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The Threat of Corruption and the Optimal Supervisory Task☆

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Abstract

In this paper we investigate the task the supervisor should be optimally charged with in an agency model in which the principal faces corruption concerns. We highlight a fundamental tradeoff between monitoring the agent's effort choice and auditing it ex-post. Monitoring proves more effective in tackling corruption since the supervisor sends the report before the profit realization. By taking advantage of the supervisor's uncertainty about the state of nature, the principal can design a compensation scheme which prevents all forms of corruption at a lower cost. Conversely auditing reduces the cost of supervision as the principal hires the supervisor only if the profit does not convey enough information about the compensation due to the agent. We show that the ultimate choice between monitoring and auditing depends on the supervisor's ability to falsify information and the cost of performing an inspection.

Keywords: Auditing, Collusion, Corruption, Extortion, Monitoring, Supervision.
JEL: D82, D86, L22

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1. Introduction

Modern organizations have boosted their productivity by extensively relying on information and communications technologies (ICT). However, employers are increasingly concerned about the potential misuse of ICT that employees may undertake for personal reasons: Surfing the internet, checking social media or personal e-mails, and shopping online are among the main non-work related activities pursued by employees in the office which reduce on-the-job focus.[1] Furthermore, employees' internet use for personal reasons can cause bandwidth and storage shortages, especially because of file sharing and audio/video streaming.[2] In some instances, it can even expose the organization to potential lawsuits.[3] Finally, employees can readily divulge confidential information causing the loss of the firm's competitive edge over its competitors.[4]

Hiring a supervisor to inspect and report on the employees' behavior has the apparent benefits of preventing wrongdoing and decreasing the cost of incentives. An employee may refrain from both improperly using the resources of the firm and shirking, fearing that a supervisor may catch him red-handed. In modern firms, however, these benefits may be dampened by the cost of performing an inspection and the inefficiencies stemming from internal corruption. Even though new technologies allow to record and store evidence on the employees' behaviors in a number of relatively inexpensive ways (e.g. video surveillance, software which allows to track activities occurring on an employee's computer, such as usage of applications and e-mail content), the inspection itself may be very costly and time-consuming (e.g. engaging a supervisor to watch the video or to check the e-mails and the on-line activities that the employees have undertaken).[5] The problem of internal corruption arises when the evidence on an agent's behavior can be manipulated and the agent is either fined or rewarded on the basis of the supervisor's report.

In this paper we show that the relative relevance of these two concerns affects a crucial internal decision that organizations must take, namely the timing at which an inspection should occur. In general, an inspection of the recorded evidence can take place before or after the outcome of the organization is observed and we say that the supervisor is assigned a monitoring task in the former case and an auditing task in the latter case. We find that monitoring is more effective than auditing in tackling corruption as the principal can request the supervisor's report before the outcome realization. This allows the principal to design a compensation scheme which prevents corruption at a lower cost by taking advantage of the supervisor's uncertainty about the state of nature. In contrast, auditing reduces the cost of supervision as it allows the principal to defer the choice of inspecting the agent's performance until after the outcome of the organization is observed. Whenever the outcome realization suffices to determine the agent's compensation, the principal will decide not to hire the supervisor thereby saving her salary. Thus the benefits of auditing stem from its being ex-ante random.

[1]See *How do you waste time at work?*, The Telegraph on October 17, 2014.

[2]See *The New Workplace Rules: No Video-Watching*, The Wall Street Journal on March 4, 2008.

[3]For instance, surfing sexual or pornographic web pages or sending e-mails containing sexually explicit language can lead to harassment lawsuits. For instance, consider *Blakey v. Cont'l Airlines, Inc., 164 N.J. 38, 751 A.2d 538 (2000)*, a sexual harassment case filled by Blakey, a female pilot for Continental, who contended that a number of his male colleagues posted insulting remarks about her on the pilots' on-line computer bulletin board called The Crew Members Forum.

[4]For example, numerous emails were exchanged between some DuPont employees and Kolon Industries Inc. personnel to steal trade secrets involving Kevlar technology. See *Kolon Industries Inc. Pleads Guilty for Conspiring to Steal DuPont Trade Secrets Involving Kevlar Technology*, United States Department of Justice webpage on April 30, 2015.

[5]A recent discussion of employees' misbehavior and monitoring practices in present-day workplaces can be found in Ciocchetti (2011).

We develop a model in which an agent privately chooses an effort level that stochastically impacts on the gross profit of the firm. The principal must decide whether to hire a supervisor to monitor the agent's effort or postpone the inspection choice until after the profit is realized. We refer to this problem as the choice of the *optimal supervisory task*. Under both monitoring and auditing, the agent and the supervisor privately observe a signal correlated with the agent's effort. Consistently with the idea that evidence can be stored, we assume that the signal is the same irrespective of the supervisory task.[6] The profitability of the alternative supervisory tasks critically depends on the supervisor's ability to falsify evidence. We characterize the optimal contract under the assumption that the principal always wants to prevent corruption.

As long as the supervisor needs the agent's cooperation to falsify evidence, the principal cannot be worse off under auditing. In this case, the only corruption concern is collusion (or group opportunism), namely the possibility that the employees can strike an agreement to jointly falsify evidence. Under both supervisory options, the agent can be provided with the second-best incentives to exert effort and collusive agreements are prevented by rewarding the supervisor when she reports evidence which is unfavorable to the agent. Unlike monitoring, auditing enables the principal to limit the recourse to supervision only in those instances in which the profit does not suffice to set the agent's compensation. This advantage of auditing is especially relevant when the supervisor must be guaranteed a substantial reservation wage.

On the contrary, when the supervisor can falsify evidence on her own bearing a non-negative cost, monitoring can outperform auditing. When this falsification cost is small, the problem of extortion (or individual opportunism) may arise, since the supervisor can credibly threaten the agent to fabricate unfavorable evidence to collect the reward paid by the principal to discourage group opportunism. Collusion and extortion can only be prevented by deemphasizing the role of the supervisor's report in setting the agent's compensation thereby weakening the latter's incentives. The threat of extortion represents a less severe concern under monitoring since the supervisor's expected gains from pursuing individual opportunism are lower relative to auditing. Under monitoring, if the supervisor decides to falsify evidence and bear the falsification cost she will collect a reward from the principal only in some states of nature, while under auditing she receives the principal's reward with probability one. Therefore, relative to auditing, monitoring entails a lower distortion of the agent's incentives.

As a result, a trade-off between the two supervisory tasks arises when the two faces of corruption, collusion and extortion, are present. On the one hand, the principal is more likely to choose monitoring the lower the falsification cost. On the other hand, the principal is more likely to choose auditing the higher the supervisor's reservation wage.

The paper thus offers a clear prescription of how inspection activities should be optimally organized. When supervision is very costly and time-consuming and the concern that the supervisor may engage in some form of opportunistic behavior is not paramount, auditing should be preferred. Namely, an inspection of the employee's behavior (for instance, internet accesses or e-mails) should be carried out only if the performance of the firm turns out to be poor or some leak of confidential information allegedly occurs. Conversely, if evidence can be easily manipulated and performing an inspection is not overly costly,

[6] In some instances, it is reasonable to assume that the signal collected under monitoring (auditing) is a sufficient statistic for that collected under auditing (monitoring). This is because only a fraction of the evidence may be available at a given moment in time. When this is the case, the principal's choice of the organizational structure will also take into account the relative efficiency of the alternative supervisory tasks. The principal faces a different problem when monitoring and auditing generate different signals about the agent's behavior. If so, the principal may find it worthwhile to run an inspection both before and after the observation of the outcome.

monitoring should be preferred.

While we mostly focus on the design of supervisory tasks within a for-profit firm, our prescriptions are more general. In particular they can be applied to the inspection of employees' behavior within public organizations and the supervision of regulated firms to ensure that they pursue the desired behavior (e.g. take some precautions to minimize the probability of accidents, reduce the amount of waste they produce).

The bulk of our analysis is carried out under the assumption that the principal wants to prevent the employees from engaging in any corruption activity. Aware of its devastating long-run consequences, firms usually attach a high value to deter internal corruption, as highlighted by the management literature (see for instance Ashforth and Anand, 2003). Tolerating, let alone promoting, opportunistic behaviors may shape an organization's culture and facilitate future wrongdoing. If internal corruption becomes embedded in a firm's structures and processes, other unethical actions which are more difficult to monitor, like tax or financial fraud and manipulation of accountancy rules, may not be perceived as such by its employees, who may then pursue some of these illegal activities. Authorizing corruption may thus dramatically shape the firm's culture and identity, with negative repercussions for the firm's reputation: Business partners and stakeholders may grow suspicious of a firm which is known to tolerate shady practices.[7] This will be especially the case in those countries in which a disputable conduct is more severely stigmatized. To signal their commitment to fight corruption firms adopt codes of corporate conduct, as discussed by Gordon and Miyake (2001), and make ample use of organizational controls, as argued by Lange (2008).

However, the assumption that the principal always wants to prevent corruption is not critical for our results. In an extension we assume that the externalities brought about by tolerating opportunistic behaviors are not significant and we find that the trade-off between the two supervisory tasks continues to arise. Moreover, we also show that in this different setting the principal prefers to tolerate a collusive agreement when the falsification cost is low enough and the supervisor has some bargaining power at the side-contracting stage. In contrast, individual opportunism is always optimally prevented. Allowing collusion has a positive effect on the agent's incentives since the agent prefers to work hard rather than shirk and share the gains from the collusive agreement with the supervisor. For this reason the positive impact of collusion on the agent's incentives decreases in the agent's bargaining power and appears only when he is not able to reap all the gains from collusion.

1.1. Related Literature

This paper contributes to the literature on the optimal design of an organization by studying the optimal allocation of the supervisory task to a third party in presence of both sides of corruption. Other authors have investigated how corruption concerns can affect the organization of a firm.[8] In particular, Strausz (1997) studies whether the principal should retain a costly monitoring task or delegate it to an independent supervisor. Although collusion may arise, delegation is more efficient as the agent's compensation can be

[7]For instance, Herbig et al. (1994) argue that how the firm is generally seen by its stakeholders has a greater impact on the firm's reputation than the quality of the services it provides. On the lingering effects of corruption on firms' reputation see also Tirole (1996).

[8]Beyond the contributions discussed in the text, additional recent papers which address related questions are Burlando and Motta (2014) on how presenting the agent with a menu of organizational structures can eliminate the inefficiencies brought about by collusion concerns; Khalil et al. (2012) who show that the principal may dispense with supervision if he can use his private information to adjust the scale of the project before the agent exerts effort; Samuel (2009) who shows that rewarding the supervisor for providing evidence unfavorable to the agent may encourage preemptive corruption, namely a collusive agreement between the supervisor and the agent before conclusive evidence about the latter's behavior is found.

tied to the supervisor's report, while the principal would always be tempted to conceal favorable evidence. Our focus is similar to Strausz (2006), who examines the optimal timing of information acquisition when the principal directly performs the supervisory activity. He shows that monitoring can be preferred to auditing if the principal cannot commit to verify the agent's effort, which creates a double moral-hazard problem. In contrast, we assume that the principal delegates the supervisory task to a third party, which may give rise to corruption concerns, and we show that monitoring can outperform auditing when both collusion and extortion are present. Hiriart et al. (2010) consider a regulatory model in which a firm should make some costly investment to prevent a stochastic accident. Different signals about the firm's investment choice are available before and after the accident realization. They investigate the efficiency of assigning the monitoring and the auditing tasks to different supervisors.[9] Our research question is different in that we investigate the choice of sending the supervisor to collect the *same* signal either before or after the outcome is realized.

Our paper is also linked to the literature on corruption in organizations, which was pioneered by the seminal contribution of Tirole (1986). Tirole highlighted the efficiency losses that can result from collusive agreements between the supervisor and the productive agent. Following Tirole, the literature initially focused on the cooperative side of corruption, without considering extortion.[10] In our paper we follow several recent works which have put extortion at the center of the analysis. For instance, Mishra and Mookherjee (2012) study the problems of collusion and extortion in law-enforcement when information is soft for the inspector. Extortion is limited by the possibility of the firm to appeal to a court if it regards the report as excessive. Rather than working out the optimal anti-corruption policy, they seek to implement the second-best compliance levels by an appropriate design of the fines and the inspector's incentives.[11] Our model is most closely related to Khalil et al. (2010). In a three-tier hierarchy with moral-hazard concerns, the authors highlight how extortion emerges as the drawback of preventing collusion. They also find that the principal is better off tolerating collusion when the agent does not have all the bargaining power. In their model they assume that the supervisor cannot forge evidence on her own and acts as an auditor sending the report after the profit is realized.[12] In our paper we broaden the corruption possibilities by assuming that the supervisor can also forge evidence by herself and we shed light on the trade-off between monitoring and auditing.

2. The Model

2.1. Players

Consider a risk-neutral principal (it) who hires an agent (he) to carry out a productive task. The agent chooses between two effort levels, $e \in \{0, 1\}$, which are unobservable to the principal, at a cost ge, with

[9] Laffont and Martimort (1999) investigate a similar issue when the signals concern different features of the firm.

[10] Hölmstrom and Milgrom (1990) and Itoh (1993) study models of collusion in presence of a risk-averse agent in pure moral hazard contexts. Conversely, Kofman and Lawarrée (1993, 1996), Baliga (1999) and Faure-Grimaud et al. (2003a) extend the hidden-type setting explored by Tirole in a soft-information framework.

[11] There are also other contributions, such as those of Hindriks et al. (1999) and Acemoglu and Verdier (2000), which have analyzed the problem of extortion in regulation and law enforcement contexts.

[12] In particular, the authors assume that the information is soft for the agent-supervisor coalition, whilst it is hard for the supervisor alone, who bears an infinite cost to falsify evidence on her own. The authors argue that it would be otherwise impossible for the principal to achieve any benefit from supervision.

$g > 0$.[13] Effort crucially affects the verifiable (gross) profit, π, which can be either high or low, that is, $\pi \in \{l, h\}$, with $h > l$. The production technology is such that if the agent works (i.e., $e = 1$) the profit is high with probability $\gamma > 1/2$. Conversely, if the agent shirks ($e = 0$) the profit is high with probability $(1 - \gamma)$. We assume that the difference between h and l is so large that the principal always wants the agent to exert high effort in equilibrium. The agent is risk-neutral, wealth-constrained and has a reservation wage equal to zero.

The principal can hire a supervisor (she) to check the agent's effort and send a verifiable report $r \in \{0, 1\}$. The supervisor is risk-neutral, wealth-constrained and must be guaranteed a reservation wage of $\bar{t} \geq 0$.[14] She can be charged with either a monitoring or an auditing task. In both cases, the supervisor collects the same signal $s \in \{0, 1\}$ about the agent's effort, consistently with the idea that evidence can be stored and checked at any time. The signal reveals the true effort exerted by the agent, $s = e$, with probability $p \geq \gamma$ and is incorrect, $s \neq e$, with probability $(1 - p)$.[15] The crucial difference between the two supervisory tasks is that the supervisor collects the signal *before* the profit realizes under monitoring and *after* the profit realization under auditing.[16]

In the presence of supervision, the principal offers a salary to the agent, w, which is contingent on the profit π and potentially on the report r. If hired, the supervisor receives a salary t which is conditional on both π and r.

The principal is risk-neutral and is the residual claimant of the firm's profits, that is, it receives $\pi - w - t$.

2.2. *Information and Opportunistic Behaviors*

Information is nested along the hierarchy. The agent has the finest information structure: he privately knows his effort decision and observes the signal s. The supervisor only observes s, while the principal observes neither the effort nor the signal.

After the signal observation the agent can make a take-it-or-leave-it offer to the supervisor, that she can either accept or reject.[17] The offer is a pair consisting of a recommended report, $\hat{r}$, and a bribe, b. Notice that, while under auditing b is contingent on $\hat{r}$, under monitoring b can be made contingent on both $\hat{r}$ and π. If the supervisor accepts the offer, the parties sign an enforceable side contract and cooperate to falsify evidence. In this case we say that the agent and the supervisor **collude** or engage in **group opportunism**.

If the supervisor rejects the offer, she independently decides which report to send. We say that the problem of **extortion** or **individual opportunism** arises if the supervisor can credibly threaten the agent to falsify evidence on her own. We require that the report choice be sequentially rational. It follows that when deciding whether or not to offer a side contract, the agent anticipates that the supervisor will pursue individual opportunism only when she finds it profitable to do so.[18] Throughout the paper, we will use the term **corruption** to refer to both the problems of collusion and extortion indistinctly.

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[13] This behavioral variable may also be interpreted as the agent's choice of improperly use of the firm's resources.

[14] Alternatively, we might assume that the supervisor collects the signal at a verifiable non-negative cost.

[15] It is possible to show that the main findings of our paper are robust to a different specification of the signal's domain in which the supervisor may not collect conclusive evidence about the agent's effort. The binary signal is made for tractability reasons and does not entail a significant loss in the interpretation of the results.

[16] We borrow the distinction between monitoring the agent's action and auditing it ex-post from Strausz (2006) who also assumes that the inspection generates an equally accurate signal.

[17] We make this assumption since the agent has private information about his effort choice. This becomes relevant under monitoring as, at the side-contracting stage, the parties must form some beliefs about the profit probability distribution.

[18] Vafaï (2002, 2010) studies a hard information framework in which the extortion threat is sustained by the commitment to a certain reporting strategy which can turn out to be ex-post unprofitable for the supervisor.

We assume that the supervisor does not bear any cost to forge information if she cooperates with the agent, while she incurs a falsification cost $c \geq 0$ if she forges information by herself.[19]

2.3. Timing of Moves

At time zero the principal can choose whether or not to hire the supervisor and with which task.

- If the supervisor is charged with a **monitoring** task, the game unfolds as follows:

  (1) the principal offers the general contract which specifies the transfers to the agent and to the supervisor as a function of the profit and of the supervisor's report; (2) the supervisor and the agent simultaneously either accept or reject the principal's offer: if either of them rejects, the game ends. If both the agent and the supervisor sign the general contract the game continues as follows; (3) the agent decides whether to work ($e = 1$) or to shirk ($e = 0$); (4) the agent and the supervisor observe the signal s. Then, the agent decides whether or not to make a take-it-or-leave-it offer (4.1). We refer to this subgame as the *collusion subgame*. If the supervisor rejects the offer, she decides whether or not to falsify evidence (4.2). We refer to this subgame as the *individual opportunism subgame*; (5) the supervisor sends the principal the report r. This message is public information within the firm, i.e., the agent can observe it; (6) profit is realized and transfers take place.

- If the principal assigns the supervisor an **auditing** task, the sequence of events is as follows:

  (1) the principal offers a contract to the agent. The contract specifies the transfers to the agent as a function of the profit and, if auditing occurs, of the supervisor's report; (2) the agent either accepts or rejects the principal's offer: if the agent rejects the general contract, production does not take place and the game ends. If the agent accepts the game continues as follows; (3) the agent decides whether to work ($e = 1$) or to shirk ($e = 0$); (4) profit is realized and the principal may or may not offer an auditing contract to the supervisor. The auditing contract specifies the supervisor's payment as a function of the profit and her report; (5) the supervisor either accepts or rejects the auditing contract. If the supervisor rejects, the agent receives a payment contingent solely on the profit and the game ends; if the supervisor accepts, the game proceeds as follows; (6) the agent and the supervisor observe the signal s. Then the collusion subgame starts (6.1) and if the supervisor rejects the agent's offer, the individual opportunism subgame takes place (6.2); (7) the supervisor sends the principal the report r and transfers take place.

It is worth stressing that under monitoring the principal hires the supervisor at the beginning of the game, while under auditing the supervisor is hired only if she can provide a valuable report given the profit realization.

Under auditing we assume that the principal can commit at stage (1) to hire the supervision depending on the profit realization.[20]

[19] The reason for these asymmetric costs lies in the nature of the different opportunistic behaviors the supervisor pursues: while under collusion the supervisor and the agent cooperate to produce evidence which ensures a bonus to the agent, under extortion the supervisor fabricates evidence on her own to the detriment of the agent. Consistently with Dewatripont and Tirole (2005), this is equivalent to assuming that the cost of a given task (falsification) decreases in the number of players involved in that task. A similar assumption has been made by Khalil et al. (2010). In a recent contribution, Corgnet and Rodriguez-Lara (2013) consider the case in which the agent can manipulate the signal of performance observed by the supervisor.

[20] The principal can costlessly commit to a hiring decision by choosing large enough out-of-equilibrium payments. In different frameworks, there emerges a commitment problem which is less easy to solve since it may never be profitable to audit ex-post, as pointed out by Khalil (1997), Khalil and Lawarrée (2006) and Finkle and Shin (2007).

In the next section we solve the model under the assumption that the principal wants the employees not to engage in any form of opportunism. As discussed in the introduction, there are a number of reasons why tolerating opportunistic behaviors within the firm can have detrimental effects. Even though we do not explicitly model the externalities caused by authorizing corruption, in what follows we implicitly assume that the principal is so concerned about its repercussions that it wants to prevent corruption from occurring.

Depending on the falsification ability of the employees, the principal may then be forced to impose some corruption-proof constraints to discourage group and/or individual opportunism.

3. Corruption-Proof Solutions

Our focus in this section is on corruption-proof contracts, namely contracts in which the supervisor always reveals truthfully the observed evidence and corruption does not take place. We first illustrate a useful benchmark in which the supervisor is not hired to check the agent's effort. Then, we compare the two alternative supervisory tasks when different forms of opportunism are available to the agent and the supervisor.

3.1. The Optimal Contract in the Absence of Supervision

We start by presenting the standard solution to the moral-hazard problem when the supervisor is not hired. The agent's salary will be only contingent on the profit realization. The salary can be either w_h if the profit is high or w_l if the profit is low. Since the principal wants the agent to exert high effort in equilibrium, it imposes the following incentive compatibility constraint:

$$\gamma w_h + (1-\gamma) w_l - g \geq \gamma w_l + (1-\gamma) w_h \tag{IC}$$

As the agent is also wealth-constrained, which implies that the principal cannot set negative salaries, it is immediate to see that the optimal contract requires that $w_h = g/(2\gamma - 1)$ and $w_l = 0$. The agent receives a rent in equilibrium whose expected value is equal to:

$$\frac{\gamma g}{2\gamma - 1} - g = \frac{(1-\gamma) g}{2\gamma - 1}$$

The expected total cost of the organization in the absence of supervision is denoted by the superscript $2th$ (two-tier hierarchy) and is given by the following expression:

$$E(T^{2th}) = \gamma w_h + (1-\gamma) w_l = \frac{\gamma g}{2\gamma - 1}$$

In the remainder of the paper we examine whether the principal can improve upon the above solution by hiring a supervisor as a monitor or an auditor.

3.2. Honest Supervisor

In this section we assume that the principal does not need to give the supervisor incentives to report truthfully the signal. This may happen because the signal is a piece of hard information that the supervisor cannot alter with or without the agent's cooperation or because the supervisor exhibits strong preferences for a honest behavior. As a result, the principal can get hold of the supervisor's information at cost $\bar{t}$. Below, we characterize the honest supervisor contracts under the alternative supervisory tasks.

Auditing

To motivate the agent to exert effort at stage (3), the principal must satisfy an *Agent's Incentive Compatibility* constraint (AICA). Under auditing the supervisor may not be hired in every state of nature and this affects the form of this constraint. We treat separately the cases in which the supervisor is hired only when the profit is high (A_h) and when the profit is low (A_l). In principle the supervisor could be hired in both states of nature. In what follows we discard this option as it would make monitoring and auditing equivalent, namely the principal's program would be exactly the same. As we will show, the benefits of auditing stem from the possibility of hiring the supervisor only in some states of the world.

