h(1-p\pi)}{p(1-h2)} \), the objective function is increasing in \( w_\emptyset \), and it is thus optimal to set \( w_\emptyset = 0 \) and tolerate abuse of authority. As above, this implies that \( w_H = \frac{\gamma}{p\pi} \). The expected cost of production and supervision is then \( C_1^A \). If instead \( \Phi < 0 \), that is, if \( \pi > \tilde{\pi} \), the objective function is decreasing with \( w_\emptyset \) and it is hence optimal to set \( w_\emptyset = \frac{\gamma}{p\pi} \), and therefore prevent abuse of authority. This implies that \( w_H = \frac{\gamma}{p\pi} \). On then has \( C_2^C.A = \frac{1-p(1-\pi)h\gamma}{p\pi} \).

(2) \( w_\emptyset \geq \frac{\gamma}{p\pi} \)

The relevant constraint on \( w_H \) is now \( w_H \geq w_\emptyset \). As in the previous proofs, one clearly has \( w_H = w_\emptyset \). Substituting this equation into the expected cost of production and supervision and expressing this cost with respect to \( w_\emptyset \), one has that the optimal wage \( w_\emptyset \) solves

\[
\min_{w_\emptyset} \left[ 1-p(1-\pi)h \right] w_\emptyset
\]

s.t. \( w_\emptyset \geq \frac{\gamma}{p\pi} \).

As in the preceding proofs, one has \( w_\emptyset = \frac{\gamma}{p\pi} \) in this case, and hence the expected cost of the firm is \( C_2^C.A \).

The difference between cases (1) and (2) is that when \( \pi \leq \tilde{\pi} \) the principal sets \( w_\emptyset = 0 \) in case (1) and \( w_\emptyset = \frac{\gamma}{p\pi} \) in case (2). To find the optimal policy one must then compare \( C_1^A \) with \( C_2^C.A \). Since one has \( C_1^A \leq C_2^C.A \) when \( \pi \leq \tilde{\pi} \), the optimal policy is to set \( w_\emptyset = 0 \).

Finally, given that \( \pi > 1 \) if \( h > \hat{h} \), one has the different cases of Proposition 5.

We have made the standard assumption that the supervisor does not engage in corruption, and hence collusion, when indifferent. Therefore, if the principal chooses to tolerate collusion, it must
set \( b^{M} = w_{0} - w_{L} \) such that the supervisor receives a strictly positive - and, clearly, as small as possible - bribe. That is, \( w_{0} - w_{L} \geq \varepsilon \), where \( \varepsilon > 0 \) and \( \varepsilon \to 0 \). The optimal contracts must also satisfy \( s_{L} < s_{0} + k(w_{0} - w_{L}) \) or \( s_{L} \leq s_{0} + k(w_{0} - w_{L} - \varepsilon) \). Since optimally \( w_{L} = s_{L} = s_{0} = 0 \), in case 1 of Proposition 5 the principal has to pay \( w_{0} = \varepsilon > 0 \) (with \( \varepsilon \to 0 \)) to the agent. As explained in the main text, we have simplified the analysis by setting \( w_{0} = 0 \) instead of \( w_{0} = \varepsilon \).

This simplification is clearly innocuous. Indeed, if one sets \( w_{0} = \varepsilon \) the expected cost of production and supervision is \( C^{CA}(\varepsilon) = C_{1}^{A} + \left[ \frac{h}{p} \left[ \pi + (1 - \pi) \varepsilon \right] \right] \varepsilon \). For \( \pi \leq \bar{\pi} \), one must then compare \( C^{CA}(\varepsilon) \) with \( C_{2}^{CA} \) instead of \( C_{1}^{A} \) with \( C_{2}^{CA} \) as is the case when \( w_{0} = 0 \). Although \( C^{CA}(\varepsilon) \geq C_{1}^{A} \) when \( \pi \leq \bar{\pi} \), for \( \varepsilon \) sufficiently small one has \( C^{CA}(\varepsilon) \leq C_{2}^{CA} \) when \( \pi \leq \bar{\pi} \). In other words, as for \( w_{0} = 0 \), for \( w_{0} = \varepsilon \) sufficiently small the optimal policy when \( h \leq \hat{h} \) and \( \pi \leq \bar{\pi} \) or \( h > \hat{h} \) is to tolerate abuse of authority.

**PROOF OF THE THEOREM**

Before turning to the determination of the firm’s optimal policy concerning collusion (and hence corruption), again observe that \( \bar{\pi} \geq \pi \) if \( h \leq \hat{h} \) and \( k \leq \bar{k} \equiv 1 - h \) while \( \pi \leq \bar{\pi} \) if \( h \leq \hat{h} \) and \( k > \bar{k} \).