Consider first the case in which the supervisor is hired only when $\pi = h$. The agent's incentive compatibility constraint can be written as:

$$\gamma[pw_{h1} + (1-p)w_{h0}] + (1-\gamma)w_l - g \geq \gamma w_l + (1-\gamma)[pw_{h0} + (1-p)w_{h1}] \tag{AICAh}$$

The principal must motivate the employees to accept the contract. While the agent's participation is always guaranteed when (AICAh) holds, the principal must ensure that the supervisor receives at least $\bar{t}$ at stage (5) when the profit is high. The principal imposes the following *Supervisor's Participation Constraint* (SPCAh):

$$pt_{h1} + (1-p)t_{h0} \geq \bar{t} \tag{SPCAh}$$

The principal chooses the transfers to minimize the expected total cost of the organization:

$$\min_{w_{hr}, t_{hr}, w_l r \in \{0,1\}} \gamma[p(w_{h1} + t_{h1}) + (1-p)(w_{h0} + t_{h0})] + (1-\gamma)w_l \tag{1}$$

subject to (AICA), (SPCAh), and all the non-negativity constraints. The following lemma determines the optimal transfers. The agent receives a positive salary only if the profit is high and the supervisor reports favorable evidence. The supervisor must be promised the reservation wage $\bar{t}$ in expectation.

Lemma 1. *The principal sets $w_{h1} = \frac{g}{\gamma+p-1}$, and $w_{h0} = w_l = 0$. The supervisor must receive her reservation wage $\bar{t}$ in expectation. One solution is $t_{h1} = \frac{\bar{t}}{p}$, and $t_{h0} = 0$.*

The expected total cost of the organization under honest auditing when $\pi = h$ is denoted by the superscript *hah*:

$$E(T^{hah}) = \frac{\gamma p g}{\gamma + p - 1} + \gamma \bar{t}$$

Consider now the case in which the supervisor is hired only when $\pi = l$. To motivate the agent to work hard, the principal sets:

$$\gamma w_h + (1-\gamma)[pw_{l1} + (1-p)w_{l0}] - g \geq \gamma[pw_{l0} + (1-p)w_{l1}] + (1-\gamma)w_h \tag{AICAl}$$

To induce the supervisor's participation in state $\pi = l$, the principal imposes:

$$pt_{l1} + (1-p)t_{l0} \geq \bar{t} \tag{SPCAl}$$

The principal chooses the transfers to minimize the expected total cost of the organization:

$$\min_{w_h, w_{lr}, t_{lr}, r \in \{0,1\}} \gamma w_h + (1-\gamma)[p(w_{l1} + t_{l1}) + (1-p)(w_{l0} + t_{l0})] \tag{2}$$

subject to (AICA), (SPCAl), and all the non-negativity constraints.

When the signal collected by the supervisor is accurate enough, the agent receives a salary only when the report is favorable, even though the profit is low. The supervisor collects no rent, but must be guaranteed her reservation wage in expectation. In contrast, when the signal collected by the supervisor is not very accurate, i.e. if $p \leq p'$, the principal does not find it profitable to audit the agent when the profit is low. In that case, minimizing the cost of providing the agent with incentives to work hard requires setting $w_h > 0$ and $w_{l1} = w_{l0} = 0$. Therefore, a supervisor hired only when the profit is low could not provide any information useful to set the agent's compensation.

Lemma 2. *There exists a threshold value $p' = \frac{\gamma^2}{\gamma^2+(1-\gamma)^2}$ such that:*

- *If $p > p'$, the principal sets $w_{l1} = \frac{g}{p-\gamma}$, and $w_{l0} = w_h = 0$. The supervisor must receive her reservation wage $\bar{t}$ in expectation. One solution is $t_{l1} = \frac{\bar{t}}{p}$, and $t_{l0} = 0$.*
- *If $p \leq p'$, the principal never finds it profitable to hire the supervisor when $h = l$*

The expected total cost of the organization under honest auditing when $\pi = l$ and $p > p'$ is denoted by the superscript *hal*:

$$E(T^{hal}) = \frac{(1-\gamma)p}{p-\gamma}g + (1-\gamma)\bar{t}$$

Monitoring

To induce the agent to exert effort, the principal must set the following *Agent's Incentive Compatibility* (AICM) constraint:

$$\begin{aligned} &\gamma[pw_{h1} + (1-p)w_{h0}] + (1-\gamma)[pw_{l1} + (1-p)w_{l0}] - g \geq \\ &\quad \gamma[pw_{l0} + (1-p)w_{l1}] + (1-\gamma)[pw_{h0} + (1-p)w_{h1}] \end{aligned} \tag{AICM}$$

The principal must motivate the employees to accept the general contract at stage (1). While the agent's participation is always guaranteed if (AICM) holds, the principal must make sure that the supervisor receives at least $\bar{t}$ in expectation. This is achieved by setting the following participation constraint (SPCM):

$$p\gamma t_{h1} + (1-p)\gamma t_{h0} + p(1-\gamma)t_{l1} + (1-p)(1-\gamma)t_{l0} \geq \bar{t} \tag{SPCM}$$

Therefore, under monitoring the principal solves the following program:

$$\min_{w_{\pi r}, t_{\pi r}, \pi \in \{h,l\}, r \in \{0,1\}} \gamma[p(w_{h1} + t_{h1}) + (1-p)(w_{h0} + t_{h0})] + (1-\gamma)[p(w_{l1} + t_{l1}) + (1-p)(w_{l0} + t_{l0})] \tag{3}$$

subject to (AICM), (SPCM), and all the non-negativity constraints.

As the following lemma illustrates, the solution to the above program entails paying the agent a salary only if the profit is high and the supervisor reports favorable evidence. Relative to the two-tier hierarchy contract, the agent's expected rent is reduced. Unlike the agent, the supervisor receives no rent as her participation constraint binds.

Lemma 3. *The principal sets $w_{h1} = \frac{g}{\gamma+p-1}$, and $w_{h0} = w_{l1} = w_{l0} = 0$. The supervisor must receive her reservation wage $\bar{t}$ in expectation. One solution is $t_{h1} = \frac{\bar{t}}{\gamma p}$, and $t_{h0} = t_{l1} = t_{l0} = 0$.*

The expected total cost of the organization under honest monitoring is denoted by the superscript *hm*:

$$E(T^{hm}) = \frac{\gamma p g}{\gamma + p - 1} + \bar{t}$$

Optimal Organizational Structure

We can now determine the principal's choice of the organizational structure of the firm when the supervisor is honest.

The next proposition shows that the principal will never hire the supervisor as a monitor when the signal cannot be altered. The cost of providing the agent with incentives to work hard is the same under monitoring and under auditing when the profit is high. However, auditing enables the principal to save on the cost of inspecting the agent, as the supervisor is not hired when the profit is low.

The principal is better off checking the agent's effort as long as the supervisor's reservation wage is not too high. If $\bar{t}$ is very high, the positive effect of supervision due to a reduction in the agent's salary is more than offset by the payment that the principal must guarantee to the supervisor. Notice also that if the supervisor's reservation wage is not too low and provided that the signal is accurate enough, the principal may prefer to audit the agent only when the profit is low. This would enable the principal to reduce the expected payment of carrying out supervision at the expense of a higher cost of providing the agent with incentives to exert effort.

Proposition 1.
1. *The principal strictly prefers auditing to monitoring when the supervisor is honest.*
2. *The principal hires the supervisor as an auditor if $\bar{t}$ is low enough.*

3.3. The Threat of Collusion

In this section we consider the case in which information is soft for the agent-supervisor coalition while it is hard for the supervisor alone, that is c is prohibitively large. As a result, the supervisor is bound to report correctly the collected evidence if she acts alone, while she can alter the signal if the agent cooperates. This creates scope for group opportunism. To prevent collusive agreements the principal must impose a set of *Coalition Incentive Compatibility* (CIC) constraints, which condition the total transfers paid to the employees.

The compensation policies adopted by an organization to deter collusion can be grouped into different categories. In what follows, we rely on the distinction between incentive and bureaucratic policies introduced by Tirole (1992).[21] Through an *incentive policy* collusion is prevented by rewarding the supervisor to report evidence which is unfavorable to the agent. Collusion does not take place since the supervisor is unwilling to accept the agent's bribe. While the supervisor collects a reward, the principal need not warp the agent's incentives. Through a *bureaucratic policy* collusion is prevented by making the agent's compensation independent of the supervisor's report. Collusion does not take place since the agent's incentives to bribe the supervisor are removed. The supervisor does not receive a reward but the cost of inducing the agent's effort is high as the principal does not make use of the informative content of the report. The organization can also implement a *mixed policy* under which both elements of incentive and bureaucratic policies are present.

We now illustrate how the threat of collusion or group opportunism affects the contracts offered under the two alternative supervisory tasks.

[21] While Tirole (1992) studies an adverse-selection problem, his insight on the compensation policies apt to prevent collusion carry over to a moral-hazard problem, such as the one we analyze.

Auditing

Consider the collusion subgame taking place at stage (6.1) in which the agent can make a take-it-or-leave-it offer to the supervisor. Since the profit has already been observed, the asymmetric information about the agent's effort choice plays no role in the supervisor's decision as to whether or not to accept the collusive offer. Collusion is prevented when the total transfer paid by the principal does not vary with the report. This ensures that either the agent does not want to bribe the supervisor to falsify evidence or the supervisor does not want to accept a bribe to falsify evidence. For any profit realization, the principal imposes the following (CICA)s:

$$w_{h1} + t_{h1} = w_{h0} + t_{h0} \tag{CICAh}$$

when $\pi = h$ and

$$w_{l1} + t_{l1} = w_{l0} + t_{l0} \tag{CICAl}$$

when $\pi = l$.

Consider first the problem in which the supervisor is hired when $\pi = h$. The principal solves (1) subject to (AICA), (SPCAh), (CICAh), and the non-negativity constraints. The following lemma provides the solution to the above program.

Lemma 4. *There exists a threshold value $\bar{t}^* = \frac{(1-p)g}{p+\gamma-1}$ such that:*

- *if $\bar{t} \leq \bar{t}^*$ then: (i) (AICA) and (CICAh) bind; (ii) all payments are equal to zero but $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$;*
- *if $\bar{t} > \bar{t}^*$ then: (i) (AICA), (CICAh) and (SPCAh) bind; (ii) all payments are equal to zero but $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h0} = \frac{pg}{p+\gamma-1} + \bar{t}$, $t_{h1} = -\frac{(1-p)g}{p+\gamma-1} + \bar{t}$;*

To provide the agent with incentives to work hard, the principal sets $w_{h1} > 0$ and $w_{h0} = w_l = 0$. To deter collusion, the principal must make sure that the coalition can never find it profitable to misreport evidence. This is achieved through an incentive policy, namely $t_{h0} = w_{h1} + t_{h1}$. As long as $\bar{t}$ is low enough, the principal can pay the supervisor only when she reports unfavorable evidence, that is, $t_{h0} = w_{h1}$ while $t_{h1} = 0$. In this case the supervisor obtains a rent. In contrast, if $\bar{t}$ is sufficiently high, the principal must pay the supervisor also when she reports favorable evidence so as to ensure her participation.

When there is the threat of collusion, the expected total cost of the organization under auditing when $\pi = h$ (denoted by the superscript *cah*) is:

$$E(T^{cah}) = \begin{cases} \frac{\gamma}{p+\gamma-1} g & \text{if } \bar{t} \leq \bar{t}^* \\ \frac{\gamma p}{p+\gamma-1} g + \gamma \bar{t} & \text{otherwise.} \end{cases}$$

Suppose now that the supervisor is hired when $h = l$. The principal solves (2) subject to (AICA), (SPCAl), (CICAl), and the non-negativity constraints.

Lemma 5. *If $p > p'$, there exists a threshold value $\bar{t}' = \frac{(1-p)g}{p-\gamma}$ such that:*

- *if $\bar{t} \leq \bar{t}'$ then: (i) (AICA) and (CICAl) bind; (ii) all payments are equal to zero but $w_{l1} = t_{l0} = \frac{g}{p-\gamma}$;*
- *if $\bar{t} > \bar{t}'$ then: (i) (AICA), (CICAl) and (SPCAl) bind; (ii) all payments are equal to zero but $w_{l1} = \frac{g}{p-\gamma}$, $t_{l0} = \frac{pg}{p-\gamma} + \bar{t}$, $t_{l1} = -\frac{(1-p)g}{p-\gamma} + \bar{t}$;*

If $p \leq p'$, the principal never finds it profitable to hire the supervisor when $h = l$.

The principal makes use of the supervisor's report to set the agent's salary when the profit is low only if the signal is accurate enough, i.e. $p > p'$. In particular, at the optimum $w_{l1} > 0 = w_{l0} = w_h$. To prevent collusion, the principal imposes $t_{l0} = w_{l1} + t_{l1}$. As long as $\bar{t}$ is low enough, the principal can pay the supervisor only when she reports unfavorable evidence, that is, $t_{l0} = w_{l1}$ while $t_{l1} = 0$. If $\bar{t}$ is high enough, the principal must pay the supervisor also when she reports favorable evidence so as to ensure her participation.

When there is the threat of collusion, the expected total cost of the organization under auditing when $\pi = l$ (denoted by the superscript *cal*) and $p > p'$ is:

$$E(T^{cal}) = \begin{cases} \frac{(1-\gamma)}{p-\gamma} g & \text{if } \bar{t} \leq \bar{t}' \\ \frac{(1-\gamma)p}{p-\gamma} g + (1-\gamma)\bar{t} & \text{otherwise.} \end{cases}$$

Monitoring

Under monitoring, at stage (4.1), the asymmetric information about e does affect the supervisor's willingness to accept or reject the collusive offer as the supervisor needs to estimate the profit probability distribution. In equilibrium, the supervisor knows that the agent is willing to exert effort and therefore it is *as though* there were no asymmetric information between the parties at the side-contracting stage. Namely, in equilibrium the supervisor has a correct belief over effort. Collusion is prevented when the total expected transfer paid by the principal is independent of the report.

$$\gamma(w_{h1} + t_{h1}) + (1-\gamma)(w_{l1} + t_{l1}) = \gamma(w_{h0} + t_{h0}) + (1-\gamma)(w_{l0} + t_{l0}) \qquad \text{(CIC1M)}$$

Off-the-equilibrium path, we need to make an assumption on how the supervisor reacts to an unexpected offer, i.e., an offer which is inconsistent with the supervisor assigning a probability equal to one to the agent having exerted effort. We make the following assumption.

Assumption 1. ***Wary beliefs***. *The supervisor regards any offer made by the agent as intentional, and changes her belief about the agent's effort choice once she receives an unexpected offer.*[22]

When the supervisor employs wary beliefs, and provided that the agent does not find it profitable to make the equilibrium offer when he has shirked, it is *as though* there were no longer asymmetric information between the agent and the supervisor at the side-contracting stage.[23] Therefore, to deter off-the-equilibrium collusion, the principal must impose:[24]

$$(1-\gamma)(w_{h1} + t_{h1}) + \gamma(w_{l1} + t_{l1}) = (1-\gamma)(w_{h0} + t_{h0}) + \gamma(w_{l0} + t_{l0}) \qquad \text{(CIC2M)}$$

[22]We borrow the concept of wary beliefs from the literature on vertical relations. In that context, beliefs are wary when an unexpected offer made by the upstream party to a downstream firm is interpreted as a deliberate choice, and not as a mistake. The notion of wary beliefs has been first used by McAfee and Schwartz (1994).

[23]By contrast, the belief about the agent's effort is immaterial under auditing for the supervisor does not need to estimate the profit probability distribution.

[24]In the Appendix, we show that our results continue to hold if the supervisor has **passive** rather than wary beliefs, that is if she does not update her belief about the agent's effort choice after receiving an offer, even if it is an off-the-equilibrium one (see the solution to Lemma 9). The unexpected offer can be interpreted as an agent's mistake. Also this notion of belief is discussed in McAfee and Schwartz (1994) and has been sometimes used in the literature on corruption in hierarchies (see for instance, Faure-Grimaud et al., 2003a).

It is important to point out that the system consisting of (CIC1M) and (CIC2M) can be reduced to that consisting of (CIC1A) and (CIC2A) and *vice versa*. As a result, the principal's choice between auditing and monitoring will not depend on how they address the collusion problem.

The principal solves (3) subject to (AICM), (SPCM), (CIC1M), (CIC2M) and the non-negativity constraints.

Lemma 6. *There exists a threshold value* $\bar{t}^{**} = \frac{(1-p)\gamma g}{p+\gamma-1}$ *such that:*

- *if* $\bar{t} \leq \bar{t}^{**}$ *then:* (i) *(AICM) and (CIC1M) bind;* (ii) *all payments are equal to zero but* $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$*;*
- *if* $\bar{t} > \bar{t}^{*}$ *then:* (i) *(AICM), (CIC1M) and (SPCM) bind;* (ii) *all payments are equal to zero but* $w_{h1} = \frac{g}{p+\gamma-1}$*,* $t_{h0} = \frac{pg}{p+\gamma-1} + \frac{\bar{t}}{\gamma}$*,* $t_{h1} = -\frac{(1-p)g}{p+\gamma-1} + \frac{\bar{t}}{\gamma}$*;*

The principal rewards the agent only when the profit is high and the report is favorable. To prevent collusion, the principal adopts an incentive policy setting $t_{h0} = w_{h1} + t_{h1}$. As long as the supervisor's reservation wage is low enough, it suffices to set $t_{h0} = w_{h1} > 0 = t_{h1}$. When this payment does not suffices to guarantee the supervisor's participation, also t_{h1} must take a positive value.

When there is the threat of collusion, the expected total cost of the organization under monitoring (indexed by *cm*) is:

$$E(T^{cm}) = \begin{cases} \frac{\gamma}{p+\gamma-1} g & \text{if } \bar{t} \leq \bar{t}^{**} \\ \frac{\gamma p}{p+\gamma-1} g + \bar{t} & \text{otherwise.} \end{cases}$$

Optimal Organizational Structure

The optimal organizational structure is only slightly affected by the threat of collusion. In particular, the principal never gains from charging the supervisor with a monitoring task. To see this, compare monitoring with auditing when the profit is high. Both supervisory options always entail the same cost of providing the agent with incentives to work hard. In contrast, the cost of preventing collusion crucially depends on the supervisor's reservation wage. When this is low enough, i.e. $\bar{t} \leq \bar{t}^{**}$, the supervisor collects a rent which is the same under both supervisory options. Therefore, the principal is indifferent between monitoring and auditing when the profit is high as long as the supervisor's participation constraint is slack. When the supervisor's reservation wage is sufficiently high, i.e. $\bar{t} > \bar{t}^{**}$, the supervisor's participation constraint under monitoring binds. Then, the principal strictly prefer auditing since it reduces the expected cost of inspecting the agent thanks to its ex-ante randomness.

The principal is better off auditing the agent unless $\bar{t}$ is very high, in which case the non-supervisory option is preferred. The following proposition summarizes the main results of this section.

Proposition 2. 1. *The principal never benefits from monitoring when the supervisor and the agent can collude.*
2. *The principal hires the supervisor if* $\bar{t}$ *is low enough.*

3.4. The Threat of Corruption

In the absence of individual opportunism, we have seen that the principal pursues an incentive policy to prevent collusion. In this section we relax the assumption that the supervisor cannot falsify evidence without the agent's cooperation. By incurring the falsification cost *c* the supervisor can report a signal different from the one she has observed.[25] The principal must ensure that there is no scope for individual opportunism by imposing conditions on the transfers received by the supervisor through the *Supervisor's Incentive Compatibility* (SIC) constraints. Consider that, if not prevented, individual opportunism has dire consequences on the incentives provided to the agent, who anticipates that a good behavior will not be rewarded.

We will show how the severity of the extortion threat crucially affects the choice of the compensation policy adopted to deter collusion and, as a result, the principal's choice of the supervisory task.

Auditing

Consider the individual opportunism subgame under auditing taking place at stage (6.2). To ensure that the supervisor prefers to report truthfully when she has not colluded with the agent at stage (6.1) without abusing her authority and engaging in individual opportunism, the principal must impose the following two (SICA)s if the supervisor is hired when the profit is high:

$$t_{h0} \geq t_{h1} - c \tag{SIC1A}$$

$$t_{h1} \geq t_{h0} - c \tag{SIC2A}$$

Likewise, the principal must impose the following two constraints if the supervisor is hired when the profit is low:

$$t_{l0} \geq t_{l1} - c \tag{SIC3A}$$

$$t_{l1} \geq t_{l0} - c \tag{SIC4A}$$

Note that we assume that the parties do not engage in opportunistic activities when indifferent, which explains why the constraints hold with equality.[26]

Consider first the problem in which the supervisor is hired only if the profit is high. The principal solves (1) subject to (AICA), (CICAh), (SIC1A), (SIC2A), (SPCAh), and all the non-negativity constraints. The following lemma provides the solution to this program.

Lemma 7. *There exists a threshold value $c^* = \frac{g}{p+\gamma-1}$ such that:*

- *if $c \geq c^*$, the contract is the same as that described in Lemma 4;*
- *while if $c < c^*$ and*
  - *$\bar{t} \leq c(1-p)$ then: (i) (AICA), (CICAh) and (SIC2A) bind; (ii) all payments are equal to zero but $w_{h1} = \frac{g-c(p-\gamma)}{2\gamma-1}$, $w_{h0} = \frac{g-c(p+\gamma-1)}{2\gamma-1}$, $t_{h0} = c$;*
  - *$\bar{t} > c(1-p)$ then: (i) (AICA), (CICAh), (SIC2A) and (SPCAh) bind; (ii) all payments are equal to zero but $w_{h1} = \frac{g-c(p-\gamma)}{2\gamma-1}$, $w_{h0} = \frac{g-c(p+\gamma-1)}{2\gamma-1}$, $t_{h0} = pc + \bar{t}$, $t_{h1} = -(1-p)c + \bar{t}$.*

[25] In the real world, the use of reports based on evidence that a supervisor could easily manipulate without the agent's cooperation is rife. For instance, Gibbs (1995) documents the use of such reports in his study of a hierarchical organization in which subjective performance ratings (a 5-point rating scheme) are used to set bonuses, raises, and promotions. Another well-known study is that of Dalton (1959) on management practices in a chemical plant in the US. The problem of the subjectivity in the evaluation of whether a given behavior is out of line persists in the information age, as stressed in Johnson and Chalmers (2007).

[26] This is a standard assumption in this literature.

The principal always sets $w_{h1} > 0$ to minimize the cost of eliciting the agent's effort. To illustrate how the transfers are affected by c, let us suppose that $\bar{t} = 0$. When the falsification cost is high enough ($c \geq c^*$), individual opportunism does not represent a concern for the principal and the optimal contract does not vary with respect to that characterized in Lemma 4. Specifically, the principal adopts the incentive policy $t_{h0} = w_{h1}$ to deter collusion without creating scope for individual opportunism and the agent can be provided with the second-best incentives.

The above solution can no longer be implemented when the falsification cost is low enough ($c < c^*$). The incentive policy would give rise to individual opportunism: The supervisor would be tempted to falsify evidence so as to collect the reward for an unfavorable report. The principal prevents both forms of opportunistic behavior by reducing t_{h0} and setting $w_{h0} > 0$ (mixed policy) thereby distorting the agent's incentives. In the polar case in which $c = 0$ the principal adopts a bureaucratic policy by setting $w_{h1} = w_{h0} = w_h > 0$ and $t_{h0} = 0$. Therefore, the threat of individual opportunism affects the compensation policy adopted to deter collusion.

Now, suppose that $\bar{t}$ is positive but not too high. If so, the contract described above is not perturbed as t_{h0} suffices to satisfy (SPCAh). Conversely, when $\bar{t}$ is relatively high, (SPCAh) binds and the principal sets $t_{h1} > 0$ and increases t_{h0} in order to keep the difference between t_{h0} and t_{h1} constant.

When there is the threat of corruption, the expected total cost of the organization under auditing when $\pi = h$, denoted by the superscript Ah, is given by:

$$E(T^{Ah}) = \begin{cases} \frac{\gamma g - \gamma(p-\gamma)c}{2\gamma-1} & \text{if } c < c^* \bigwedge \bar{t} \leq (1-p)c \\ \frac{\gamma g - \gamma(2p-1)(1-\gamma)c}{2\gamma-1} + \gamma\bar{t} & \text{if } c < c^* \bigwedge \bar{t} > (1-p)c \\ \frac{\gamma g}{p+\gamma-1} & \text{if } c \geq c^* \bigwedge \bar{t} \leq \bar{t}^* \\ \frac{p\gamma g}{p+\gamma-1} + \gamma\bar{t} & \text{if } c \geq c^* \bigwedge \bar{t} > \bar{t}^* \end{cases}$$

Consider next the contract in which the supervisor is hired only when $\pi = l$. The principal solves (2) subject to (AICA), (CICAl), (SIC3A), (SIC4A), (SPCAl), and all the non-negativity constraints.

Lemma 8. *If $p > p'$, there exists a threshold value $c' = \frac{g}{p-\gamma}$ such that:*

- *if $c \geq c'$, the contract is the same as that described in Lemma 5;*
- *while if $c < c'$ and*
  - *$\bar{t} \leq c(1-p)$ then: (i) (AICA), (CICA) and (SIC4A) bind; (ii) all payments are equal to zero but $w_{l1} = c$, $w_h = \frac{g-c(p-\gamma)}{2\gamma-1}$, $t_{l0} = c$;*
  - *$\bar{t} > c(1-p)$ then: (i) (AICA), (CICA), (SIC4A) and (SPCA) bind; (ii) all payments are equal to zero but $w_{l1} = c$, $w_h = \frac{g-c(p-\gamma)}{2\gamma-1}$, $t_{l0} = pc + \bar{t}$, $t_{h1} = -(1-p)c + \bar{t}$.*

If $p \leq p'$ the principal never finds it profitable to hire the supervisor when the profit is low.

Lemma 8 shows that also when the supervisor is hired only when the profit is low, a smaller falsification cost increases the cost of the organization, magnifying the distortion of the agent's incentives.

There are some important differences between the two auditing contracts. The expected cost of supervision is minimized under A_l since the supervisor is hired in a more unlikely state of nature than under A_h. The drawback of A_l is that it always provides the agent with worse incentives than A_h, under which the agent receives the second-best salary when $c \geq c^*$.

When there is the threat of corruption, the expected total cost of the organization under auditing when $\pi = l$ and $p > p'$, denoted by the superscript Al, is given by:

$$E(T^{Al}) = \begin{cases} \frac{\gamma g - \gamma(p-\gamma)c}{2\gamma-1} + (1-\gamma)c & \text{if } c < c' \wedge \bar{t} \leq (1-p)c \\ \frac{\gamma g - \gamma(2p-1)(1-\gamma)c}{2\gamma-1} + (1-\gamma)pc + (1-\gamma)\bar{t} & \text{if } c < c' \wedge \bar{t} > (1-p)c \\ \frac{(1-\gamma)g}{p-\gamma} & \text{if } c \geq c' \wedge \bar{t} \leq \bar{t}' \\ \frac{p(1-\gamma)g}{p-\gamma} + (1-\gamma)\bar{t} & \text{if } c \geq c' \wedge \bar{t} > \bar{t}'. \end{cases}$$

Monitoring

Consider the individual opportunism subgame under monitoring taking place at stage (4.2). The supervisor must prefer to report truthfully when she has not colluded with the agent at stage (4.1) without abusing her authority and engaging in individual opportunism. Since the profit has not yet been realized, the supervisor compares her expected utility under alternative reporting strategies, given her belief about e at that stage. Knowing that the principal induces the agent to work, the (SIC)s take the following forms:

$$\gamma t_{h0} + (1-\gamma)t_{l0} \geq \gamma t_{h1} + (1-\gamma)t_{l1} - c \tag{SIC1M}$$

$$\gamma t_{h1} + (1-\gamma)t_{l1} \geq \gamma t_{h0} + (1-\gamma)t_{l0} - c \tag{SIC2M}$$

where the first (respectively, the second) constraint ensures that the supervisor reveals truthfully $s = 0$ (resp., $s = 1$). The way the supervisor updates her belief about the agent's effort does not affect the (SIC)s under the corruption-proof contracts since a collusive offer is not made.

The above supervisor's incentive compatibility constraints can be more easily satisfied than the corresponding constraints under auditing since the principal can take advantage of the supervisor's uncertainty about the profit realization.

The principal solves (3) subject to (AICM), (SPCM), (CIC1M), (CIC2M), (SIC1M), (SIC2M), and all the non-negativity constraints. Lemma 9 provides the solution to this program.

Lemma 9. *There exists a threshold value $c^{**} = \frac{\gamma g}{p+\gamma-1}$ such that:*

- *if $c \geq c^{**}$, the contract is the same as that described in Lemma 6;*
- *while if $c < c^{**}$ and*
  - *$\bar{t} \leq c(1-p)$ then: (i) (AICM), (CIC1M) and (SIC2M) bind; (ii) all payments are equal to zero but $w_{h1} = \frac{g}{2\gamma-1} - \frac{(p-\gamma)c}{(2\gamma-1)\gamma}$, $w_{h0} = \frac{g}{2\gamma-1} - \frac{(p+\gamma-1)c}{(2\gamma-1)\gamma}$, $t_{h0} = \frac{c}{\gamma}$;*
  - *$\bar{t} > c(1-p)$ then: (i) (AICM), (CIC1M), (SIC2M) and (SPCM) bind; (ii) all payments are equal to zero but $w_{h1} = \frac{g}{2\gamma-1} - \frac{(p-\gamma)c}{(2\gamma-1)\gamma}$, $w_{h0} = \frac{g}{2\gamma-1} - \frac{(p+\gamma-1)c}{(2\gamma-1)\gamma}$, $t_{h0} = \frac{pc+\bar{t}}{\gamma}$, $t_{h1} = \frac{-(1-p)c+\bar{t}}{\gamma}$.*

Lemma 9 shows that, from a qualitative standpoint, the monitoring contract exhibits strong similarities with the auditing ones. This is so as the determinants of the contracts are the same: the falsification cost c, that affects the severity of opportunism, and the reservation wage $\bar{t}$, that impacts on the cost of supervision. First, as c takes a higher value, the agent can be provided with better incentives to exert effort. Second, a higher $\bar{t}$ may require the principal to set positive salaries to the supervisor when she reports evidence favorable to the agent (t_{h1} in A_h and M and t_{l1} in A_l) to induce her participation.

When there is the threat of corruption, the expected total cost of the organization under monitoring, denoted by the superscript M, is given by:

$$E(T^M) = \begin{cases} \frac{\gamma g-(p-\gamma)c}{2\gamma-1} & \text{if } c < c^{**} \wedge \bar{t} \leq (1-p)c \\ \frac{\gamma g-(2p-1)(1-\gamma)c}{2\gamma-1} + \bar{t} & \text{if } c < c^{**} \wedge \bar{t} > (1-p)c \\ \frac{\gamma g}{p+\gamma-1} & \text{if } c \geq c^{**} \wedge \bar{t} \leq \bar{t}^{**} \\ \frac{p\gamma g}{p+\gamma-1} + \bar{t} & \text{if } c \geq c^{**} \wedge \bar{t} > \bar{t}^{**} \end{cases}$$

3.5. Comparison of Organizational Structures

We now turn to determine the principal's choice of the organizational structure of the firm when the supervisor can falsify evidence on her own at a cost.

Best Supervisory Task

We first compare the three alternative supervisory options. The most relevant difference with the case in which evidence can be falsified only by the agent-supervisor coalition is that monitoring may emerge as the principal's favorite supervisory task.

Recall that when the supervisor cannot falsify evidence by herself, an incentive policy is efficient to deter collusion. In contrast, when also individual opportunism is a concern, an incentive policy is not adopted as it would create scope for extortion. We find that a mixed policy must be undertaken, thereby distorting the agent's incentives away from efficiency. Compared to auditing, monitoring alleviates such distortion as the supervisor's uncertainty about the profit realization makes it easier to prevent individual opportunism.

Proposition 3. *There exist two functions $\bar{t}^a(c)$ and $\bar{t}^m(c)$, with $\bar{t}^a(c) > \bar{t}^m(c)$ for all $c > 0$, such that:*

- *if $\bar{t} > \bar{t}^a(c)$, the principal strictly prefers A_l;*
- *if $\bar{t} \in [\bar{t}^a(c), \bar{t}^m(c))$ the principal strictly prefers A_h;*
- *if $\bar{t} \leq \bar{t}^m(c)$ and:*
  - *$c < c^*$, the principal strictly prefers M;*
  - *$c \geq c^*$ the principal is indifferent between M and A_h.*

The above proposition illustrates the relative strengths of the three supervisory options and how the principal's choice depends on c and $\bar{t}$. Figure .1 plots the regions in which each supervisory tasks is preferred by the principal as a function of these two parameters.

FIGURE 1 HERE

When $\bar{t}$ is high, the principal focuses on reducing the cost of supervision. For this reason the principal prefers A_l to both A_h and M, although it entails the highest cost of inducing the agent's effort. The level of $\bar{t}$ above which A_l outperforms the other supervisory tasks is increasing in the falsification cost. When c is small, even a low level of $\bar{t}$ suffices to make A_l superior to M and A_h, as their comparative advantages in providing the agent with better incentives are weakened.

For intermediate values of $\bar{t}$, the principal favors A_h. This option represents the best balance between providing the agent with strong incentives (relative to A_l) and reducing the cost of supervision (relative to M).

When $\bar{t}$ is low, inducing the supervisor's participation is a minor issue as the reward paid to deter corruption is sufficient to induce her participation. Thus, the principal can focus on minimizing the cost of motivating the agent to work. Monitoring outperforms A_h when $c < c^*$ as the former mitigates the distortion of the agent's incentives. The advantage of monitoring in strengthening the agent's incentives is related to the timing of the report. Since the supervisor sends her report before the profit is realized, she is less willing to pursue individual opportunism. To see this, consider that if the supervisor decides to incur the falsification cost c she can collect a reward from the principal only with a probability strictly lower than one under monitoring while she collects the reward with certainty under auditing. This implies that the supervisor's expected gains from individual opportunism are higher under auditing than under monitoring.

In contrast, when $\bar{t}$ is low and $c \geq c^*$, the principal is indifferent between M and A_h as neither individual opportunism nor the supervisor's participation represent a concern. Under both supervisory options the agent is offered the second-best wage schedule and the expected payment the supervisor receives to avoid collusion suffices to ensure her participation.

We have assumed that under monitoring the principal asks for the supervisor's report before the realization of the profit. If the report is asked after the profit is observed, individual opportunism is discouraged by setting the same collections of constraints that are imposed under auditing, that is the same (SICA). As a result of Proposition 3, the following corollary holds:

Corollary 1. *Under monitoring, the principal (weakly) prefers to ask for the supervisor's report before the profit is realized.*

Therefore, the principal can use the timing of the report as a policy instrument to mitigate the trade-off between group and individual opportunism.[27]

We have not considered the case in which individual opportunism is the only concern. This might occur, for instance, if the agent and the supervisor cannot communicate, but the latter can misreport information. The principal can discourage individual opportunism by making the supervisor's compensation independent of the report, without altering the agent's incentives. The principal would prefer auditing to monitoring as the former would reduce the cost of inspection. Therefore, monitoring may dominate auditing only if both forms of corruption are simultaneously present.

Optimal Organizational Structure

After characterizing the corruption-proof contracts, we now determine the optimal organizational structure. Namely we check whether and under what conditions the principal can benefit from dispensing with the supervisor.

Proposition 4. *There exists a function $\bar{t}^{2th}(c)$, increasing in c with $\bar{t}^{2th}(0) = 0$, $\bar{t}^{2th}(c) > \bar{t}^{s}(c)$ for all $c > 0$, such that:*

- *if $\bar{t} > \bar{t}^{2th}(c)$, the principal dispenses with the supervisor;*
- *if $\bar{t} \leq \bar{t}^{2th}(c)$ the principal hires the supervisor.*

[27] In a related vein, Faure-Grimaud et al. (2003b) shows that requesting the report before the realization of the verifiable outcome can reduce the cost of providing a risk-averse supervisor with insurance.

Proposition 4 shows that the principal may be better off dispensing with the supervisor. This occurs when the cost of supervision outweighes its beneficial effects on the agent's incentives. As shown in Figure .2, allowing the principal to dispense with the supervisor implies that A_l is never adopted. The threshold value of $\bar{t}$ above which the two-tier hierarchy is the best organizational structure is increasing in c. A lower falsification cost implies a higher distortion of the agent's incentives which reduces the benefits of supervision.

Both M and A_h are valuable options for the principal who faces a tradeoff between them. Provided that the two-tier hierarchy is not the optimal organizational structure, A_h is preferred to M when c and $\bar{t}$ are high. There, individual opportunism is not an issue whereas inducing the supervisor's participation is not costless for the principal.[28] In contrast, M is preferred to A_h when both c and $\bar{t}$ are low. In that case, individual opportunism is the most severe concern for the principal and monitoring better mitigates the distortion of the agent's incentives.

FIGURE 2 HERE

4. Collusion Contracts and Bargaining Power

In this section we relax the assumption that the principal wants to prevent corruption and we show that our main results concerning the existence of a trade-off between monitoring and auditing continues to arise.[29] To prevent corruption, the principal needs to impose several interlinked constraints. When this is the case, preventing corruption may not be optimal.[30] Here we examine whether the principal may be better off tolerating some forms of opportunistic behavior to reduce the cost of motivating the agent to provide effort or to save on the supervisor's payment.

4.1. Agent's Take-it-or-Leave-it Offer

First we study whether the principal can benefit from allowing corruption when the agent makes a take-it-or-leave-it offer at the collusion subgame, namely in the same setting analyzed in the previous sections. The following proposition shows that our restriction to corruption-proof contracts was inconsequential.

Proposition 5. *The principal never benefits from allowing corruption.*

The principal never benefits from tolerating individual opportunism as this always weakens the agent's incentives without reducing the cost of supervision. Since the supervisor would have a dominant reporting strategy, the report would be uninformative about the signal. In contrast, the principal could benefit from tolerating group opportunism when the falsification cost is low. When c is small, deterring corruption

[28]This seems to be consistent with casual observation. The cost of testing an athlete in a sport competition for the presence of performance-enhancing drugs in her/his urine or blood is very large. At the same time, it is complicated to manipulate evidence collected in a laboratory. This is why in most cases an athlete is tested only if she/he ends up high in the final ranking. For instance this is what happens in rowing contests such as the Silver Skiff International Regatta or at national and international level marathons. At the Olympics, in addition to the medal winners also other randomly-selected athletes are tested. See *London 2012 Olympics: Q&A on drug testing* on BBC news UK, 31 July 2012 at http://www.bbc.com/news/uk-19066937 .

[29]Both the economic and the management literatures suggest a clear relationship between cultural traits and corruption (e.g., see Licht et al., 2007 and Martin et al., 2007). Therefore, the principal's concern about the consequences of tolerating opportunistic behaviors may well depend on the general attitude towards corruption in the environment in which the firm operates.

[30]This was first noted by Tirole (1992).

requires $w_{h0} > 0$ which distorts the agent's incentives. The principal may set $w_{h0} = 0$ and let the agent collude with the supervisor to report $r = 1$. Note that the agent must pay a bribe to the supervisor to have $r = 1$ reported when $s = 0$. Thus he may dislike sharing the gains from collusion with the supervisor and be more motivated to work to increase the probability that $s = 1$. However, this does not occur here since the agent is able to extract all the gains from collusion and, as a result, his incentives cannot be improved by tolerating a collusive agreement.

4.2. Nash-bargaining and Collusion

In this section we check the robustness of our results when the supervisor has some bargaining power at the side-contracting stage. This assumption does not affect the corruption-proof contracts, while it may impact on the desirability of allowing opportunistic behaviors. To model this, we assume that there exists a third party, the collusion designer, who organizes the bargaining protocol and enforces the side-contract. The coalition designer knows the rules of the game, observes s and chooses the report which maximizes the coalition's expected transfer from the principal. To determine the side-transfers, the designer solves a Nash-bargaining game with weights β and $(1-\beta)$ for the agent and the supervisor, respectively.[31] When offering the general contract, the principal takes into account the outcome of the collusion subgame and sets all the constraints accordingly. We set out the collusion subgame of the two supervisory tasks separately.

Auditing

Under auditing collusion takes place after the profit observation. The designer chooses the report which maximizes the total transfer given the profit realization. We call such report $\hat{r}$. The coalition obtains $w_{\pi\hat{r}} + t_{\pi\hat{r}}$ which the supervisor and the agent will share. We define as $w^{\hat{r}}_{\pi s}$ and $t^{\hat{r}}_{\pi s}$ the net payoffs the agent and the supervisor, respectively, receive from collusion when the signal is s, the profit π and the report $\hat{r}$. For instance, suppose that $\hat{r} = 1$ when $\pi = h$. If the signal is 0, the agent's payoff is not w_{h1}, the payment he directly receives form the principal, but rather w^1_{h0}.

To determine $w^{\hat{r}}_{\pi s}$ and $t^{\hat{r}}_{\pi s}$ the designer solves the following problem:

$$\max_{w^{\hat{r}}_{\pi s}, t^{\hat{r}}_{\pi s}} (w^{\hat{r}}_{\pi s} - w^{T}_{\pi s})^{\beta} (t^{\hat{r}}_{\pi s} - t^{T}_{\pi s})^{(1-\beta)}$$

subject to the participation constraints:

$$w^{\hat{r}}_{\pi s} \geq w^{T}_{\pi s}$$
$$t^{\hat{r}}_{\pi s} \geq t^{T}_{\pi s}$$

and

$$w^{\hat{r}}_{\pi s} + t^{\hat{r}}_{\pi s} \leq w_{\pi\hat{r}} + t_{\pi\hat{r}} \tag{FC}$$

$\forall \pi \in \{h, l\}$, where $w^{T}_{\pi s}$ (respectively, $t^{T}_{\pi s}$) is the agent's (resp., the supervisor's) threat point, which depends on the reporting strategy of the supervisor when collusion does not take place. The feasibility constraints (FC) ensures that the outcome of the bargaining process does not exceed the total transfer received by the principal. In the comparisons that follow we do not consider A_l as it can be shown that it is never profitable for the principal to implement such contract.

[31] In a different setting, Faure-Grimaud et al. (2003a) also assume the presence of a third party who offers a side-contract to the agent and the supervisor to maximize a weighted sum of their utility functions.

Monitoring

Under monitoring collusion takes place before the profit is observed. The designer chooses the report which maximizes the expected total transfer given the signal observation. As the agent's incentive compatibility is satisfied in equilibrium, the designer assigns probability γ to π_h and probability $1-\gamma$ to π_l.[32]

$$\max_{w_{hs}^{\hat{r}}, w_{ls}^{\hat{r}}, t_{hs}^{\hat{r}}, t_{ls}^{\hat{r}}} \gamma(w_{hs}^{\hat{r}} - w_{hs}^{T})^{\beta}(t_{hs}^{\hat{r}} - t_{hs}^{T})^{(1-\beta)} + (1-\gamma)(w_{ls}^{\hat{r}} - w_{ls}^{T})^{\beta}(t_{ls}^{\hat{r}} - t_{ls}^{T})^{(1-\beta)}$$

subject to the participation constraints:

$$\gamma w_{hs}^{\hat{r}} + (1-\gamma) w_{ls}^{\hat{r}} \geq \gamma w_{hs}^{T} + (1-\gamma) w_{ls}^{T}$$
$$\gamma t_{hs}^{\hat{r}} + (1-\gamma) t_{ls}^{\hat{r}} \geq \gamma t_{hs}^{T} + (1-\gamma) t_{ls}^{T}$$

and

$$w_{hs}^{\hat{r}} + t_{hs}^{\hat{r}} \leq w_{h\hat{r}} + t_{h\hat{r}} \tag{FC1}$$
$$w_{ls}^{\hat{r}} + t_{ls}^{\hat{r}} \leq w_{l\hat{r}} + t_{l\hat{r}} \tag{FC2}$$

where (FC1) and (FC2) ensure that the outcome of the bargaining process is feasible when $\pi = h$ and $\pi = l$, respectively.

We relegate to Appendix B all the computations and technical details, while here we provide the main implications of the supervisor's bargaining power for the principal's choice of the organizational structure.

Irrespective of the supervisory task, the principal cannot gain from tolerating corruption when c is sufficiently high ($c \geq c^*$). In this case, individual opportunism is not an issue and, as a result, collusion is efficiently prevented through an incentive policy.

In contrast, when c is relatively low individual opportunism represents a concern. As seen in the previous section, when the principal induces truthful-reporting, an incentive policy cannot be used. The principal should raise the salary paid to the agent when $r = 0$ to prevent collusion and this would increase the cost of inducing effort. To reduce such distortion, the principal allows the coalition to sign a collusive agreement in which the supervisor reports $r = 1$ when evidence is unfavorable to the agent, i.e. when $s = 0$. Even if the agent receives the same payment from the principal when $s = 0$ and $s = 1$, he collects the entire payment only in the latter instance. In the former instance, the agent pockets only a fraction of the salary as he must share the gains from collusion with the supervisor. Thus, the agent is more motivated to work hard so as to decrease the probability of having to share his salary with the supervisor. This positive effect of collusion on the agent's incentives is increasing in the supervisor's bargaining power: as β takes a lower value, the share of the collusion gains accruing to the agent decreases and, therefore, his willingness to exert effort rises. When $\beta = 1$ the incentive effect of collusion disappears and the principal is indifferent between tolerating and deterring collective manipulation of unfavorable evidence.

Unlike collusion, individual opportunism is always optimally prevented as the principal wants to avoid that the supervisor has a dominant reporting strategy.

[32]It is shown in Appendix B that the Nash-bargaining outcome is independent of the designer's belief about the agent's effort as the parties are wealth constrained and they cannot transfer wealth from one state to another.

Comparison of Organizational Structures

As the supervisor's bargaining power increases, the principal is able to provide the agent with stronger incentives when c is small. This is so irrespective of the supervisory task and has two main implications. The first is that the advantages of monitoring relative to auditing tend to disappear. In particular, as β diminishes the function which divides the areas where monitoring and auditing dominate tends to flatten out around t^{**} as shown in Figure 3. Thus, for low values of c, monitoring is adopted in a larger area than when $\beta = 1$. For intermediate values of c the area in which monitoring is preferred to auditing becomes smaller. For high values of c the principal continues to be indifferent between the two supervisory options as long as $\bar{t}$ is not too large. For $\beta = 0$ monitoring no longer has any advantage over auditing: the agent can be provided with the second best incentives for all values of c. Therefore the tradeoff between monitoring and auditing arises whenever $\beta > 0$.

FIGURE 3 HERE

The second implication of the negative relationship between β and the cost of inducing effort is that hiring the supervisor becomes profitable even for non-negligible values of $\bar{t}$ and c. This is shown in Figure 4.