To determine the optimal policy regarding collusion, one has to compare the firm’s costs in Propositions 4 and 5, that is: A. For \( k \leq \bar{k} \), 1. \( h \leq \hat{h} \), and a. \( \pi \leq \bar{\pi} \), \( C_{1}^{A} \) with \( C_{1}^{A} \); b. \( \pi \in (\bar{\pi}, \bar{\pi}] \), \( C_{1}^{CA} \) with \( C_{1}^{A} \); c. \( \pi > \bar{\pi} \), \( C_{1}^{A} \) with \( C_{2}^{CA} \); 2. \( h > \hat{h} \), \( C_{1}^{A} \) with \( C_{1}^{A} \). B. For \( k > \bar{k} \), 1. \( h \leq \hat{h} \), and a. \( \pi \leq \bar{\pi} \), \( C_{1}^{A} \) with \( C_{1}^{A} \); b. \( \pi \in (\bar{\pi}, \bar{\pi}] \), \( C_{1}^{A} \) with \( C_{2}^{CA} \); c. \( \pi > \bar{\pi} \), \( C_{1}^{CA} \) with \( C_{2}^{CA} \); 2. \( h > \hat{h} \), \( C_{1}^{A} \) with \( C_{1}^{A} \).

As noted both in the main text and above, we have simplified the analysis by setting \( w_{0} = 0 \) (and hence \( C(w, s) = C_{1}^{A} \)) instead of \( w_{0} = \varepsilon > 0 \) in case 1 of Proposition 5. This is why in the above cases A1a, A2, B1a, and B2, the comparisons are straightforward since in these cases one has the same expected cost of the firm in Propositions 4 and 5. The optimal policy is then to prevent collusion and one has \( C(w, s) = C_{1}^{A} \). As stressed in the text and above, setting \( w_{0} = 0 \) instead of \( w_{0} = \varepsilon \) is inconsequential. Indeed, as explained earlier, if one sets \( w_{0} = \varepsilon \) in case 1 of Proposition 5, the expected cost of the firm is \( C^{CA}(\varepsilon) \) instead of \( C_{1}^{A} \). One must then compare \( C_{1}^{A} \) with \( C^{CA}(\varepsilon) \) in the above cases A1a, A2, B1a, and B2. Given that \( C_{1}^{A} \leq C^{CA}(\varepsilon) \) if \( \pi \leq \bar{\pi} \) and that one has \( \bar{\pi} > 1 \) if \( h > \hat{h} \), as above, the optimal policy is to prevent collusion, and thus \( C(w, s) = C_{1}^{A} \).

The principal optimally deters collusion in the above case A1c and tolerates collusion in case B1c. This is because \( C_{2}^{CA} \leq C_{2}^{CA} \) if \( k \leq \bar{k} \).

Given that \( C_{2}^{CA} < C_{1}^{A} \) when \( \pi > \bar{\pi} \), tolerating collusion is optimal in the above case B1b.

Finally, one has \( C_{1}^{CA} < C_{1}^{A} \) if \( \pi > \bar{\pi} \). Therefore, preventing collusion is optimal in case A1b,
and one has \( C(w, s) = C_1^{CA} \). It is easy to see that, in this case, simplifying the analysis by setting \( w_0 = 0 \) instead of \( w_0 = \varepsilon \) is again innocuous. Indeed, if one sets \( w_0 = \varepsilon \) in case 1 of Proposition 5, one must compare \( C_1^{CA} \) with \( C^{CA}(\varepsilon) \) instead of \( C_1^{CA} \) with \( C_1^A \) in the above case A1b. Since \( C_1^A \leq C^{CA}(\varepsilon) \) if \( \pi \leq \tilde{\pi} \), one has \( C_1^{CA} \leq C^{CA}(\varepsilon) \) in case A1b. The optimal policy is thus to prevent collusion, and one has \( C(w, s) = C_1^{CA} \).

Combining these cases, one has the results of the first point of the Theorem.

To prove claim 2d of the Theorem, we must proceed to the following comparisons between the expected costs of Propositions 3 and 4 and those of Propositions 3 and 5. Since \( \bar{\pi} \geq \hat{\pi} \) (resp. \( \tilde{\pi} \geq \hat{\pi} \)) when \( h \leq \hat{h} \), comparing the expected costs of Propositions 3 and 4 (resp. Propositions 3 and 5) boils down to \( C_2^A \) vs \( C_1^A \) for \( h \leq \hat{h} \) and \( \pi \in (\hat{\pi}, \bar{\pi}] \), and to \( C_2^A \) vs \( C_1^{CA} \) for \( h \leq \hat{h} \) and \( \pi > \bar{\pi} \) (resp. \( C_2^A \) vs \( C_1^A \) for \( h \leq \hat{h} \) and \( \pi \in (\hat{\pi}, \tilde{\pi}] \), and to \( C_2^A \) vs \( C_2^{CA} \) for \( h \leq \hat{h} \) and \( \pi > \tilde{\pi} \)). We have \( C_2^A < C_1^A \iff \pi > \hat{\pi} \) and \( C_2^A < C_1^{CA} \iff k > 0 \) (resp. \( C_2^A \leq C_2^{CA} \iff h \leq 1 \)). We thus have that when the firm is exposed to both collusion and abuse of authority and collusion is deterred (resp. tolerated), the efficiency loss sustained is higher compared with the case where the firm is exposed only to abuse of authority.
References