FIGURE 4 HERE

The fact that tolerating collusion may be optimal is not a new finding in the literature. Khalil et al. (2010) study a moral-hazard problem in a three-tier hierarchy in which the supervisor acts as an auditor and cannot falsify evidence on her own. They also show that the principal can improve upon the corruption-proof contract by tolerating collusion as long as the agent does not have all the bargaining power. The intuition is analogous: the principal can provide the (risk-averse) agent with better incentives by allowing a collusive agreement since he dislikes sharing the salary with the supervisor.[33]

5. Conclusions

In this paper we have highlighted the existence of a tradeoff between monitoring the agent's effort ex-ante and auditing it ex-post. There are two key factors which affect the principal's choice of the organizational structure: (i) the supervisor's falsification ability, which makes it more difficult to simultaneously address individual and group opportunism and (ii) the cost of supervision which makes it more costly to induce the supervisor's participation.

When the principal prefers to prevent corruption, supervision is valuable unless both factors are relevant concerns, in which case the principal dispenses with the supervisor. When only one of the factors bites, the principal has a favorite supervisory task: if the falsification ability of the supervisor is the main concern, the principal prefers monitoring as it is more efficient than auditing in tackling corruption; if the cost of supervision is the main concern, the principal prefers auditing to monitoring as the former allows

[33]Even if c is infinite in their setting, tolerating collusion is optimal. In contrast, in our set-up collusion is optimally allowed only if c is sufficiently small. The reason of this divergence lies in the different attitude towards risk of the agent, who is risk-neutral in our model and risk-averse in theirs. In this latter scenario, optimal insurance requires that the agent be paid also when the profit is low and the signal is good. This hurts incentives to provide effort thereby making it profitable for the principal to tolerate a collusive agreement.

to save the supervisor's salary in some states of the world. If neither factor bites the principal is indifferent between the two supervisory options.

When the principal does not mind allowing corruption, supervision may be valuable even when both factors represent a serious concern, provided that the agent does not reap all the gains from collusion. The trade-off between monitoring and auditing persists and the principal's choice of the supervisory task will depend on which factor is the most severe.

The prescriptions of our theoretical model are clear-cut: Auditing should be preferred to monitoring in all those circumstances in which: *(i)* the supervisor cannot easily falsify evidence on her own; *(ii)* inducing the supervisor's participation is costly.

Although in the model we have focused on the internal organization of a firm, the insights stemming from the paper can be applied to a broader range of situations. Consider for instance a regulatory setting similar to that studied by Hiriart et al. (2010) in which a firm must make a non-observable investment decision that reduces the probability that an accident occurs. Suppose that performing an inspection which imperfectly reveals the investment is costly and, to make matters worse, the inspector may blackmail or collude with the firm. The regulator must decide whether to send the inspector ex-ante or ex-post if an accident occurs. While sending the inspector ex-post allows the regulator to save the inspection cost in the event of no accident, with an ex-ante inspection it is possible to address corruption more effectively. The optimal inspection choice will ultimately depend on the variables that we have discussed in the paper.

Our results are obtained in a model with a risk neutral agent. This implies that the optimal payments to the agent following a low profit are set equal to zero. A natural question is whether the benefits of auditing still arises when the agent is risk averse. In that case, the optimal insurance provided by an honest supervisor requires the agent be paid also when the profit is low and the report is favorable. In this scenario the supervisor's report is valuable irrespective of the profit realization. While the desirability of monitoring the agent's effort choice undoubtedly increases, there may still be circumstances in which auditing turns out to be the most profitable supervisory task. This is more likely to occur when the insurance provided by the supervisor is not very efficient (i.e., when p is low) and/or the agent's demand for insurance is low. In these cases, the principal prefers to dispense with the supervisor in case of low profit.

An interesting extension that we leave for future research concerns the optimal choice between monitoring and auditing when the supervisor has social preferences. For instance, the supervisor may be altruistic towards the agent and as a consequence has an incentive to systematically over-report his effort, as in Giebe and Gurtler (2012). Such preferences may originate from the close interaction between the employees and the possibility for the supervisor to impact on the agent's well-being with her report. The intensity of the social preferences can also be related to the timing of the supervisory task: arguably, the supervisor builds a stronger personal relationship with the agent under monitoring given that she directly observes the agent's effort.

Appendix A

Lemmas 1-9 are proved using the *Pivot Madly Method*, a standard solution method for linear programming problems.[34] This method consists of pivoting madly the simplex tableau representing the minimization problem until all entries in the last column and last row (exclusive of the corner) are nonnegative. Then, the solution is achieved by setting the variables on the left to zero and the variables on top to the corresponding entry on the last row. The value of the problem is the lower right corner.

Proof of Lemma 1

Suppose that the principal offers the supervisor an auditing contract only when $\pi = h$. The agent's incentive compatibility constraint is rewritten as:

$$(p+\gamma-1)w_{h1} - (p-\gamma)w_{h0} - (2\gamma-1)w_l - g \geq 0 \tag{AICAh}$$

The agent's participation constraint can be written as:

$$\gamma(pw_{h1} + (1-p)w_{h0}) + (1-\gamma)(pw_{l1} + (1-p)w_{l0}) - g \geq 0 \tag{APCAh}$$

The principal solves the following program:

$$\min_{w_{h1},t_{h1},w_{h0},t_{h0},w_h} \gamma(p(w_{h1}+t_{h1}) + (1-p)(w_{h0}+t_{h0})) + (1-\gamma)w_l$$

subject to (AICAh), (SPCAh) and all the non-negativity constraints. This problem is represented in the following tableau:

	k_1	k_2	
w_{h1}	$(p+\gamma-1)$	0	$p\gamma$
t_{h1}	0	p	$p\gamma$
w_{h0}	$-(p-\gamma)$	0	$(1-p)\gamma$
t_{h0}	0	$1-p$	$(1-p)\gamma$
w_l	$-(2\gamma-1)$	0	$(1-\gamma)$
	$-g$	$-\bar{t}$	0

TAB. $HAh0$

Where the first inner-column represents (AICAh), the second inner-column represents (SPCAh) and the external column at the extreme right represents the principal's objective function. (APCAh) is checked ex-post.

Following the pivot rule for the simplex method we interchange, in sequence, w_{h1} and k_1 and t_{h1} and k_2 in tableau $HAh0$ and we obtain:

	w_{h1}	t_{h1}	
k_1	$\frac{1}{(p+\gamma-1)}$	0	$\frac{p\gamma}{p+\gamma-1}$
k_2	0	$\frac{1}{p}$	γ
w_{h0}	$\frac{(p-\gamma)}{p+\gamma-1}$	0	$\frac{\gamma(1-\gamma)(2p-1)}{p+\gamma-1}$
t_{h0}	0	$-\frac{1-p}{p}$	0
w_l	$\frac{(2\gamma-1)}{p+\gamma-1}$	0	$\frac{\gamma^2(2p-1)+(2\gamma-1)(1-p)}{p+\gamma-1}$
	$\frac{g}{p+\gamma-1}$	$\frac{\bar{t}}{p}$	$\frac{p\gamma g}{p+\gamma-1} + \gamma\bar{t}$

TAB. $HAh1$

All entries of the last row and last column are positive. It can be easily shown that (APCAh) is satisfied. The following remark holds:

Remark 1. *When the supervisor is honest and auditing occurs only when the profit is high, the principal sets $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$, all the other payments to zero. (AICAh), (CICAh) are binding, (SPCAh) binds if and only if $\bar{t} = \bar{t}^*$, (APCAh) is slack.*

□

[34]For further details on this method, see Glicksman (2001). Thomas S. Ferguson provides useful notes on his website.

Proof of Lemma 2

Suppose that the principal offers the supervisor an auditing contract only when $\pi = l$. The agent's incentive compatibility constraint is rewritten as:

$$(2\gamma - 1)w_h - (p + \gamma - 1)(w_{l0}) + (p - \gamma)(w_{l1}) - g \geq 0 \tag{AICAl}$$

while the agent's participation constraint can be written as:

$$\gamma w_h + (1-\gamma)[p w_{l1} + (1-p) w_{l0}] - g \geq 0 \tag{APCAl}$$

The following program has to be solved:

$$\min_{t_{l0}, t_{l1}, w_{l0}, w_{l1}, w_h} \gamma w_h + (1-\gamma)[p(w_{l1} + t_{l1}) + (1-p)(w_{l0} + t_{l0})]$$

subject to (AICAl), (SPCAl) and all the non-negativity constraints. This problem is represented in the following tableau:

	l_1	l_2	
w_h	$(2\gamma - 1)$	0	γ
w_{l1}	$p - \gamma$	0	$p(1-\gamma)$
t_{l1}	0	p	$p(1-\gamma)$
w_{l0}	$-(p + \gamma - 1)$	0	$(1-p)(1-\gamma)$
t_{l0}	0	$1-p$	$(1-p)(1-\gamma)$
	$-g$	$-\bar{t}$	0

TAB. $HAl0$

Where the first inner-column represents (AICA), the second inner-column (SPCAl) and the external column at the extreme right represents the objective function.

First notice that interchanging w_h and l_1 in tabular $HAl0$, we obtain:

	w_h	l_2	
k_1	$\frac{1}{(2\gamma-1)}$	0	$\frac{\gamma}{2\gamma-1}$
w_{l1}	$-\frac{p-\gamma}{2\gamma-1}$	0	$\frac{p(2\gamma-1)(1-\gamma)-\gamma(p-\gamma)}{2\gamma-1}$
t_{l1}	0	p	$p(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{2\gamma-1}$	0	$\frac{\gamma(p+\gamma-1)}{2\gamma-1} + (1-p)(1-\gamma)$
t_{l0}	0	$1-p$	$(1-p)(1-\gamma)$
	$\frac{g}{2\gamma-1}$	$-\bar{t}$	$\frac{\gamma g}{2\gamma-1}$

TAB. $HAl2$

If $p \leq \frac{\gamma^2}{\gamma^2 + (1-\gamma)^2} = p'$, then the only negative entry in the last column and last row is $-\bar{t}$. But the principal knows that it cannot improve upon the incentives provided to the agent and it prefers to dispense with the supervisor and set the two-tier hierarchy.

Remark 2. *If the signal s is not informative enough compared to the profit, the principal never finds it profitable to set up contract Al.*

In the rest of the proof we assume that $p > p'$.

Interchanging firstly l_1 and w_{l1} and secondly l_2 and t_{l1} in tabular $HAl0$ we obtain:

	w_{l1}	t_{l1}	
w_h	$-\frac{(2\gamma-1)}{p-\gamma}$	0	$\gamma - \frac{(2\gamma-1)p(1-\gamma)}{p-\gamma}$
l_1	$\frac{1}{p-\gamma}$	0	$\frac{p(1-\gamma)}{p-\gamma}$
l_2	0	$\frac{1}{p}$	$(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{p-\gamma}$	0	$\frac{(1-\gamma)(2p-1)p}{p-\gamma}$
t_{l0}	0	$-\frac{1-p}{p}$	0
	$\frac{g}{p-\gamma}$	$\frac{\bar{t}}{p}$	$\frac{(1-\gamma)p}{p-\gamma} g + (1-\gamma)\bar{t}$

TAB. $HAl1$

This tabular represents the solution to our problem.

Remark 3. *When the supervisor is honest and auditing occurs only when the profit is low, the principal sets $w_{l1} = \frac{g}{p-\gamma}$, all the other payments to the agent to zero. (AICAl) and (SPCAl) bind and for this reason the principal must pay the supervisor, for instance setting $t_{l1} = \frac{\bar{t}}{p}$. (APCAl) is slack.*

□

Proof of Lemma 3

If the principal offers the supervisor a monitoring contract it solves:

$$\min_{w_{\pi r}, t_{\pi r}, \pi \in \{h,l\}, r \in \{0,1\}} \gamma[p(w_{h1} + t_{h1}) + (1-p)(w_{h0} + t_{h0})] + (1-\gamma)[p(w_{l1} + t_{l1}) + (1-p)(w_{l0} + t_{l0})]$$

subject to (AICM), (SPCM), all the non-negativity constraints and the following *Agent's Participation Constraint*:

$$\gamma(pw_{h1} + (1-p)w_{h0}) + (1-\gamma)(pw_{l1} + (1-p)w_{l0}) - g \geq 0 \tag{APCM}$$

This program is represented in the following tableau:

	s_1	s_2	
w_{h1}	$(p+\gamma-1)$	0	$p\gamma$
t_{h1}	0	$p\gamma$	$p\gamma$
w_{h0}	$-(p-\gamma)$	0	$(1-p)\gamma$
t_{h0}	0	$\gamma(1-p)$	$(1-p)\gamma$
w_{l1}	$p-\gamma$	0	$p(1-\gamma)$
t_{l1}	0	$(1-\gamma)p$	$p(1-\gamma)$
w_{l0}	$-(p+\gamma-1)$	0	$(1-p)(1-\gamma)$
t_{l0}	0	$(1-\gamma)(1-p)$	$(1-p)(1-\gamma)$
	$-g$	$-\bar{t}$	0

TAB. $HM0$

where the first inner-column represents (AICM), the second inner-column represents (SPCM) and the external column at the extreme right represents the principal's objective function. (APCM) is checked ex-post.

Following the pivot rule for the simplex method we interchange, in sequence, w_{h1} and s_1 and t_{h1} and s_2 in tableau $HM0$ and we obtain:

	w_{h1}	t_{h1}	
s_1	$\frac{1}{(p+\gamma-1)}$	0	$\frac{p\gamma}{(p+\gamma-1)}$
s_2	0	$\frac{1}{p-\gamma}$	1
w_{h0}	$\frac{(p-\gamma)}{(p+\gamma-1)}$	0	$\frac{(1-\gamma)\gamma(2p-1)}{p+\gamma-1}$
t_{h0}	0	$-\frac{(1-p)}{p}$	0
w_{l1}	$-\frac{p-\gamma}{(p+\gamma-1)}$	0	$\frac{p(1-p)(2\gamma-1)}{(p+\gamma-1)}$
t_{l1}	0	$-\frac{(1-\gamma)}{\gamma}$	0
w_{l0}	1	0	$1-p-\gamma+2\gamma p$
t_{l0}	0	$-\frac{(1-\gamma)(1-p)}{\gamma p}$	0
	$\frac{g}{(p+\gamma-1)}$	$\frac{\bar{t}}{p\gamma}$	$\frac{p\gamma g}{(p+\gamma-1)} + \bar{t}$

TAB. $HM1$

All the entries of the last row and last column are positive. (APCM) is trivially satisfied by this solution. Hence, the following remark holds:

Remark 4. *When the supervisor is honest, the optimal contract under monitoring entails $w_{h1} = \frac{g}{p+\gamma-1}$, while all the other payments to the agent are equal to zero. The supervisor must receive a positive salary. For instance, $t_{h1} = \frac{\bar{t}}{p\gamma}$, while all the other transfer are equal to zero. At the optimum, (AICM) and (SPCM) bind, (APCM) is slack.*

□

Proof of Proposition 1

First, notice that $E(T^{hah}) < E(T^{hm})$ since the agent is provided with the same incentives to exert effort while the supervisor's salary is paid in a more unlikely state of the world. This proves point 1.

Second, comparing $E(T^{hah})$ and $E(T^{2th})$, we find that the principal prefers to hire the supervisor as an auditor when the profit is high rather than dispense with inspecting the agent if and only if:

$$\bar{t} \leq \frac{(2p-1)(1-\gamma)}{(2\gamma-1)(\gamma+p-1)}g$$

The principal's preferred organizational structure could entail inspecting the agent's behavior when the profit is low. This requires that three conditions are simultaneously satisfied. First, the accuracy of the signal must be high enough, for otherwise the principal would not find it profitable to set $w_{l1} > 0$:

$$p \geq \frac{\gamma^2}{(1-\gamma)^2+\gamma^2} = p'$$

Provided that the above inequality is satisfied, it must be that the principal prefers to audit the agent when the profit is low rather than when the profit is high. That is, comparing $E(T^{hah})$ and $E(T^{hal})$, it must be that:

$$\bar{t} \geq \frac{(1-p)p}{(p-\gamma)(\gamma+p-1)}g$$

Relative to auditing when the profit is high, auditing when the profit is low reduces the cost of supervision at the expense of deteriorating the agent's incentives. Therefore, for it to be profitable it must be that the supervisor's reservation wage is sufficiently high. However, if $\bar{t}$ is too high, the principal prefers not to inspect the agent. Thus, the third condition requires that:

$$\bar{t} \leq \left[\frac{p(1-\gamma)}{(2\gamma-1)(p-\gamma)} - \frac{\gamma^2(1-p)}{(2\gamma-1)(p-\gamma)(1-\gamma)}\right]g$$

which is obtained by comparing $E(T^{hal})$ and $E(T^{2th})$.

□

Proof of Lemma 4

The principal offers the supervisor an auditing contract only when $\pi = h$.The principal solves the following program:

$$\min_{w_{h1},t_{h1},w_{h0},t_{h0},w_h} \gamma(p(w_{h1}+t_{h1})+(1-p)(w_{h0}+t_{h0}))+(1-\gamma)w_l$$

subject to (AICAh), (CICAh), (SPCAh) and all the non-negativity constraints. This problem is represented in the following tableau:

	k_1	k_2	k_3	
w_{h1}	$(p+\gamma-1)$	-1	0	$p\gamma$
t_{h1}	0	-1	p	$p\gamma$
w_{h0}	$-(p-\gamma)$	1	0	$(1-p)\gamma$
t_{h0}	0	1	$1-p$	$(1-p)\gamma$
w_l	$-(2\gamma-1)$	0	0	$(1-\gamma)$
	$-g$	0	$-\bar{t}$	0

TAB. $CAh0$

Where the first inner-column represents (AICAh), the second inner-column represents (CICAh), the third inner-column represents (SPCAh) and the external column at the extreme right represents the principal's objective function. (APCAh) is checked ex-post.

• $\bar{t} \leq \bar{t}^*$

Following the pivot rule for the simplex method we interchange, in sequence, w_{h1} and k_1 and t_{h0} and k_2 in tableau $CAh0$ and we obtain:

	w_{h1}	t_{h0}	k_3	
k_1	$\frac{1}{(p+\gamma-1)}$	$\frac{1}{p+\gamma-1}$	$\frac{1-p}{p+\gamma-1}$	$\frac{\gamma}{p+\gamma-1}$
t_{h1}	0	1	1	γ
w_{h0}	$\frac{(p-\gamma)}{p+\gamma-1}$	$-\frac{(2\gamma-1)}{p+\gamma-1}$	$-\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(p-\gamma)}{p+\gamma-1}$
k_2	0	1	$1-p$	$(1-p)\gamma$
w_{l1}	$\frac{(2\gamma-1)}{p+\gamma-1}$	$-\frac{(2\gamma-1)}{p+\gamma-1}$	$-\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2\gamma-1)+(p+\gamma-1)(1-\gamma)}{p+\gamma-1}$
	$\frac{g}{p+\gamma-1}$	$\frac{g}{p+\gamma-1}$	$\frac{(1-p)g}{p+\gamma-1}-\bar{t}$	$\frac{\gamma g}{p+\gamma-1}$

TAB. $CAh1$

All entries of the last row and last column are positive whenever $\bar{t} \leq \frac{(1-p)g}{p+\gamma-1} = \bar{t}^*$. It can be easily shown that (APCAh) is satisfied. The following remark holds:

Remark 5. *If $t \leq \bar{t}^*$, the optimal collusion-proof contract under Ah entails $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$, all the other payments to zero. (AICAh), (CICAh) are binding, (SPCAh) binds if and only if $\bar{t} = \bar{t}^*$, (APCAh) is slack.*

- $\bar{t} > \bar{t}^*$

Interchanging t_{h1} and k_3 in tableau $CAh1$ we achieve:

	w_{h1}	t_{h0}	t_{h1}	
k_1	$\frac{1}{(p+\gamma-1)}$	$\frac{1}{p+\gamma-1}$	$-\frac{1-p}{p+\gamma-1}$	$\frac{p\gamma}{p+\gamma-1}$
k_3	0	1	1	γ
w_{h0}	$\frac{(p-\gamma)}{p+\gamma-1}$	$-\frac{p(2\gamma-1)}{p+\gamma-1}$	$\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2p-1)(1-\gamma)}{p+\gamma-1}$
k_2	0	p	$-(1-p)$	0
w_l	$\frac{(2\gamma-1)}{p+\gamma-1}$	$-\frac{p(2\gamma-1)}{p+\gamma-1}$	$\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2\gamma-1)(2-p)+(p+\gamma-1)(1-\gamma)}{p+\gamma-1}$
	$\frac{g}{p+\gamma-1}$	$\frac{pg}{p+\gamma-1}+\bar{t}$	$-\frac{(1-p)g}{p+\gamma-1}+\bar{t}$	$\frac{p\gamma g}{p+\gamma-1}+\gamma\bar{t}$

TAB. $CAh2$

Since (APCAh) is satisfied, tableau $CAh2$ represents the solution to the principal's problem if and only if $\bar{t} > \bar{t}^*$.

Remark 6. *If $\bar{t} > \bar{t}^*$, the optimal collusion-proof contract under Ah entails $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h1} = -\frac{(1-p)g}{p+\gamma-1} + \bar{t}$, $t_{h0} = \frac{pg}{p+\gamma-1} + \bar{t}$, all the other payments to zero. (AICAh), (CICAh) and (SPCAh) are binding, (APCAh) is slack.*

□

Proof of Lemma 5

The principal offers the supervisor an auditing contract only when $\pi = l$. The following program has to be solved:

$$\min_{t_{l0},t_{l1},w_{l0},w_{l1},w_h} \gamma w_h + (1-\gamma)[p(w_{l1}+t_{l1}) + (1-p)(w_{l0}+t_{l0})]$$

subject to (AICAl), (CICA), (SPCAl) and all the non-negativity constraints. This problem is represented in the following tableau:

	l_1	l_2	l_3	
w_h	$(2\gamma-1)$	0	0	γ
w_{l1}	$p-\gamma$	-1	0	$p(1-\gamma)$
t_{l1}	0	-1	p	$p(1-\gamma)$
w_{l0}	$-(p+\gamma-1)$	1	0	$(1-p)(1-\gamma)$
t_{l0}	0	1	$1-p$	$(1-p)(1-\gamma)$
	$-g$	0	$-\bar{t}$	0

TAB. $CAl0$

Where the first inner-column represents (AICA), the second inner-column (CICAl), the third inner-column represents (SPCAl) and the external column at the extreme right represents the objective function.

First notice that interchanging w_h and k_1 in tabular $CAl0$, we obtain:

	w_h	k_2	k_3	
k_1	$\frac{1}{(2\gamma-1)}$	0	0	$\frac{\gamma}{2\gamma-1}$
w_{l1}	$-\frac{p-\gamma}{2\gamma-1}$	-1	0	$\frac{p(2\gamma-1)(1-\gamma)-\gamma(p-\gamma)}{2\gamma-1}$
t_{l1}	0	-1	p	$p(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{2\gamma-1}$	1	0	$\frac{\gamma(p+\gamma-1)}{2\gamma-1}+(1-p)(1-\gamma)$
t_{l0}	0	1	$1-p$	$(1-p)(1-\gamma)$
	$\frac{g}{2\gamma-1}$	0	$-\bar{t}$	$\frac{\gamma g}{2\gamma-1}$

TAB. $CAl3$

If $p \leq \frac{\gamma^2}{\gamma^2+(1-\gamma)^2} = p'$, then the only negative entry in the last column and last row is $-\bar{t}$. But the principal knows that it cannot improve upon the incentives provided to the agent and it prefers to dispense with the supervisor and set the two-tier hierarchy.

Remark 7. *If the signal s is not informative enough compared to the profit, the principal never finds it profitable to set up contract Al.*

In the rest of the proof we assume that $p > p'$.

• $\bar{t} \leq \bar{t}'$

Interchanging firstly l_1 and w_{l1} and secondly l_2 and t_{l0} in tabular $CAl0$ we obtain:

	w_{l1}	t_{l0}	l_3	
w_h	$-\frac{(2\gamma-1)}{p-\gamma}$	$-\frac{(2\gamma-1)}{p-\gamma}$	$-\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$\gamma-\frac{(2\gamma-1)(1-\gamma)}{p-\gamma}$
l_1	$\frac{1}{p-\gamma}$	$\frac{1}{p-\gamma}$	$\frac{1-p}{p-\gamma}$	$\frac{(1-\gamma)}{p-\gamma}$
t_{l1}	0	1	1	$(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{p-\gamma}$	$\frac{(2\gamma-1)}{p-\gamma}$	$\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$(1-\gamma)\left[\frac{(2p-1)p+(1-p)(2\gamma-1)}{p-\gamma}\right]$
l_2	0	1	$1-p$	$(1-p)(1-\gamma)$
	$\frac{g}{p-\gamma}$	$\frac{g}{p-\gamma}$	$\frac{(1-p)g}{p-\gamma}-\bar{t}$	$\frac{(1-\gamma)g}{p-\gamma}$

TAB. $CAl1$

This tabular represents the solution of our problem if $\bar{t} \leq \frac{(1-p)g}{p-\gamma}$.

Remark 8. *If $t \leq \bar{t}'$, the optimal collusion-proof contract under Al entails $w_{l1} = t_{l0} = \frac{g}{p-\gamma}$, all the other payments to zero. (AICAl), (CICAl) are binding, (SPCAl) binds if and only if $\bar{t} = \bar{t}^*$, (APCAl) is slack.*

• $\bar{t} > \bar{t}'$

Interchanging t_{l1} and l_3 in tableau $CAl1$ we achieve:

	w_{l1}	t_{l0}	t_{l1}	
w_h	$-\frac{(2\gamma-1)}{p-\gamma}$	$-\frac{p(2\gamma-1)}{p-\gamma}$	$\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$\gamma-\frac{(2\gamma-1)p(1-\gamma)}{p-\gamma}$
l_1	$\frac{1}{p-\gamma}$	$\frac{p}{p-\gamma}$	$-\frac{1-p}{p-\gamma}$	$\frac{p(1-\gamma)}{p-\gamma}$
l_3	0	1	1	$(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{p-\gamma}$	$\frac{p(2\gamma-1)}{p-\gamma}$	$-\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$(1-\gamma)\frac{(2p-1)p}{p-\gamma}$
l_2	0	p	$-(1-p)$	0
	$\frac{g}{p-\gamma}$	$\frac{pg}{p-\gamma}+\bar{t}$	$-\frac{(1-p)g}{p-\gamma}+\bar{t}$	$\frac{p(1-\gamma)g}{p-\gamma}+(1-\gamma)\bar{t}$

TAB. $CAl2$

Since (APCAl) is satisfied, tableau $CAl2$ represents the solution of our problem if $\bar{t} > \frac{(1-p)g}{p-\gamma}$.

Remark 9. *If $\bar{t} > \bar{t}'$, the optimal collusion-proof contract under Al entails $w_{l1} = \frac{g}{p-\gamma}$, $t_{l1} = -\frac{(1-p)g}{p-\gamma} + \bar{t}$, $t_{h0} = \frac{pg}{p-\gamma} + \bar{t}$, all the other payments to zero. (AICAl), (CICAl) and (SPCAl) are binding, (APCAl) is slack.*

□

Proof of Lemma 6

The principal offers the supervisor a monitoring contract. Under the monitoring contract, the principal solves:

$$\min_{w_{\pi r}, t_{\pi r}, \pi \in \{h,l\}, r \in \{0,1\}} \gamma[p(w_{h1} + t_{h1}) + (1-p)(w_{h0} + t_{h0})] + (1-\gamma)[p(w_{l1} + t_{l1}) + (1-p)(w_{l0} + t_{l0})]$$

subject to (AICM), (APCM), (SPCM), (CIC1M), (CIC2M) and all the non-negativity constraints

This program is represented in the following tableau:

	s_1	s_2	s_3	
w_{h1}	$(p+\gamma-1)$	$-\gamma$	0	$p\gamma$
t_{h1}	0	$-\gamma$	$p\gamma$	$p\gamma$
w_{h0}	$-(p-\gamma)$	γ	0	$(1-p)\gamma$
t_{h0}	0	γ	$\gamma(1-p)$	$(1-p)\gamma$
w_{l1}	$p-\gamma$	$-(1-\gamma)$	0	$p(1-\gamma)$
t_{l1}	0	$-(1-\gamma)$	$(1-\gamma)p$	$p(1-\gamma)$
w_{l0}	$-(p+\gamma-1)$	$(1-\gamma)$	0	$(1-p)(1-\gamma)$
t_{l0}	0	$(1-\gamma)$	$(1-\gamma)(1-p)$	$(1-p)(1-\gamma)$
	$-g$	0	$-\bar{t}$	0

TAB. $CM0$

where the first inner-column represents (AICM), the second inner-column represents (CIC1M), the third inner-column represents (SPCM) and the external column at the extreme right represents the principal's objective function. (APCM), (CIC2M) are checked ex-post.

• $\bar{t} \leq \bar{t}^{**}$

Following the pivot rule for the simplex method we interchange, in sequence, w_{h1} and s_1 and t_{h0} and s_2 in tableau $CM0$ and we obtain:

	w_{h1}	t_{h0}	s_3	
s_1	$\frac{1}{(p+\gamma-1)}$	$\frac{1}{(p+\gamma-1)}$	$\frac{(1-p)\gamma}{p+\gamma-1}$	$\frac{\gamma}{(p+\gamma-1)}$
t_{h1}	0	1	γ	γ
w_{h0}	$\frac{(p-\gamma)}{(p+\gamma-1)}$	$-\frac{(2\gamma-1)}{(p+\gamma-1)}$	$-\frac{(1-p)\gamma(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(p-\gamma)}{p+\gamma-1}$
s_2	0	$\frac{1}{\gamma}$	$(1-p)$	$(1-p)$
w_{l1}	$-\frac{p-\gamma}{(p+\gamma-1)}$	$\frac{(2\gamma-1)(1-p)}{\gamma(p+\gamma-1)}$	$\frac{(1-p)^2(2\gamma-1)}{p+\gamma-1}$	$\frac{(1-p)(2\gamma-1)}{(p+\gamma-1)}$
t_{l1}	0	$\frac{(1-\gamma)}{\gamma}$	$(1-\gamma)$	$(1-\gamma)$
w_{l0}	1	$\frac{(2\gamma-1)}{\gamma}$	$(1-p)(2\gamma-1)$	γ
t_{l0}	0	$-\frac{(1-\gamma)}{\gamma}$	0	0
	$\frac{g}{(p+\gamma-1)}$	$\frac{g}{(p+\gamma-1)}$	$\frac{(1-p)\gamma g}{p+\gamma-1} - \bar{t}$	$\frac{\gamma g}{(p+\gamma-1)}$

TAB. $CM1$

All the entries of the last row and last column are positive whenever $\bar{t} \leq \frac{(1-p)\gamma g}{p+\gamma-1} = \bar{t}^{**}$. (APCM) and (CIC2M) are trivially satisfied by this solution. Hence, the following remark holds:

Remark 10. *Whenever $\bar{t} \leq \bar{t}^{**}$ the optimal collusion-proof contract under monitoring entails $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$, while all the other payments are equal to zero. At the optimum, (AICM), (CIC1M) and (CIC2M) are binding, (SPCM) binds if and only if $\bar{t} = \bar{t}^{**}$, (APCM) is slack.*

Whenever the supervisor's reservation wage is not too high, truthful reporting is achieved by paying the supervisor a reward in state $\{h, 0\}$. This reward equals what the agent receives in state $\{h, 1\}$, so as to prevent collusion.

• $\bar{t} > \bar{t}^{**}$

If $\bar{t} > \bar{t}^{**}$ tableau $CM1$ no longer represents a solution of the principal's problem. In particular, $CM1$ is not a solution as (SPCM) is not satisfied. Interchanging s_3 and t_{h1} in tableau $CM1$ we achieve:

	w_{h1}	t_{h1}	t_{h0}	
s_1	$\frac{1}{(p+\gamma-1)}$	$-\frac{(1-p)}{(p+\gamma-1)}$	$\frac{p}{p+\gamma-1}$	$\frac{p}{p+\gamma-1}$
s_3	0	$\frac{1-p}{\gamma}$	$-\frac{p}{\gamma}$	$-\frac{p(1-\gamma)}{\gamma}$
w_{h0}	$\frac{p-\gamma}{(p+\gamma-1)}$	$\frac{(2\gamma-1)(1-p)}{(p+\gamma-1)}$	$-\frac{p(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2p-1)(1-\gamma)}{(p+\gamma-1)}$
s_2	0	$\frac{1}{\gamma}$	$\frac{1}{\gamma}$	1
w_{l1}	$-\frac{p-\gamma}{(p+\gamma-1)}$	$-\frac{(2\gamma-1)(1-p)^2}{(p+\gamma-1)\gamma}$	$\frac{(2\gamma-1)(1-p)p}{(p+\gamma-1)\gamma}$	$\frac{(2\gamma-1)(1-p)p}{(p+\gamma-1)}$
t_{l1}	0	$-\frac{(1-\gamma)}{\gamma}$	0	0
w_{l0}	1	$-\frac{(1-p)(2\gamma-1)}{\gamma}$	$\frac{p(2\gamma-1)}{\gamma}$	$(1-\gamma)+p(2\gamma-1)$
t_{l0}	0	0	$-\frac{(1-\gamma)}{\gamma}$	0
	$\frac{g}{(p+\gamma-1)}$	$\frac{\bar{t}}{\gamma}-\frac{(1-p)g}{p+\gamma-1}$	$\frac{\bar{t}}{\gamma}+\frac{pg}{p+\gamma-1}$	$\frac{p\gamma g}{p+\gamma-1}+\bar{t}$

TAB. $CM2$

Since (APCM) and (CIC2M) are satisfied, tableau $CM2$ represents the solution of the principal's problem if $\bar{t} \geq \bar{t}^{**}$. The following remark holds:

Remark 11. *Whenever $\bar{t} \geq \bar{t}^{**}$ the optimal collusion-proof contract under monitoring entails $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h0} = \frac{\bar{t}}{\gamma} + \frac{pg}{p+\gamma-1}$, $t_{h1} = \frac{\bar{t}}{\gamma} - \frac{(1-p)g}{p+\gamma-1}$ while all the other payments are equal to zero. At the optimum, (AICM), (CIC1M), (CIC2M) and (SPCM) are binding, (APCM) is slack.*

Whenever the supervisor's reservation wage is high, the principal induces the supervisor participation by setting $t_{h0}, t_{h1} > 0$, $p\gamma t_{h1} + (1-p)\gamma t_{h0} = \bar{t}$ and simultaneously address collusion setting $t_{h0} = w_{h1} + t_{h1}$.

□

Proof of Proposition 2

First, let us compare $E(T^{cah})$ and $E(T^{cm})$. Note that $\bar{t}^{**} = \frac{(1-p)\gamma}{p+\gamma-1}g > \frac{(1-p)}{p+\gamma-1}g = \bar{t}^{*}$ and the contracts provide the same incentives to the agent.

If $\bar{t} \leq \bar{t}^{**}$, the expected total transfer is the same under monitoring and auditing when the profit is high. In both cases, the supervisor's participation constraint does not bind.

If $\bar{t} \in (\bar{t}^{**}, \bar{t}^{*}]$, the expected total transfer is higher under monitoring than auditing when the profit is high. Only if the supervisor is assigned a monitoring task her participation constraint binds and this increases the cost of the organization.

If $\bar{t} > \bar{t}^{*}$, the expected total transfer is higher under monitoring than auditing when the profit is high. Even though the supervisor's participation constraint binds in both cases, in expectation supervision is less costly under auditing since the supervisor is hired with probability $\gamma < 1$.

Second, comparing $E(T^{cah})$ and $E(T^{2th})$, we find that the principal prefers to hire the supervisor as an auditor when the profit is high rather than dispense with inspecting the agent if and only if:

$$\bar{t} \leq \frac{(2p-1)(1-\gamma)}{(2\gamma-1)(\gamma+p-1)}g$$

The principal's preferred organizational structure could entail inspecting the agent's behavior when the profit is low. This requires that the same three conditions presented in the Proof of Proposition 1 be satisfied.

□

Proof of Lemma 7

Suppose that both forms of opportunism are present and the principal offers the supervisor an auditing contract only when $\pi = h$.

The principal solves the following program:

$$\min_{w_{h1}, t_{h1}, w_{h0}, t_{h0}, w_h} \gamma(p(w_{h1} + t_{h1}) + (1-p)(w_{h0} + t_{h0})) + (1-\gamma)w_l$$

subject to (AICAh), (CICAh), (SIC1A), (SIC2A), (SPCAh) and all the non-negativity constraints. This problem is represented in the following tableau:

	k_1	k_2	k_3	k_4	
w_{h1}	$(p+\gamma-1)$	0	-1	0	$p\gamma$
t_{h1}	0	1	-1	p	$p\gamma$
w_{h0}	$-(p-\gamma)$	0	1	0	$(1-p)\gamma$
t_{h0}	0	-1	1	$1-p$	$(1-p)\gamma$
w_l	$-(2\gamma-1)$	0	0	0	$(1-\gamma)$
	$-g$	c	0	$-\bar{t}$	0

TAB. $Ah0$

Where the first inner-column represents (AICAh), the second inner-column represents (SIC2A), the third inner-column represents (CICAh), the fourth inner-column represents (SPCAh) and the external column at the extreme right represents the principal's objective function. (APCAh) and (SIC1A) are checked ex-post.

• $c \geq c^*$ **and** $\bar{t} \leq \bar{t}^*$

Following the pivot rule for the simplex method we interchange, in sequence, w_{h1} and k_1 and t_{h0} and k_3 in tableau $Ah0$ and we obtain:

	w_{h1}	k_2	t_{h0}	k_4	
k_1	$\frac{1}{(p+\gamma-1)}$	$-\frac{1}{p+\gamma-1}$	$\frac{1}{p+\gamma-1}$	$\frac{1-p}{p+\gamma-1}$	$\frac{\gamma}{p+\gamma-1}$
t_{h1}	0	0	1	1	γ
w_{h0}	$\frac{(p-\gamma)}{p+\gamma-1}$	$\frac{2\gamma-1}{p+\gamma-1}$	$-\frac{(2\gamma-1)}{p+\gamma-1}$	$-\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(p-\gamma)}{p+\gamma-1}$
k_3	0	-1	1	$1-p$	$(1-p)\gamma$
w_{l1}	$\frac{(2\gamma-1)}{p+\gamma-1}$	$\frac{2\gamma-1}{p+\gamma-1}$	$-\frac{(2\gamma-1)}{p+\gamma-1}$	$-\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2\gamma-1)+(p+\gamma-1)(1-\gamma)}{p+\gamma-1}$
	$\frac{g}{p+\gamma-1}$	$c-\frac{g}{p+\gamma-1}$	$\frac{g}{p+\gamma-1}$	$\frac{(1-p)g}{p+\gamma-1}-\bar{t}$	$\frac{\gamma g}{p+\gamma-1}$

TAB. $Ah1$

All entries of the last row and last column are positive whenever $c \geq \frac{g}{p+\gamma-1} = c^*$ and $\bar{t} \leq \frac{(1-p)g}{p+\gamma-1} = \bar{t}^*$. It can be easily shown that (APCAh) and (SIC1A) are satisfied. The following remark holds:

Remark 12. *If $c \geq c^*$ and $t \leq \bar{t}^*$, the optimal corruption-proof contract under Ah entails $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$, all the other payments to zero. (AICAh), (CICAh) are binding, (SIC2A) binds if and only if $c = c^*$, (SPCAh) binds if and only if $\bar{t} = \bar{t}^*$, (APCAh) and (SIC1A) are slack.*

• $c \geq c^*$ **and** $\bar{t} > \bar{t}^*$

Interchanging t_{h1} and k_4 in tableau $Ah1$ we achieve:

	w_{h1}	k_2	t_{h0}	t_{h1}	
k_1	$\frac{1}{(p+\gamma-1)}$	$-\frac{1}{p+\gamma-1}$	$\frac{1}{p+\gamma-1}$	$-\frac{1-p}{p+\gamma-1}$	$\frac{p\gamma}{p+\gamma-1}$
k_4	0	0	1	1	γ
w_{h0}	$\frac{(p-\gamma)}{p+\gamma-1}$	$\frac{2\gamma-1}{p+\gamma-1}$	$-\frac{p(2\gamma-1)}{p+\gamma-1}$	$\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2p-1)(1-\gamma)}{p+\gamma-1}$
k_3	0	-1	p	$-(1-p)$	0
w_l	$\frac{(2\gamma-1)}{p+\gamma-1}$	$\frac{2\gamma-1}{p+\gamma-1}$	$-\frac{p(2\gamma-1)}{p+\gamma-1}$	$\frac{(1-p)(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2\gamma-1)(2-p)+(p+\gamma-1)(1-\gamma)}{p+\gamma-1}$
	$\frac{g}{p+\gamma-1}$	$c-\frac{g}{p+\gamma-1}$	$\frac{pg}{p+\gamma-1}+\bar{t}$	$-\frac{(1-p)g}{p+\gamma-1}+\bar{t}$	$\frac{p\gamma g}{p+\gamma-1}+\gamma\bar{t}$

TAB. $Ah2$

Since (APCAh) and (SIC1A) are satisfied, tableau $Ah2$ represents the solution to the principal's problem if and only if $c \geq c^*$ and $\bar{t} > \bar{t}^*$.

Remark 13. *If $c \geq c^*$ and $\bar{t} > \bar{t}^*$, the optimal corruption-proof contract under Ah entails $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h1} = -\frac{(1-p)g}{p+\gamma-1} + \bar{t}$, $t_{h0} = \frac{pg}{p+\gamma-1} + \bar{t}$, all the other payments to zero. (AICAh), (CICAh) and (SPCAh) are binding, (SIC2A) binds if and only if $c = c^*$, (APCAh) and (SIC1A) are slack.*

• $c < c^*$ **and** $\bar{t} \leq (1-p)c$

Interchanging w_{h0} and k_2 in tableau $Ah1$ we achieve:

	w_{h1}	w_{h0}	t_{h0}	k_4	
k_1	$\frac{1}{(2\gamma-1)}$	$\frac{1}{2\gamma-1}$	0	0	$\frac{\gamma}{2\gamma-1}$
t_{h1}	0	0	1	1	γ
k_2	$\frac{(p-\gamma)}{2\gamma-1}$	$\frac{p+\gamma-1}{2\gamma-1}$	-1	$-(1-p)$	$\frac{\gamma(p-\gamma)}{2\gamma-1}$
k_3	$\frac{p-\gamma}{p+\gamma-1}$	$\frac{p+\gamma-1}{2\gamma-1}$	0	0	$\frac{\gamma(2p-1)(1-\gamma)}{(p+\gamma-1)(2\gamma-1)}$
w_{l1}	$\frac{3\gamma-p-1}{2\gamma-1}$	-1	0	0	$\frac{\gamma(3\gamma-1-p)+(p+\gamma-1)(1-\gamma)}{p+\gamma-1}$
	$\frac{g}{2\gamma-1}-\frac{c(p-\gamma)}{2\gamma-1}$	$\frac{g}{2\gamma-1}-\frac{(p+\gamma-1)c}{2\gamma-1}$	c	$(1-p)c-\bar{t}$	$\frac{\gamma g}{2\gamma-1}-\frac{\gamma(p-\gamma)c}{2\gamma-1}$

TAB. $Ah3$

Since (APCAh) and (SIC1A) are satisfied, tableau $Ah3$ represents the solution of the principal's problem if $c < c^*$ and $\bar{t} \leq (1-p)c$.

Remark 14. *If $c < c^*$ and $t \leq (1-p)c$, the optimal corruption-proof contract under Ah entails $w_{h1} = \frac{g}{2\gamma-1} - \frac{c(p-\gamma)}{2\gamma-1}$, $w_{h0} = \frac{g}{2\gamma-1} - \frac{(p+\gamma-1)c}{2\gamma-1}$, $t_{h0} = c$, all the other payments to zero. At the optimum, (AICAh), (CICAh), (SICA2) bind, (SIC1A) binds if and only if $c = 0$, (SPCAh) binds if and only if $\bar{t} = c(1-p)$, (APCAh) is slack.*

- $c < c^*$ **and** $\bar{t} > (1-p)c$

Interchanging t_{h1} and k_4 into tableau $Ah3$ we achieve:

	w_{h1}	w_{h0}	t_{h0}	t_{h1}	
k_1	$\frac{1}{(2\gamma-1)}$	$\frac{1}{2\gamma-1}$	0	0	$\frac{\gamma}{2\gamma-1}$
k_4	0	0	1	1	γ
k_2	$\frac{(p-\gamma)}{2\gamma-1}$	$\frac{p+\gamma-1}{2\gamma-1}$	-1	$-p$	$\frac{\gamma(p-\gamma)}{2\gamma-1}$
k_3	$\frac{p-\gamma}{p+\gamma-1}$	$\frac{p+\gamma-1}{2\gamma-1}$	0	0	$\frac{\gamma(2p-1)(1-\gamma)}{(p+\gamma-1)(2\gamma-1)}$
w_{l1}	$\frac{3\gamma-p-1}{2\gamma-1}$	-1	0	0	$\frac{\gamma(3\gamma-1-p)+(p+\gamma-1)(1-\gamma)}{p+\gamma-1}$
	$\frac{g}{2\gamma-1}-\frac{c(p-\gamma)}{2\gamma-1}$	$\frac{g}{2\gamma-1}-\frac{(p+\gamma-1)c}{2\gamma-1}$	$\bar{t}+pc$	$-(1-p)c+\bar{t}$	$\frac{\gamma g}{2\gamma-1}+\gamma\bar{t}-\frac{\gamma(2p-1)(1-\gamma)c}{2\gamma-1}$

TAB. $Ah4$

Since (SIC1A) and (APCAh) are satisfied by tableau $Ah4$ if and only if $c \geq \frac{g}{p+\gamma-1} = c^*$ and $\bar{t} \leq \frac{(1-p)g}{p+\gamma-1} = \bar{t}^*$.

Remark 15. *If $c < c^*$ and $t > (1-p)c$, the optimal corruption-proof contract under Ah entails $w_{h1} = \frac{g}{2\gamma-1} - \frac{c(p-\gamma)}{2\gamma-1}$, $w_{h0} = \frac{g}{2\gamma-1} - \frac{(p+\gamma-1)c}{2\gamma-1}$, $t_{h1} = -(1-p)c+\bar{t}$, $t_{h0} = \bar{t}+pc$, all the other payments to zero. At the optimum, (AICAh), (CICAh), (SPCAh) and (SIC2A) bind, (SIC1A) bind if and only if $c = 0$, (APCAh) is slack.*

FIGURE 5 HERE

□

Proof of Lemma 8

Suppose that both forms of opportunism are present and the principal offers the supervisor an auditing contract only when $\pi = l$. The following program has to be solved:

$$\min_{t_{l0},t_{l1},w_{l0},w_{l1},w_h} \gamma w_h + (1-\gamma)[p(w_{l1}+t_{l1}) + (1-p)(w_{l0}+t_{l0})]$$

subject to (AICAl), (CICA), (SIC3A), (SIC4A), (SPCAl) and all the non-negativity constraints. This problem is represented in the following tableau:

	l_1	l_2	l_3	l_4	
w_h	$(2\gamma-1)$	0	0	0	γ
w_{l1}	$p-\gamma$	0	-1	0	$p(1-\gamma)$
t_{l1}	0	1	-1	p	$p(1-\gamma)$
w_{l0}	$-(p+\gamma-1)$	0	1	0	$(1-p)(1-\gamma)$
t_{l0}	0	-1	1	$1-p$	$(1-p)(1-\gamma)$
	$-g$	c	0	$-\bar{t}$	0

TAB. A_l0

Where the first inner-column represents (AICA), the second inner-column (SIC4A), the third inner-column represents (CICAl) and the fourth inner-column represents (SPCAl) and the first column on the right represents the objective function.

First notice that interchanging w_h and k_1 in tabular $Al0$, we obtain:

	w_h	k_2	k_3	k_4	
k_1	$\frac{1}{(2\gamma-1)}$	0	0	0	$\frac{\gamma}{2\gamma-1}$
w_{l1}	$-\frac{p-\gamma}{2\gamma-1}$	0	-1	0	$\frac{p(2\gamma-1)(1-\gamma)-\gamma(p-\gamma)}{2\gamma-1}$
t_{l1}	0	1	-1	p	$p(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{2\gamma-1}$	0	1	0	$\frac{\gamma(p+\gamma-1)}{2\gamma-1}+(1-p)(1-\gamma)$
t_{l0}	0	-1	1	$1-p$	$(1-p)(1-\gamma)$
	$\frac{g}{2\gamma-1}$	c	0	$-\bar{t}$	$\frac{\gamma g}{2\gamma-1}$

TAB. $Al5$

If $p \leq \frac{\gamma^2}{\gamma^2+(1-\gamma)^2} = p'$, then the only negative entry in the last column and last row is $-\bar{t}$. But the principal knows that it cannot improve upon the incentives provided to the agent and it prefers to dispense with the supervisor and set the two-tier hierarchy.

Remark 16. *If the signal s is not informative enough compared to the profit, the principal never finds it profitable to set up contract Al.*

In the rest of the proof we assume that $p > p'$.

- $c \geq c'$ **and** $\bar{t} \leq \bar{t}'$

Interchanging firstly l_1 and w_{l1} and secondly l_3 and t_{l0} in tabular A_l we obtain:

	w_{l1}	l_2	t_{l0}	l_4	
w_h	$-\frac{(2\gamma-1)}{p-\gamma}$	$\frac{2\gamma-1}{p-\gamma}$	$-\frac{(2\gamma-1)}{p-\gamma}$	$-\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$\gamma-\frac{(2\gamma-1)(1-\gamma)}{p-\gamma}$
l_1	$\frac{1}{p-\gamma}$	$-\frac{1}{p-\gamma}$	$\frac{1}{p-\gamma}$	$\frac{1-p}{p-\gamma}$	$\frac{(1-\gamma)}{p-\gamma}$
t_{l1}	0	0	1	1	$(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{p-\gamma}$	$-\frac{(2\gamma-1)}{p-\gamma}$	$\frac{(2\gamma-1)}{p-\gamma}$	$\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$(1-\gamma)\left[\frac{(2p-1)p+(1-p)(2\gamma-1)}{p-\gamma}\right]$
l_3	0	-1	1	$1-p$	$(1-p)(1-\gamma)$
	$\frac{g}{p-\gamma}$	$c-\frac{g}{p-\gamma}$	$\frac{g}{p-\gamma}$	$\frac{(1-p)g}{p-\gamma}-\bar{t}$	$\frac{(1-\gamma)g}{p-\gamma}$

TAB. $Al1$

This tabular represents the solution of our problem if $\bar{t} \leq \frac{(1-p)g}{p-\gamma}$ and $c \geq \frac{g}{p-\gamma}$.

Remark 17. *If $c \geq c'$ and $t \leq \bar{t}'$, the optimal corruption-proof contract under Al entails $w_{l1} = t_{l0} = \frac{g}{p-\gamma}$, all the other payments to zero. (AICAl), (CICAl) are binding, (SIC4A) binds if and only if $c = c'$, (SPCAl) binds if and only if $\bar{t} = \bar{t}^*$, (APCAl) and (SIC3A) are slack.*

- $c \geq c'$ **and** $\bar{t} > \bar{t}'$

Interchanging t_{l1} and l_4 in tableau $Al1$ we achieve:

	w_{l1}	l_2	t_{l0}	t_{l1}	
w_h	$-\frac{(2\gamma-1)}{p-\gamma}$	$\frac{2\gamma-1}{p-\gamma}$	$-\frac{p(2\gamma-1)}{p-\gamma}$	$\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$\gamma-\frac{(2\gamma-1)p(1-\gamma)}{p-\gamma}$
l_1	$\frac{1}{p-\gamma}$	$-\frac{1}{p-\gamma}$	$\frac{p}{p-\gamma}$	$-\frac{1-p}{p-\gamma}$	$\frac{p(1-\gamma)}{p-\gamma}$
l_4	0	0	1	1	$(1-\gamma)$
w_{l0}	$\frac{(p+\gamma-1)}{p-\gamma}$	$-\frac{(2\gamma-1)}{p-\gamma}$	$\frac{p(2\gamma-1)}{p-\gamma}$	$-\frac{(1-p)(2\gamma-1)}{p-\gamma}$	$(1-\gamma)\frac{(2p-1)p}{p-\gamma}$
l_3	0	-1	p	$-(1-p)$	0
	$\frac{g}{p-\gamma}$	$c-\frac{g}{p-\gamma}$	$\frac{pg}{p-\gamma}+\bar{t}$	$-\frac{(1-p)g}{p-\gamma}+\bar{t}$	$\frac{p(1-\gamma)g}{p-\gamma}+(1-\gamma)\bar{t}$

TAB. $Al2$

Since (APCAl) and (SIC3A) are satisfied, tableau $Ah2$ represents the solution of our problem if $\bar{t} > \frac{(1-p)g}{p-\gamma}$ and $c \geq \frac{g}{p-\gamma}$.

Remark 18. *If $c < c'$ and $\bar{t} > \bar{t}'$, the optimal corruption-proof contract under Al entails $w_{l1} = \frac{g}{p-\gamma}$, $t_{l1} = -\frac{(1-p)g}{p-\gamma} + \bar{t}$, $t_{h0} = \frac{pg}{p-\gamma} + \bar{t}$, all the other payments to zero. (AICAl), (CICAl) and (SPCAl) are binding, (SIC4A) binds if and only if $c = c^*$, (APCAl) and (SIC3A) are slack.*

- $c < c'$ **and** $\bar{t} > (1-p)c$

Interchanging first l_3 and w_{l1} and then l_2 and t_{l0} in tableau $Al5$ we achieve:

	w_h	t_{l0}	w_{l1}	l_4	
l_1	$-\frac{1}{2\gamma-1}$	0	0	0	$\frac{\gamma}{2\gamma-1}$
l_3	$\frac{p-\gamma}{2\gamma-1}$	0	-1	0	$\frac{\gamma(p-\gamma)}{2\gamma-1} - p(1-\gamma)$
t_{l1}	0	1	0	1	$(1-\gamma)$
w_{l0}	1	0	1	0	1
l_2	$\frac{p-\gamma}{2\gamma-1}$	-1	-1	$-(1-p)$	$\frac{\gamma(p-\gamma)}{2\gamma-1} - (1-\gamma)$
	$\frac{g-c(p-\gamma)}{2\gamma-1}$	c	c	$(1-p)c - \bar{t}$	$\frac{\gamma g}{2\gamma-1} + (1-\gamma)c - \frac{\gamma(p-\gamma)c}{2\gamma-1}$

TAB. $Al3$

Since (SIC3A) and (APCAl) are satisfied by tableau $Al3$ if and only if $c <= c'$ and $\bar{t} \leq (1-p)c$.

Remark 19. *If $c < c'$ and $t \leq (1-p)c$, the optimal corruption-proof contract under Al entails $w_{l1} = c$ $w_h = \frac{g}{2\gamma-1} - \frac{c(p-\gamma)}{2\gamma-1}$, $t_{l0} = c$, all the other payments to zero. At the optimum, (AICAl), (CICAl), (SIC4A) bind, (SPCAh) binds if and only if $\bar{t} = (1-p)c$, (SIC3A) bind if and only if $c = 0$, (APCAh) binds if and only if $p = 1$.*

- $c < c'$ **and** $\bar{t} > (1-p)c$

Interchanging t_{l1} and l_4 in tableau $Al3$ we have:

	w_h	t_{l0}	w_{l1}	t_{l1}	
l_1	$-\frac{1}{2\gamma-1}$	0	0	0	$\frac{\gamma}{2\gamma-1}$
l_3	$\frac{p-\gamma}{2\gamma-1}$	0	-1	0	$\frac{\gamma(p-\gamma)}{2\gamma-1} - p(1-\gamma)$
l_4	0	1	0	1	$(1-\gamma)$
w_{l0}	1	0	1	0	1
l_2	$\frac{p-\gamma}{2\gamma-1}$	$-p$	-1	$+(1-p)$	$\frac{\gamma(p-\gamma)}{2\gamma-1} - p(1-\gamma)$
	$\frac{g-c(p-\gamma)}{2\gamma-1}$	$\bar{t} + pc$	c	$-(1-p)c + \bar{t}$	$\frac{\gamma g}{2\gamma-1} + (1-\gamma)[pc + \bar{t}] - \frac{\gamma(p-\gamma)c}{2\gamma-1}$

TAB. $Al4$

Since (APCAl) and (SIC3A) are satisfied, tableau $Al4$ represents a solution if $\bar{t} > (1-p)c$ and $c < \frac{g}{p-\gamma}$.

Remark 20. *If $c < c'$ and $t > (1-p)c$, the optimal corruption-proof contract under Al entails $w_{l1} = c$, $w_h = \frac{g}{2\gamma-1} - \frac{(p-\gamma)c}{2\gamma-1}$, $t_{l0} = pc + \bar{t}$, $t_{l1} = -(1-p)c + \bar{t}$ all the other payments to zero. At the optimum, (AICAl), (CICAl), (SIC4A), (SPCAl) bind, (SIC3A) binds if and only if $c = 0$, (APCAh) binds if and only if $p = 1$.*

FIGURE 6 HERE

□

Proof of Lemma 9

Suppose that both forms of opportunism are present and the principal offers the supervisor a monitoring contract. The principal solves

$$\min_{w_{\pi r}, t_{\pi r}, \pi \in \{h,l\}, r \in \{0,1\}} \gamma[p(w_{h1} + t_{h1}) + (1-p)(w_{h0} + t_{h0})] + (1-\gamma)[p(w_{l1} + t_{l1}) + (1-p)(w_{l0} + t_{l0})]$$

subject to (AICM), (APCM), (SPCM), (CIC1M), (CIC2M), (SIC1M), (SIC2M), and all the non-negativity constraints.

This program is represented in the following tableau:

	s_1	s_2	s_3	s_4	
w_{h1}	$(p+\gamma-1)$	0	$-\gamma$	0	$p\gamma$
t_{h1}	0	γ	$-\gamma$	$p\gamma$	$p\gamma$
w_{h0}	$-(p-\gamma)$	0	γ	0	$(1-p)\gamma$
t_{h0}	0	$-\gamma$	γ	$\gamma(1-p)$	$(1-p)\gamma$
w_{l1}	$p-\gamma$	0	$-(1-\gamma)$	0	$p(1-\gamma)$
t_{l1}	0	$(1-\gamma)$	$-(1-\gamma)$	$(1-\gamma)p$	$p(1-\gamma)$
w_{l0}	$-(p+\gamma-1)$	0	$(1-\gamma)$	0	$(1-p)(1-\gamma)$
t_{l0}	0	$-(1-\gamma)$	$(1-\gamma)$	$(1-\gamma)(1-p)$	$(1-p)(1-\gamma)$
	$-g$	c	0	$-\bar{t}$	0

TAB. $M0$

where the first inner-column represents (AICM), the second inner-column represents (SIC2M), the third inner-column represents (CIC1M), the fourth inner-column represents (SPCM) and the external column at the extreme right represents the principal's objective function. (APCM), (CIC2M) and (SIC1M) are checked ex-post.

• $c \geq c^{**}$ **and** $\bar{t} \leq \bar{t}^{**}$

Following the pivot rule for the simplex method we interchange, in sequence, w_{h1} and s_1 and t_{h0} and s_3 in tableau $M0$ and we obtain:

	w_{h1}	s_2	t_{h0}	s_4	
s_1	$\frac{1}{(p+\gamma-1)}$	$-\frac{\gamma}{p+\gamma-1}$	$\frac{1}{(p+\gamma-1)}$	$\frac{(1-p)\gamma}{p+\gamma-1}$	$\frac{\gamma}{(p+\gamma-1)}$
t_{h1}	0	0	1	γ	γ
w_{h0}	$\frac{(p-\gamma)}{(p+\gamma-1)}$	$\frac{\gamma(2\gamma-1)}{p+\gamma-1}$	$-\frac{(2\gamma-1)}{(p+\gamma-1)}$	$-\frac{(1-p)\gamma(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(p-\gamma)}{p+\gamma-1}$
s_3	0	-1	$\frac{1}{\gamma}$	$(1-p)$	$(1-p)$
w_{l1}	$-\frac{p-\gamma}{(p+\gamma-1)}$	$-\frac{(2\gamma-1)(1-p)}{p+\gamma-1}$	$\frac{(2\gamma-1)(1-p)}{\gamma(p+\gamma-1)}$	$\frac{(1-p)^2(2\gamma-1)}{p+\gamma-1}$	$\frac{(1-p)(2\gamma-1)}{(p+\gamma-1)}$
t_{l1}	0	0	$\frac{(1-\gamma)}{\gamma}$	$(1-\gamma)$	$(1-\gamma)$
w_{l0}	1	$-(2\gamma-1)$	$\frac{(2\gamma-1)}{\gamma}$	$(1-p)(2\gamma-1)$	γ
t_{l0}	0	0	$-\frac{(1-\gamma)}{\gamma}$	0	0
	$\frac{g}{(p+\gamma-1)}$	$-\frac{\gamma g}{p+\gamma-1}+c$	$\frac{g}{(p+\gamma-1)}$	$\frac{(1-p)\gamma g}{p+\gamma-1}-\bar{t}$	$\frac{\gamma g}{(p+\gamma-1)}$

TAB. $M1$

All the entries of the last row and last column are positive whenever $c \geq \frac{\gamma g}{p+\gamma-1} = c^{**}$, $\bar{t} \leq \frac{(1-p)\gamma g}{p+\gamma-1} = \bar{t}^{**}$. (APCM), (SIC1M) and (CIC2M) are trivially satisfied by this solution. Hence, the following remark holds:

Remark 21. *Whenever $c \geq c^{**}$, $\bar{t} \leq \bar{t}^{**}$ the optimal corruption-proof contract under monitoring entails $w_{h1} = t_{h0} = \frac{g}{p+\gamma-1}$, while all the other payments are equal to zero. At the optimum, (AICM), (CIC1M) and (CIC2M) are binding, (SIC2M) binds if and only if $c = c^{**}$,(SPCM) binds if and only if $\bar{t} = \bar{t}^{**}$, (APCM) and (SIC1M) are slack.*

Whenever falsification is sufficiently costly and the supervisor's reservation wage is not too high, truthful reporting is achieved by paying the supervisor a reward in state $\{h, 0\}$. This reward equals what the agent receives in state $\{h, 1\}$, so as to prevent collusion. Extortion does not increase the cost of the organization as it is overly costly for the supervisor to falsify evidence on her own.

• $c \geq c^{**}$ **and** $\bar{t} > \bar{t}^{**}$

If $\bar{t} > \bar{t}^{**}$ or $c < c^{**}$, tableau $M1$ no longer represents a solution of the principal's problem. In particular, if the first inequality holds, $M1$ is not a solution as (SPCM) is not satisfied. Interchanging s_4 and t_{h1} in tableau $M1$ we achieve:

	w_{h1}	s_2	t_{h0}	t_{h1}	
s_1	$\frac{1}{(p+\gamma-1)}$	$-\frac{\gamma}{p+\gamma-1}$	$-\frac{(1-p)}{(p+\gamma-1)}$	$\frac{p}{p+\gamma-1}$	$\frac{p}{p+\gamma-1}$
s_4	0	1	$\frac{1-p}{\gamma}$	$-\frac{p}{\gamma}$	$-\frac{p(1-\gamma)}{\gamma}$
w_{h0}	$\frac{p-\gamma}{(p+\gamma-1)}$	$\frac{(2\gamma-1)\gamma}{p+\gamma-1}$	$\frac{(2\gamma-1)(1-p)}{(p+\gamma-1)}$	$-\frac{p(2\gamma-1)}{p+\gamma-1}$	$\frac{\gamma(2p-1)(1-\gamma)}{(p+\gamma-1)}$
s_3	0	0	$\frac{1}{\gamma}$	$\frac{1}{\gamma}$	1
w_{l1}	$-\frac{p-\gamma}{(p+\gamma-1)}$	$-\frac{(2\gamma-1)(1-p)}{p+\gamma-1}$	$-\frac{(2\gamma-1)(1-p)^2}{(p+\gamma-1)\gamma}$	$\frac{(2\gamma-1)(1-p)p}{(p+\gamma-1)\gamma}$	$\frac{(2\gamma-1)(1-p)p}{(p+\gamma-1)}$
t_{l1}	0	0	$-\frac{(1-\gamma)}{\gamma}$	0	0
w_{l0}	1	$-(2\gamma-1)$	$-\frac{(1-p)(2\gamma-1)}{\gamma}$	$\frac{p(2\gamma-1)}{\gamma}$	$(1-\gamma)+p(2\gamma-1)$
t_{l0}	0	0	0	$-\frac{(1-\gamma)}{\gamma}$	0
	$\frac{g}{(p+\gamma-1)}$	$-\frac{\gamma g}{p+\gamma-1}+c$	$\frac{\bar{t}}{\gamma}-\frac{(1-p)g}{p+\gamma-1}$	$\frac{\bar{t}}{\gamma}+\frac{pg}{p+\gamma-1}$	$\frac{p\gamma g}{p+\gamma-1}+\bar{t}$

TAB. $M2$

Since (APCM), (SIC1M) and (CIC2M) are satisfied, tableau $M2$ represents the solution of the principal's problem if $c \geq c^{**}$ and $\bar{t} \geq \bar{t}^{**}$. The following remark holds:

Remark 22. *Whenever $c \geq c^{**}$, $\bar{t} \geq \bar{t}^{**}$ the optimal corruption-proof contract under monitoring entails $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h0} = \frac{\bar{t}}{\gamma} + \frac{pg}{p+\gamma-1}$, $t_{h1} = \frac{\bar{t}}{\gamma} - \frac{(1-p)g}{p+\gamma-1}$ while all the other payments are equal to zero. At the optimum, (AICM), (CIC1M), (CIC2M) and (SPCM) are binding, (SIC2M) binds if and only if $c = c^{**}$, (APCM) and (SIC1M) are slack.*

Whenever both the falsification cost and the supervisor's reservation wage are high, the principal induces the supervisor participation by setting $t_{h0}, t_{h1} > 0$, $p\gamma t_{h1} + (1-p)\gamma t_{h0} = \bar{t}$ and simultaneously address collusion setting $t_{h0} = w_{h1} + t_{h1}$. Extortion does not increase the cost of the organization as it is overly costly for the supervisor to falsify evidence on her own.

• $c < c^{**}$ **and** $\bar{t} \leq (1-p)c$

If $c < c^{**}$, tableau $M1$ does not represent a solution as (SIC2M) is not satisfied. Interchanging w_{h0} and s_2 in tableau $M1$ we achieve:

	w_{h1}	w_{h0}	t_{h0}	s_4	
s_1	$\frac{1}{(2\gamma-1)}$	$\frac{1}{2\gamma-1}$	0	0	$\frac{\gamma}{(2\gamma-1)}$
t_{h1}	0	0	1	γ	γ
s_2	$\frac{p-\gamma}{(2\gamma-1)\gamma}$	$\frac{p+\gamma-1}{(2\gamma-1)\gamma}$	$-\frac{1}{\gamma}$	$-(1-p)$	$\frac{\gamma(p-\gamma)}{p+\gamma-1}$
s_3	$\frac{p-\gamma}{p+\gamma-1}$	$\frac{p+\gamma-1}{(2\gamma-1)\gamma}$	0	0	$\frac{(2p-1)(1-\gamma)}{2\gamma-1}$
w_{l1}	$-\frac{p-\gamma}{\gamma}$	$\frac{(1-p)}{\gamma}$	0	0	$(1-p)$
t_{l1}	0	0	$\frac{(1-\gamma)}{\gamma}$	$(1-\gamma)$	$(1-\gamma)$
w_{l0}	$\frac{p}{\gamma}$	$\frac{(p+\gamma-1)}{\gamma}$	0	0	p
t_{l0}	0	0	$-\frac{(1-\gamma)}{\gamma}$	0	0
	$\frac{g}{(2\gamma-1)}-\frac{(p-\gamma)c}{(2\gamma-1)\gamma}$	$\frac{g}{2\gamma-1}-\frac{(p+\gamma-1)c}{(2\gamma-1)\gamma}$	$\frac{c}{\gamma}$	$(1-p)c-\bar{t}$	$\frac{\gamma g}{(2\gamma-1)}-\frac{(p-\gamma)c}{2\gamma-1}$

TAB. $M3$

All the entries of the last column and last row are positive provided that $c < c^{**}$ and $\bar{t} \leq c(1-p)$. Since (APCM), (SIC1M) and (CIC2M) are satisfied, tableau $M3$ represents the solution of the principal's problem. The following remark holds:

Remark 23. *Whenever $c < c^{**}$, $\bar{t} < (1-p)c$ the optimal corruption-proof contract under monitoring entails $w_{h1} = \frac{g}{(2\gamma-1)} - \frac{(p-\gamma)c}{(2\gamma-1)\gamma}$, $t_{h0} = \frac{c}{\gamma}$, $w_{h0} = \frac{g}{2\gamma-1} - \frac{(p+\gamma-1)c}{(2\gamma-1)\gamma}$, while all the other payments are equal to zero. At the optimum, (AICM), (CIC1M), (CIC2M), (SIC2M) are binding, (SIC1M) binds if and only if $c = 0$, (SPCM) binds if and only if $\bar{t} = c(1-p)$, (APCM) is slack.*

Whenever both the falsification cost and the supervisor's reservation wage are not too high, truthful reporting is achieved paying $t_{h0} = \frac{c}{\gamma}$ which is always smaller than what the agent receives in state $\{h, 1\}$, for otherwise the supervisor would have an incentive to pursue individual opportunism and falsify $s = 1$. Collusion is prevented by weakening the agent's incentives and setting $w_{h0} = w_{h1} - t_{h0} > 0$.

• $c < c^{**}$ **and** $\bar{t} > c(1-p)$

If $\bar{t} > (1-c)p$, tableau $M3$ does not represent a solution as (SPCM) is not satisfied. Interchanging s_4 and t_{h1} in tableau $M3$ we obtain:

	w_{h1}	w_{h0}	t_{h0}	t_{h1}	
s_1	$\frac{1}{(2\gamma-1)}$	$\frac{1}{2\gamma-1}$	0	0	$\frac{\gamma}{(2\gamma-1)}$
s_4	0	0	$\frac{1}{\gamma}$	$\frac{1}{\gamma}$	1
s_2	$\frac{p-\gamma}{(2\gamma-1)\gamma}$	$\frac{p+\gamma-1}{(2\gamma-1)\gamma}$	$-\frac{p}{\gamma}$	$\frac{(1-p)}{\gamma}$	$\frac{\gamma(p-\gamma)}{p+\gamma-1}+(1-p)$
s_3	$\frac{p-\gamma}{p+\gamma-1}$	$\frac{p+\gamma-1}{(2\gamma-1)\gamma}$	0	0	$\frac{(2p-1)(1-\gamma)}{2\gamma-1}$
w_{l1}	$-\frac{p-\gamma}{\gamma}$	$\frac{(1-p)}{\gamma}$	0	0	$(1-p)$
t_{l1}	0	0	0	$\frac{(1-\gamma)}{\gamma}$	0
w_{l0}	$\frac{p}{\gamma}$	$\frac{(p+\gamma-1)}{\gamma}$	0	0	p
t_{l0}	0	0	0	0	0
	$\frac{g}{(2\gamma-1)}-\frac{(p-\gamma)c}{(2\gamma-1)\gamma}$	$\frac{g}{2\gamma-1}-\frac{(p+\gamma-1)c}{(2\gamma-1)\gamma}$	$\frac{\bar{t}}{\gamma}+\frac{pc}{\gamma}$	$-\frac{(1-p)c}{\gamma}+\frac{\bar{t}}{\gamma}$	$\frac{\gamma g}{(2\gamma-1)}-\frac{(2p-1)(1-\gamma)c}{2\gamma-1}+\bar{t}$

TAB. $M4$

Since (SIC1M), (CIC2M) and (APCM) are satisfied by the solution shown in tableau $M4$, the following remark holds:

Remark 24. *Whenever $\gamma \leq p$, $c < c^{**}$, $\bar{t} > (1-p)c$ the optimal corruption-proof contract under monitoring entails $w_{h1} = \frac{g}{(2\gamma-1)} - \frac{c(p-\gamma)}{(2\gamma-1)\gamma}$, $t_{h0} = \frac{\bar{t}}{\gamma} + \frac{pc}{\gamma}$, $t_{h1} = \frac{\bar{t}}{\gamma} - \frac{(1-p)c}{\gamma}$, $w_{h0} = \frac{\gamma g}{2\gamma-1} - \frac{(p+\gamma-1)c}{(2\gamma-1)\gamma}$ while all the other payments are equal to zero. At the optimum, (AICM), (CIC1M), (CIC2M), (SPCM) and (SIC2M) are binding, (SIC1M) binds if and only if $c = 0$ and (APCM) is slack unless $p = 1$.*

Whenever the falsification cost is relatively low but the supervisor's reservation wage is high, the principal has to increase t_{h1} with respect to the solution shown by tabular $M3$. However, $t_{h0} - t_{h1}$ has to be kept equal to $\frac{c}{\gamma}$ in order to discourage individual opportunism. Collusion is prevented by weakening the agent's incentives and setting $w_{h0} = w_{h1} - \frac{c}{\gamma} > 0$.

□

Figure .7 provides a graphical representation of the four different regions of the truthful-monitoring contract.

FIGURE 7 HERE

Remark 25. *The solution to the truthful-monitoring contract is unaltered if the supervisor has passive rather than wary beliefs.*

When the supervisor has passive beliefs, she does not update her belief about the agent's effort choice after receiving an offer, even if this is inconsistent with equilibrium play. Therefore, if the agent deviates and chooses $e = 0$, the supervisor remains unaware of his deviation. Then the agent might be willing to convince the supervisor to report $r = 1$ when $s = 0$. While the agent knows that the profit will be low with probability γ, the supervisor believes that the profit will be high with probability γ. If they do not collude, the agent expects to get $\gamma w_{l0} + (1-\gamma)w_{h0}$ and the supervisor expects to get $\gamma t_{h0} + (1-\gamma)t_{l0}$. Two constraints must be imposed to avoid collusion in monitoring. The first ensures that the agent is unwilling to bribe the supervisor:

$$\gamma w_{l0} + (1-\gamma)w_{h0} \geq \gamma[w_{l1} - \tau_l] + (1-\gamma)[w_{h1} - \tau_h] \tag{A1}$$

where τ_π is the bribe offered by the agent to the supervisor with $\pi \in \{l, h\}$. A second constraint ensures that the supervisor is unwilling to accept a bribe. This requires:

$$\gamma t_{h0} + (1-\gamma)t_{l0} \geq \gamma[t_{h1} + \tau_h] + (1-\gamma)[t_{l1} + \tau_l] \tag{A2}$$

We now show that the optimal corruption-proof contract satisfies both constraints. Notice that, irrespective of c and $\bar{t}$, the solution always satisfies the following equality: $w_{h1} - w_{h0} = t_{h0} - t_{h1}$. The other transfers are always set equal to 0. Inequality (A1) can be rewritten as

$$\gamma\tau_l + (1-\gamma)\tau_h \geq (1-\gamma)(w_{h1} - w_{h0}) \tag{A3}$$

while inequality A1 can be rewritten as

$$\gamma(t_{h0} - t_{h1}) \geq \gamma\tau_h + (1-\gamma)\tau_l \tag{A4}$$

From A3 the maximum bribe the agent is willing to pay to have $r = 1$ reported is $(1-\gamma)(w_{h1} - w_{h0})$. Since $\gamma > 1/2$ the agent would offer $\tau_h = (w_{h1} - w_{h0})$ and $\tau_l = 0$ to maximize the value of the bribe for the supervisor. Substituting these values into (A3), we have $\gamma(t_{h0} - t_{h1}) \geq \gamma(w_{h1} - w_{h0})$ which is always satisfied.

□

Proof of Proposition 3

To prove this proposition we have to compare the total expected transfers of each supervisory options, which are:

$$E(T^M) = \begin{cases} \frac{\gamma g-(p-\gamma)c}{2\gamma-1} & \text{if } c < c^{**} \bigwedge \bar{t} \le (1-p)c \\ \frac{\gamma g-(2p-1)(1-\gamma)c}{2\gamma-1} + \bar{t} & \text{if } c < c^{**} \bigwedge \bar{t} > (1-p)c \\ \frac{\gamma g}{p+\gamma-1} & \text{if } c \ge c^{**} \bigwedge \bar{t} \le \bar{t}^{**} \\ \frac{p\gamma g}{p+\gamma-1} + \bar{t} & \text{if } c \ge c^{**} \bigwedge \bar{t} > \bar{t}^{**} \end{cases}$$

$$E(T^{Ah}) = \begin{cases} \frac{\gamma g-\gamma(p-\gamma)c}{2\gamma-1} & \text{if } c < c^{*} \bigwedge \bar{t} \le (1-p)c \\ \frac{\gamma g-\gamma(2p-1)(1-\gamma)c}{2\gamma-1} + \gamma\bar{t} & \text{if } c < c^{*} \bigwedge \bar{t} > (1-p)c \\ \frac{\gamma g}{p+\gamma-1} & \text{if } c \ge c^{*} \bigwedge \bar{t} \le \bar{t}^{*} \\ \frac{p\gamma g}{p+\gamma-1} + \gamma\bar{t} & \text{if } c \ge c^{*} \bigwedge \bar{t} > \bar{t}^{*} \end{cases}$$

$$E(T^{Al}) = \begin{cases} \frac{\gamma g-\gamma(p-\gamma)c}{2\gamma-1} + (1-\gamma)c & \text{if } c < c' \bigwedge \bar{t} \le (1-p)c \\ \frac{\gamma g-\gamma(2p-1)(1-\gamma)c}{2\gamma-1} + (1-\gamma)pc + (1-\gamma)\bar{t} & \text{if } c < c' \bigwedge \bar{t} > (1-p)c \\ \frac{(1-\gamma)g}{p-\gamma} & \text{if } c \ge c' \bigwedge \bar{t} \le \bar{t}' \\ \frac{p(1-\gamma)g}{p-\gamma} + (1-\gamma)\bar{t} & \text{if } c \ge c' \bigwedge \bar{t} > \bar{t}'. \end{cases}$$

Each expected transfers generates four regions of the space $C \times \bar{T}$, with $C, \bar{T} = \mathbb{R}_+ \bigcup 0$. The intersection of these regions generates 14 sub-regions. The threshold functions $\bar{t}^m(c)$ and $\bar{t}^a(c)$ are computed by directly comparing the three contracts, M, Ah and Al, in all 14 sub-regions. These comparisons lead to:

$$\bar{t}^m(c) = \begin{cases} \frac{(1-\gamma)(2p-1)c}{2\gamma-1} & \text{if } c \in [0, c^{**}) \\ \frac{\gamma(2p-1)}{2\gamma-1}\left[\frac{g}{p+\gamma-1} - c\right] & \text{if } c \in [c^{**}, \hat{c}) \\ \frac{\gamma(2p-1)(1-\gamma)g}{(p+\gamma-1)(2\gamma-1)} - \frac{\gamma(p-\gamma)c}{2\gamma-1} & \text{if } c \in [\hat{c}, c^{*}) \\ \bar{t}^{**} & \text{if } c \ge c^{*} \end{cases}$$

$$\bar{t}^a(c) = \begin{cases} \frac{(p+\gamma-2p\gamma)c}{2\gamma-1} & \text{if } c \in [0, c^{**}) \\ \frac{\gamma(2p-1)(1-\gamma)g}{(2\gamma-1)^2(p+\gamma-1)} - \frac{\gamma(p-\gamma)c}{(2\gamma-1)^2} + \frac{(1-\gamma)pc}{2\gamma-1} & \text{if } c \in [c^{*}, c') \\ t' & \text{if } c \ge c'. \end{cases}$$

where $\hat{c} = \frac{\gamma(2p-1)g}{(p+\gamma-1)^2}$. It can be shown that $\bar{t}^a(c) \ge (>) \bar{t}^m(c)$ for all $c \ge (>) 0$. Moreover, from $E(T^M)$ and $E(T^{Ah})$ it is possible to see that they are equal for all $c \ge c^*$.

□

Proof Proposition 4

Recall the total expected transfer of the two-tier hierarchy, $E(T^{2th}) = \frac{\gamma g}{2\gamma-1}$ and note that:

(i) if $c = 0$ and $\bar{t} = 0$, the two-tier hierarchy is equivalent to any supervisory option;

(ii) the two-tier hierarchy never dominates the best supervisory option whenever $\bar{t} \le \bar{t}^m(c)\ \forall c > 0$.

As a result of points (i) and (ii) $\bar{t}^{2th}(0) = 0$ and $\bar{t}^{2th}(c) \ge \bar{t}^m(c)\ \forall\ c > 0$;

(iii) the principal prefers the two-tier hierarchy and Ah if:

$$\bar{t} = \begin{cases} \frac{(1-\gamma)(2p-1)c}{2\gamma-1} & \text{if } c \in [0, c^{*}) \\ \frac{(2p-1)(1-\gamma)c}{(2\gamma-1)(p+\gamma-1)} & \text{if } c \ge c^{*} \end{cases} = \bar{\tau}(c)$$

(iv) it can be seen that $\bar{\tau}(c) < \bar{t}^a(c)$ for all $c \ge 0$;

(v) for all $c \ge 0$, the total expected transfers of all supervisor's contracts are (weakly) increasing in $\bar{t}$.

From (i) to (v) we can set $\bar{t}^{2th}(c) = \bar{\tau}(c)$.

□

Proof Proposition 5

The Proof of Proposition 5 unfolds as follows: we consider the *Ah* contract and we prove that the principal (i) never finds it profitable to tolerate individual opportunism irrespective of whether collusion is prevented or not, and (ii) never finds it profitable to tolerate collusion when individual opportunism is prevented. The proofs for *M* and *Al* follow the same argument and are not reported here.

Tolerating Individual Opportunism. If individual opportunism is tolerated one of the (SICAh)s is not satisfied. Under the assumption that the supervisor reports truthfully when indifferent, this implies that the supervisor has a strictly dominant strategy to report either 1 or 0. Suppose first that the principal does not impose (CICAh). We distinguish between two cases:

1. If the supervisor has a dominant strategy to report evidence favorable to the agent, then the parties do not collude. The best the principal can do is to pay the agent the two-tier hierarchy contract (i.e., a payment schedule contingent solely on profit). Since the principal must also guarantee the supervisor's participation, this option is always worse than dispensing with the supervisor and setting up the two-tier hierarchy.
2. If the supervisor has a dominant strategy to report evidence unfavorable to the agent, then collusion may take place to prevent individual opportunism. Then the agent's incentives are weakened with respect to case 1 because even when he exerts effort and evidence is favorable he has to pay the supervisor a bribe to have it reported.

If collusion is prevented, neither of the above cases can occur. Since the agent receives the same salary irrespective of the report, it is not possible to simultaneously satisfy the (CICAh) and induce a dominant reporting strategy to the supervisor.

Tolerating Collusion. As the agent holds all the bargaining power, he is able to collect all the net gains from collusion and his only concern is to ensure the supervisor's participation in the collusion subgame. Since individual opportunism is prevented, the agent has to guarantee to the supervisor at least what she obtains if collusion does not take place and she reports truthfully.

When collectively falsifying the signal, the coalition chooses to send the report which maximizes the total payment given $\pi = h$, say $\hat{r}$. Consider the case in which the principal sets $\hat{r} = 1$. If $s = 1$, the coalition does not have incentives to falsify the signal, hence no side transfer takes place.

If $s = 0$, collective falsification of evidence takes place and the net payoff from collusion of the agent and of the supervisor are, respectively:

$$
\begin{aligned}
t^1_{h0} &= t_{h0} \\
w^1_{h0} &= \underbrace{w_{h1} + t_{h1}}_{\text{net gains from collusion}} - \underbrace{t_{h0}}_{\text{supervisor's participation constraint in the collusive subgame}}
\end{aligned}
$$

The problem can be rewritten taking into account that the supervisor and the agent collude to misreport $s = 0$, that is:

$$\min_{t_{h1}, w_{h1}, t_{h0}, w_{h0}, w_l} \gamma[w_{h1} + t_{h1}] + (1-\gamma)w_l$$

subject to:

$$\gamma[w_{h1} + t_{h1} - t_{h0}] + (1-\gamma)w_l - g \geq 0 \tag{APCAh}$$

$$(2\gamma - 1)w_{h1} - (p-\gamma)(t_{h1} - t_{h0}) - (2\gamma-1)w_l - g \geq 0 \tag{AICAh}$$

$$w_{h1} + t_{h1} - w_{h0} - t_{h0} > 0 \tag{mCAh}$$

$$t_{h0} - t_{h1} + c \geq 0 \tag{SIC1A}$$

$$t_{h1} - t_{h0} + c \geq 0 \tag{SIC2A}$$

$$pt_{h1} + (1-p)(t_{h0}) - \bar{t} \geq 0 \tag{SPCAh}$$

where (mCAh) ensures that $\hat{r} = 1$.

The problem is represented in the following tableau

	l_1	l_2	l_3	l_4	
w_{h1}	$2\gamma-1$	0	1	0	γ
t_{h1}	$-(p-\gamma)$	1	1	p	γ
w_{h0}	0	0	-1	0	0
t_{h0}	$(p-\gamma)$	-1	-1	$(1-p)$	0
w_l	$-(2\gamma-1)$	0	0	0	$(1-\gamma)$
	$-g$	c	0	$-\bar{t}$	0

where the first inner-column represents (AICAh), the second inner-column represents (SIC2A), the third inner-column represents (mCAh), the fourth inner-column represents (SPCAh) and the external column on the right represents the principal's objective function.

• $\mathbf{c} < \mathbf{c}^*$

Interchanging w_{h1} and l_1 and t_{h0} and l_2 we achieve:

	w_{h1}	t_{h0}	l_3	l_4	
l_1	$\frac{1}{2\gamma-1}$	0	$\frac{1}{2\gamma-1}$	0	$\frac{\gamma}{2\gamma-1}$
t_{h1}	0	1	0	1	γ
w_{h0}	0	0	-1	0	0
l_2	$\frac{(p-\gamma)}{2\gamma-1}$	-1	$\frac{(p+\gamma-1)}{2\gamma-1}$	$-\frac{(1-p)(2\gamma-1)}{2\gamma-1}$	$\frac{(p-\gamma)\gamma}{2\gamma-1}$
w_l	1	0	1	0	1
	$\frac{g-(p-\gamma)c}{2\gamma-1}$	c	$\frac{g-c(p+\gamma-1)}{2\gamma-1}$	$-\bar{t}+(1-p)c$	$\frac{\gamma[g-c(p-\gamma)]}{2\gamma-1}$

TAB. CAh

This represents the solution of the principal's problem whenever $c < c^*$ and $\bar{t} \leq (1-p)c$. It can be easily checked that this solution is equivalent to the one shown in the Proof of Lemma 7 by tableau $Ah3$. It follows that in this region tolerating collusion does not improve the principal's payoff.

The same holds true when $c < c^*$ and $\bar{t} > (1-p)c$, as a tableau equivalent to $Ah4$ is achieved by interchanging l_4 and t_{h1} in CAh.

• $\mathbf{c} \geq \mathbf{c}^*$

The (mCAh) constraint is no longer satisfied in tableau CAh. This implies that for $\bar{t} \leq \bar{t}^*$ the principal would optimally make (mCAh) bind and no collusion would occur in equilibrium. The same holds true for $\bar{t} > \bar{t}^*$. To see this, notice that interchanging l_4 and t_{h1} in tableau CAh does not impact on the column representing (mCAh), as the this column does not depend on t_{h1}.

If the principal sets $\hat{r} = 0$ the results are similar.

□

Appendix B

In this appendix we show the main computations and technical details of the robustness check carried out in Section 4, wherein the principal try to improve upon the corruption-proof contracts by tolerating some form of opportunism. As argued in the Proof of Proposition 4, tolerating individual opportunism is always harmful to the principal, who prefers to make the supervisor willing to report truthfully whenever collusion does not take place. Conversely, tolerating collusion can be beneficial to the principal.

In what follows, we first characterize the Nash-bargaining solution of the collusive subgame and the solution of the principal's problem for each supervisory option. Finally we compare the two supervisory options and we illustrate the optimal organizational structure.

Auditing

Suppose that the signal s has been observed and that the total transfer is maximized when the designer reports $r = \hat{r}$. The designer solves the following problem:

$$\max_{w_{hs}^{\hat{r}}, t_{hs}^{\hat{r}}} (w_{hs}^{\hat{r}} - w_{hs}^T)^\beta (t_{hs}^{\hat{r}} - t_{hs}^T)^{1-\beta}$$

subject to:

$$w_{hs}^{\hat{r}} + t_{hs}^{\hat{r}} = w_{h\hat{r}} + t_{h\hat{r}} \tag{FCAh}$$

Replacing the constraint into the objective function we can rewrite the problem as a function of $w_{hs}^{\hat{r}}$ only:

$$C^{ah} = \max_{w_{hs}^{\hat{r}}} (w_{hs}^{\hat{r}} - w_{hs}^T)^\beta (w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T)^{1-\beta}$$

Then we compute the partial derivative with respect to $w_{hs}^{\hat{r}}$:

$$\frac{\partial C^{ah}}{\partial w_{hs}^{\hat{r}}} = 0 \Leftrightarrow \beta \left(\frac{w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T}{(w_{hs}^{\hat{r}} - w_{hs}^T)} \right)^{1-\beta} = (1-\beta) \left(\frac{(w_{hs}^{\hat{r}} - w_{hs}^T)}{w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T} \right)^\beta$$

which implies:

$$\frac{w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T}{(w_{hs}^{\hat{r}} - w_{hs}^T)} = \frac{(1-\beta)}{\beta}$$

that is:

$$w_{hs}^{\hat{r}} = \beta(w_{h\hat{r}} + t_{h\hat{r}} - t_{hs}^T) + (1-\beta) w_{hs}^T$$

Replacing it into (FCAh), we obtain:

$$t_{hs}^{\hat{r}} = (1-\beta)(w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^T) + \beta t_{hs}^T$$

In setting the general contracts the principal has to decide $\hat{r}$, that is, the report which maximizes the total transfer received by the coalition. It can be shown that setting $\hat{r} = 0$ is too penalizing for the agent's incentives in order to be beneficial for the principal. Hence, we do not consider this case here.

When the principal set $\hat{r} = 1$, the net payoff received by the agent and the supervisor are, respectively:

$$w_{h1}^1 = w_{h1}$$

$$w_{h0}^1 = (1-\beta) w_{h0} + \beta(w_{h1} + t_{h1} - t_{h0})$$

$$t_{h1}^1 = t_{h1}$$

$$t_{h0}^1 = (1-\beta)(w_{h1} + t_{h1} - w_{h0}) + \beta t_{h0}$$

It can be seen that no collusion occurs when $s = \hat{r} = 1$, as no Pareto improvements are feasible to the coalition. Conversely, collusion occurs when $s = 0$, as the coalition can reach a Pareto superior allocation by falsifying evidence and reporting $r = 1$. The principal takes into account the possibility that collusion takes place in setting its problem, which can be written as:

$$\min_{t_{h1}, w_{h1}, t_{h0}, w_{h0}, w_l} \gamma[w_{h1} + t_{h1}] + (1-\gamma) w_l$$

subject to:

$$\gamma[pw_{h1} + (1-p)(\beta(w_{h1} + t_{h1} - t_{h0}) + (1-\beta)w_{h0})] + (1-\gamma)w_l - g \geq 0 \tag{APCAh}$$

$$(p+\gamma-1)w_{h1} - (p-\gamma)(\beta(w_{h1} + t_{h1} - t_{h0}) + (1-\beta)w_{h0} - (2\gamma-1)w_l - g \geq 0 \tag{AICAh}$$

$$w_{h1} + t_{h1} - w_{h0} - t_{h0} > 0 \tag{mCAh}$$

$$t_{h0} - t_{h1} + c \geq 0 \tag{SIC1A}$$

$$t_{h1} - t_{h0} + c \geq 0 \tag{SIC2A}$$

$$pt_{h1} + (1-p)((1-\beta)(w_{h1} + t_{h1} - w_{h0}) + \beta t_{h0}) - \bar{t} \geq 0 \tag{SPCAh}$$

Let us define the threshold value $\bar{t}^{ca} = (1-p)[(1-\beta)g + \beta(2\gamma-1)c]/(p+\gamma-1-\beta(p-\gamma))$. Solving this problem through the pivot madly method, we achieve the following solution:

• $\mathbf{c < c^*}$ **and** $\mathbf{\bar{t} \leq \bar{t}^{ca}}$

The principal sets $w_{h1} = \frac{g-\beta(p-\gamma)c}{p+\gamma-1-\beta(p-\gamma)}$, $t_{h0} = c$ and all the other payments to zero. (AICAh) and (SIC2A) are binding, (SPCAh) binds if and only if $t = \bar{t}^{ca}$, (APCAh) binds if and only if $p = 1$, (SIC1A) binds if and only if $c = 0$, (mCAh) is slack.

• $\mathbf{c < c^*}$ **and** $\mathbf{\bar{t} \geq \bar{t}^{ca}}$

The principal sets $w_{h1} = \frac{g-\beta(p-\gamma)c}{p+\gamma-1-\beta(p-\gamma)}$, $t_{h0} = -\frac{(1-\beta)(1-p)g}{p+\gamma-1-\beta(p-\gamma)} + \frac{[(p+\gamma-1)(1-\beta)+p\beta(2\gamma-1)]c}{p+\gamma-1-\beta(p-\gamma)} + \bar{t}$, $t_{h1} = -\frac{(1-\beta)(1-p)g}{p+\gamma-1-\beta(p-\gamma)} + \bar{t} - \frac{c[\beta(1-p)(2\gamma-1)]}{p+\gamma-1-\beta(p-\gamma)}$ and all the other payments to zero. (AICAh), (SIC2A), (SPCAh) are binding, (APCAh) binds if and only if $p = 1$, (SIC1A) binds if and only if $c = 0$, (mCAh) is slack.

• $\mathbf{c \geq c^*}$ **and** $\mathbf{\bar{t} \leq \bar{t}^*}$

The principal sets $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h0} = \frac{g}{p+\gamma-1}$, and all the other payments to zero. (AICAh), (mCAh) are binding, (SPCAh) binds if and only if $\bar{t} = \bar{t}^*$, (APCAh) binds if and only if $p = 1$, (SIC1A) and (SIC2A) are slack.

• $\mathbf{c \geq c^*}$ **and** $\mathbf{\bar{t} \geq \bar{t}^*}$

The principal sets $w_{h1} = \frac{g)c}{p+\gamma-1}$, $t_{h0} = \bar{t} + \frac{pg}{p+\gamma-1}$, $t_{h1} = \bar{t} - \frac{(1-p)g}{p+\gamma-1}$ and all the other payments to zero. (AICAh), (SIC2A), (mCAh), (SPCAh) bind, (APCAh) binds if and only if $p = 1$, (SIC1A) and (SIC2A) are slack.

To summarize, the principal optimally tolerate collusion whenever $c < c^*$. In this case, the designer always reports $r = 1$ irrespective of the signal observation. Conversely, when $c \geq c^*$, collusion is optimally prevented. The principal expected cost is given by:

$$E(T^{ca}) = \begin{cases} \frac{\gamma[g-c\beta(p-\gamma)]}{p+\gamma-1-\beta(p-\gamma)} & \text{if } \mathbf{c < c^*, \bar{t} \leq \bar{t}^{ca}} \\ \gamma\frac{\{[p+\beta(1-p)]g-\beta(2p-1)(1-\gamma)c\}}{p+\gamma-1-\beta(p-\gamma)} + \gamma\bar{t} & \text{if } \mathbf{c < c^*, \bar{t} \geq \bar{t}^{ca}} \\ \frac{\gamma g}{p+\gamma-1} & \text{if } \mathbf{c \geq c^*, \bar{t} \leq \bar{t}^*} \\ \gamma\bar{t} + \frac{p\gamma g}{p+\gamma-1} & \text{if } \mathbf{c \geq c^*, \bar{t} \geq \bar{t}^*} \end{cases}$$

Monitoring

Suppose that the signal s has been observed and that the total transfer is maximized when the supervisor reports $r = \hat{r}$. Under monitoring, the collusion designer solves the following problem:

$$\max_{w_{hs}^{\hat{r}}, w_{hs}, t_{hs}^{\hat{r}}, t_{ls}} \gamma(w_{hs}^{\hat{r}} - w_{hs}^T)^\beta (t_{hs}^{\hat{r}} - t_{hs}^T)^{1-\beta} + (1-\gamma)(w_{ls}^{\hat{r}} - w_{ls}^T)^\beta (t_{ls}^{\hat{r}} - t_{ls}^T)$$

subject to:

$$w_{hs}^{\hat{r}} + t_{hs}^{\hat{r}} = w_{h\hat{r}} + t_{h\hat{r}} \tag{FC1M}$$
$$w_{ls}^{\hat{r}} + t_{ls}^{\hat{r}} = w_{l\hat{r}} + t_{l\hat{r}} \tag{FC2M}$$

(FC1M) (respectively, FC2M) ensures that the outcome of the bargaining process is feasible when $\pi = h$ (respectively, when $\pi = l$). Replacing these constraints into the objective function we can rewrite the problem as a function of $w_{hs}^{\hat{r}}$ and $w_{ls}^{\hat{r}}$ only:

$$C^m = \max_{w_{hs}^{\hat{r}}, w_{ls}^{\hat{r}}} \gamma(w_{hs}^{\hat{r}} - w_{hs}^T)^\beta (w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T)^{1-\beta} + (1-\gamma)(w_{ls}^{\hat{r}} - w_{ls}^T)^\beta (w_{l\hat{r}} + t_{l\hat{r}} - w_{ls}^{\hat{r}} - t_{ls}^T)^{1-\beta}$$

Then we compute the partial derivatives with respect to $w_{hs}^{\hat{r}}$ and $w_{ls}^{\hat{r}}$:

$$\frac{\partial C^m}{\partial w_{hs}^{\hat{r}}} = 0 \Leftrightarrow \beta \left(\frac{w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T}{(w_{hs}^{\hat{r}} - w_{hs}^T)} \right)^{1-\beta} = (1-\beta) \left(\frac{(w_{hs}^{\hat{r}} - w_{hs}^T)}{w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T} \right)^\beta$$
$$\frac{\partial C^m}{\partial w_{ls}^{\hat{r}}} = 0 \Leftrightarrow \beta \left(\frac{w_{l\hat{r}} + t_{l\hat{r}} - w_{ls}^{\hat{r}} - t_{ls}^T}{(w_{ls}^{\hat{r}} - w_{ls}^T)} \right)^{1-\beta} = (1-\beta) \left(\frac{(w_{ls}^{\hat{r}} - w_{ls}^T)}{w_{h\hat{r}} + t_{l\hat{r}} - w_{ls}^{\hat{r}} - t_{ls}^T} \right)^\beta$$

which imply:

$$\frac{w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^{\hat{r}} - t_{hs}^T}{(w_{hs}^{\hat{r}} - w_{hs}^T)} = \frac{(1-\beta)}{\beta}$$
$$\frac{w_{l\hat{r}} + t_{l\hat{r}} - w_{ls}^{\hat{r}} - t_{ls}^T}{(w_{ls}^{\hat{r}} - w_{ls}^T)} = \frac{(1-\beta)}{\beta}$$

that are:

$$w_{hs}^{\hat{r}} = \beta(w_{h\hat{r}} + t_{h\hat{r}} - t_{hs}^T) + (1-\beta)w_{hs}^T$$
$$w_{ls}^{\hat{r}} = \beta(w_{l\hat{r}} + t_{l\hat{r}} - t_{ls}^T) + (1-\beta)w_{ls}^T$$

Replacing them into (FC1M) and (FC2M), we obtain:

$$t_{hs}^{\hat{r}} = (1-\beta)(w_{h\hat{r}} + t_{h\hat{r}} - w_{hs}^T) + \beta t_{hs}^T$$
$$t_{ls}^{\hat{r}} = (1-\beta)(w_{l\hat{r}} + t_{l\hat{r}} - w_{ls}^T) + \beta t_{ls}^T$$

It can be noticed that the outcome of the collusion subgame is independent of the weight the designer attaches to each states when maximizing the coalition surplus. Hence that the outcome is independent of the designer's beliefs about e. It can be shown that this follows from the assumption about the colluding parties being wealth constrained.

As in the auditing case, the principal sets $\hat{r} = 1$ to make the most of collusion. It follows that the net payoffs received by the employees in the collusion subgame are as follows:

$$w^1_{h1} = w_{h1}$$

$$w^1_{h0} = (1-\beta)w_{h0} + \beta(w_{h1} + t_{h1} - t_{h0})$$

$$t^1_{h1} = t_{h1}$$

$$t^1_{h0} = (1-\beta)(w_{h1} + t_{h1} - w_{h0}) + \beta t_{h0}$$

$$w^1_{l1} = w_{l1}$$

$$w^1_{l0} = (1-\beta)w_{l0} + \beta(w_{l1} + t_{l1} - t_{l0})$$

$$t^1_{l1} = t_{l1}$$

$$t^1_{l0} = (1-\beta)(w_{l1} + t_{l1} - w_{l0}) + \beta t_{l0}$$

Clearly, collusion only occurs if $s = 0$ is observed.
The principal solves the following problem:

$$\min_{t_{h1},w_{h1},t_{h0},w_{h0},t_{l1},w_{l1},t_{l0},w_{l0}} \gamma[w_{h1} + t_{h1}] + (1-\gamma)[w_{l1} + t_{l1}]$$

subject to:

$$\gamma[pw_{h1} + (1-p)(\beta(w_{h1} + t_{h1} - t_{h0}) + (1-\beta)w_{h0})] \\ + (1-\gamma)[pw_{l1} + (1-p)(\beta(w_{l1} + t_{l1} - t_{l0}) + (1-\beta)w_{l0})] - g \geq 0 \tag{APCM}$$

$$(p+\gamma-1)[w_{h1} - (\beta(w_{l1} + t_{l1} - t_{l0}) + (1-\beta)w_{l0})] \\ + (p-\gamma)[w_{l1} - (\beta(w_{h1} + t_{h1} - t_{h0}) + (1-\beta)w_{h0})] - g \geq 0 \tag{AIC1M}$$

$$[p+\gamma-1+\beta(1-p)](w_{h1} - w_{l0}) \\ + [p-\gamma+\beta(1-p)](w_{l1} - w_{h0}) + \beta(1-p)(t_{h1} + t_{l1} - t_{h0} - t_{l0}) - g \geq 0 \tag{AIC2M}$$

$$\gamma[w_{h1} + t_{h1} - w_{h0} - t_{h0}] + (1-\gamma)[w_{l1} + t_{l1} - w_{l0} - t_{l0}] > 0 \tag{mCM}$$

$$\gamma(t_{h0} - t_{h1}) + (1-\gamma)(t_{l0} - t_{l1}) + c \geq 0 \tag{SIC1M}$$

$$\gamma(t_{h1} - t_{h0}) + (1-\gamma)(t_{l1} - t_{l0}) + c \geq 0 \tag{SIC2M}$$

$$\gamma[pt_{h1} + (1-p)((1-\beta)(w_{h1} + t_{h1} - w_{h0}) + \beta t_{h0})] \\ + (1-\gamma)[pt_{l1} + (1-p)((1-\beta)(w_{l1} + t_{l1} - w_{l0}) + \beta t_{l0})] - \bar{t} \geq 0 \tag{SPCM}$$

Let us define the threshold value $\bar{t}^{cm} = (1-p)\frac{\gamma(1-\beta)g+\beta(2\gamma-1)c}{p+\gamma-1-\beta(p-\gamma)}$. Through the pivot madly method we achieve the following solution:

- $\mathbf{c < c^{**}}$ **and** $\mathbf{\bar{t} \leq \bar{t}^{cm}}$

The principal sets $w_{h1} = \frac{g - \frac{\beta(p-\gamma)c}{\gamma}}{p+\gamma-1-\beta(p-\gamma)}$, $t_{h0} = \frac{c}{\gamma}$ and all the other payments to zero. (AICM) and (SIC2M) are binding, (SPCM) binds if and only if $t = \bar{t}^{cm}$, (APCM) binds if and only if $p = 1$, (SIC1M) binds if and only if $c = 0$, (mCM) is slack.

• $\mathbf{c < c^{**}}$ **and** $\bar{\mathbf{t}} > \bar{\mathbf{t}}^{\mathbf{cm}}$

The principal sets $w_{h1} = \frac{g-\beta(p-\gamma)c}{p+\gamma-1-\beta(p-\gamma)}$, $t_{h0} = -\frac{(1-\beta)(1-p)g}{p+\gamma-1-\beta(p-\gamma)} + \frac{[(p+\gamma-1)(1-\beta)+p\beta(2\gamma-1)]c}{\gamma(p+\gamma-1-\beta(p-\gamma))} + \frac{\bar{t}}{\gamma}$, $t_{h1} = -\frac{(1-\beta)(1-p)g}{p+\gamma-1-\beta(p-\gamma)} + \frac{\bar{t}}{\gamma} - \frac{c\beta(1-p)(2\gamma-1)}{\gamma(p+\gamma-1-\beta(p-\gamma))}$ and all the other payments to zero. (AICM), (SIC2M), (SPCM) are binding, (APCM) binds if and only if $p = 1$, (SIC1M) binds if and only if $c = 0$, (mCM) is slack.

• $\mathbf{c \geq c^{**}}$ **and** $\bar{\mathbf{t}} \leq \bar{\mathbf{t}}^{**}$

The principal sets $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h0} = \frac{g}{p+\gamma-1}$, and all the other payments to zero. (AICM), (mCM) are binding, (SPCM) binds if and only if $\bar{t} = \bar{t}^{*}$, (APCM) binds if and only if $p = 1$, (SIC1M) and (SIC2M) are slack.

• $\mathbf{c \geq c^{**}}$ **and** $\bar{\mathbf{t}} \geq \bar{\mathbf{t}}^{**}$

The principal sets $w_{h1} = \frac{g}{p+\gamma-1}$, $t_{h0} = \bar{t} + \frac{pg}{p+\gamma-1}$, $t_{h1} = \bar{t} - \frac{(1-p)g}{p+\gamma-1}$ and all the other payments to zero. (AICM), (SICM), (mCM), (SPCM) bind, (APCM) binds if and only if $p = 1$, (SIC1M) and (SIC2M) are slack.

To summarize, the principal optimally tolerate collusion whenever $c < c^{**}$. In this case, the designer always reports $r = 1$ irrespective of the signal observation. Conversely, when $c \geq c^{**}$, collusion is optimally prevented. The principal expected cost is given by:

$$E(T^{cm}) = \begin{cases} \frac{\gamma g - c\beta(p-\gamma)}{p+\gamma-1-\beta(p-\gamma)} & \text{if } \mathbf{c < c^{**}}, \bar{\mathbf{t}} \leq \bar{\mathbf{t}}^{\mathbf{cm}} \\ \frac{\gamma[p+\beta(1-p)]g - [\beta(2p-1)(1-\gamma)]c}{p+\gamma-1-\beta(p-\gamma)} + \bar{t} & \text{if } \mathbf{c < c^{**}}, \bar{\mathbf{t}} \geq \bar{\mathbf{t}}^{\mathbf{cm}} \\ \frac{\gamma g}{p+\gamma-1} & \text{if } \mathbf{c \geq c^{**}}, \bar{\mathbf{t}} \leq \bar{\mathbf{t}}^{**} \\ \bar{t} + \frac{p\gamma g}{p+\gamma-1} & \text{if } \mathbf{c \geq c^{**}}, \bar{\mathbf{t}} \geq \bar{\mathbf{t}}^{**} \end{cases}$$

From a direct comparison between $E(T^{cm})$ and $E(T^{ca})$ we can determine the following threshold function:

$$\bar{t}^{coll}(c, \beta) = \begin{cases} \frac{\gamma(1-p)(1-\beta)g}{p+\gamma-1-\beta(p-\gamma)} + \frac{c\beta[(2\gamma-1)(1-p)+(1-\gamma)(p-\gamma)]}{p+\gamma-1-\beta(p-\gamma)} & \text{if } c < c^{**} \\ \frac{\gamma\beta[2p\gamma+\gamma-1]g}{(p+\gamma-1)(p+\gamma-1-\beta(p-\gamma))(1-\gamma)} - \frac{\gamma\beta(2p-1)c}{p+\gamma-1-\beta(p-\gamma)} & \text{if } c \in [c^{**}, \check{c}) \\ \frac{\gamma g[(p+\gamma-1)(1-p)+\beta(p-\gamma)p]}{(p+\gamma-1)(p+\gamma-1-\beta(p-\gamma))} - \frac{\gamma c\beta(p-\gamma)}{p+\gamma-1-\beta(p-\gamma)} & \text{if } c \in [\check{c}, c^{*}) \\ \bar{t}^{**} & \text{if } c \geq c^{*}. \end{cases}$$

The proposition below follows:

Proposition 6. *When the agent has a bargaining power $\beta < 1$ at the side-contracting stage, the principal favorite organizational structure is: If $c \geq c^{*}$ and*

- *$\bar{t} \leq \bar{t}^{coll}(c, \beta)$, the principal is indifferent between monitoring and auditing;*
- *$\bar{t} > \bar{t}^{coll}(c, \beta)$, the principal strictly prefers auditing to monitoring.*

If $c < c^{*}$ and

- *$\bar{t} < t^{coll}(c, \beta)$, the principal strictly prefers monitoring to auditing;*
- *$\bar{t} = \bar{t}^{coll}(c, \beta)$, the principal is indifferent between monitoring and auditing;*
- *$\bar{t} > \bar{t}^{coll}(c, \beta)$, the principal strictly prefers auditing to monitoring.*

where $\check{c} = \frac{g}{\beta[(2\gamma-1)(1-p)+\gamma(p-\gamma)]}\left[(1-p)(\gamma+\beta-1) + \frac{\beta(p-\gamma)p\gamma}{p+\gamma-1}\right]$. Note that $\bar{t}^{coll}(c, 0) = \bar{t}^{**}$.

A similar comparison can be done between the best supervisory option and the two-tier hierarchy.

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Figures

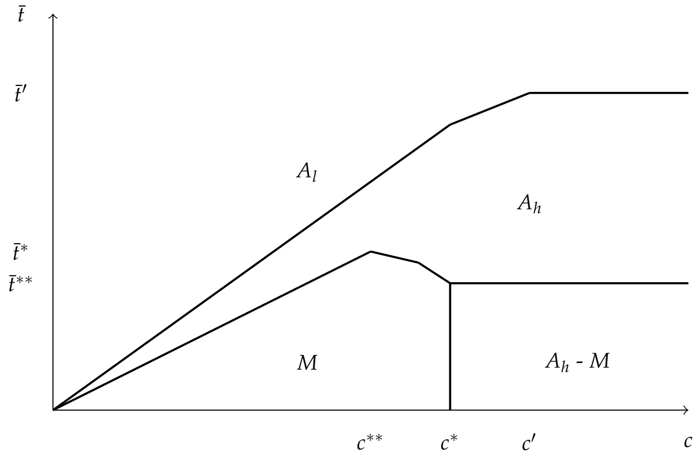

Figure .1: Corruption-Proof Contracts

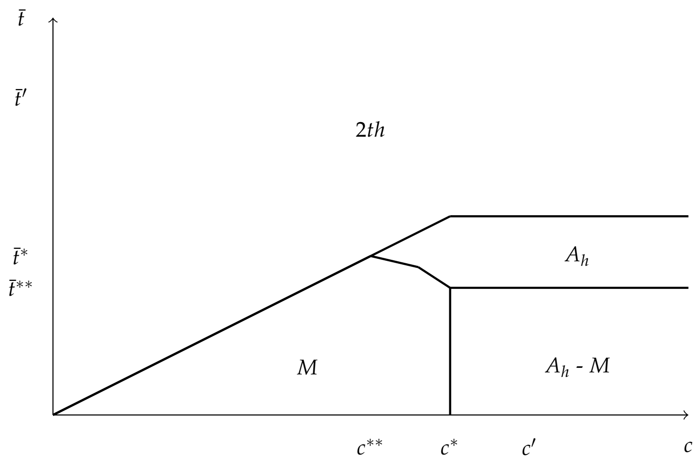

Figure .2: Optimal Organizational Structure

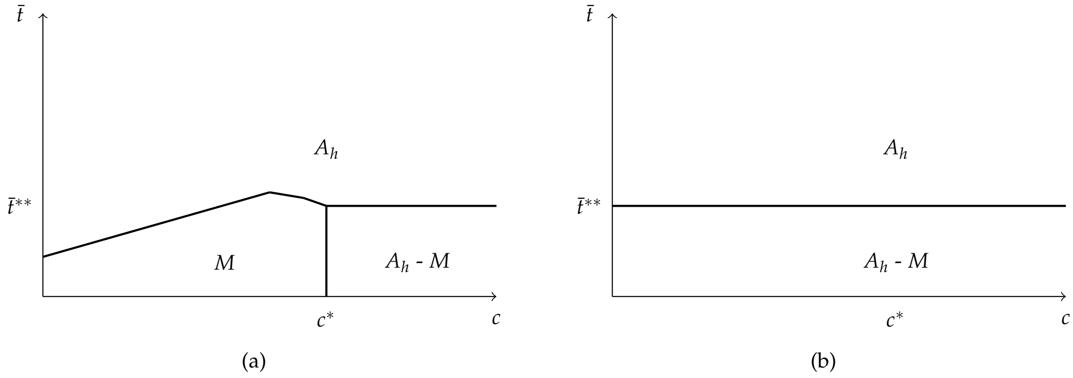

Figure .3: Supervisory tasks for $\beta = 1/2$ and $\beta = 0$.

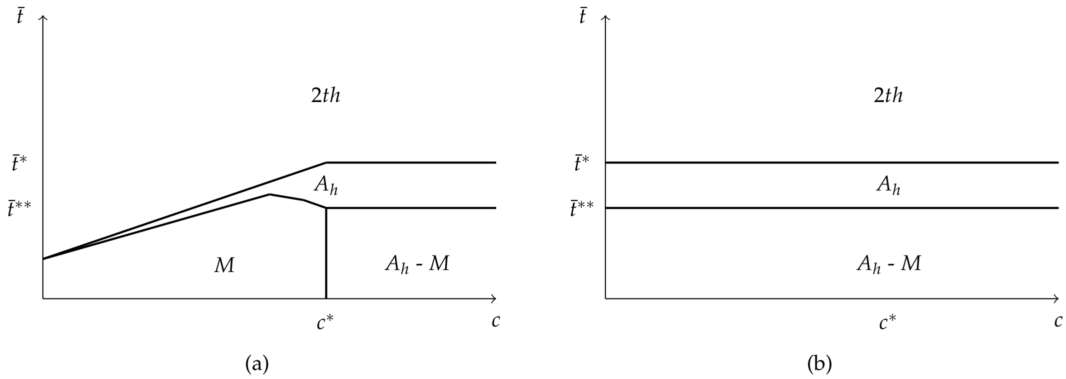

Figure .4: Organizational Structure for $\beta = 1/2$ and $\beta = 0$.

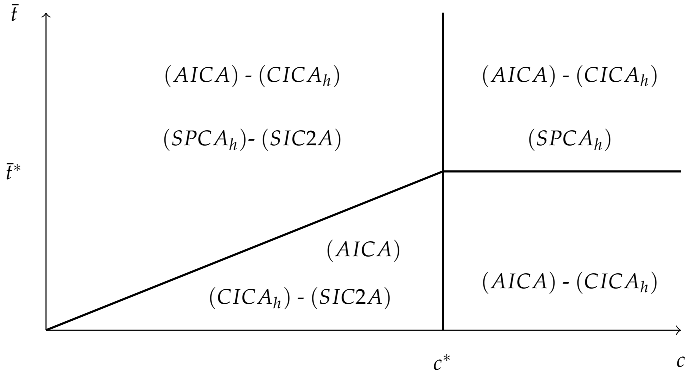

Figure .5: Truthful-Auditing A_h

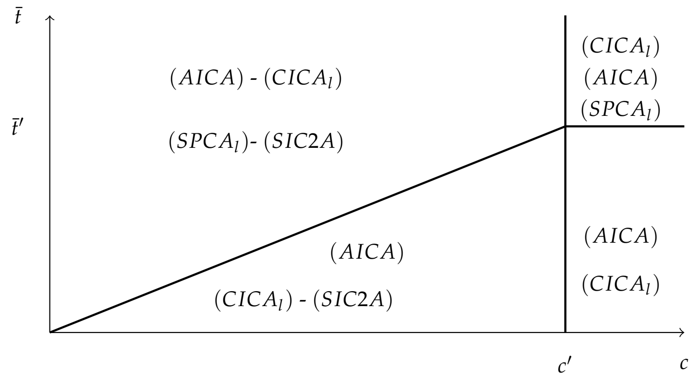

Figure .6: Truthful-Auditing A_l

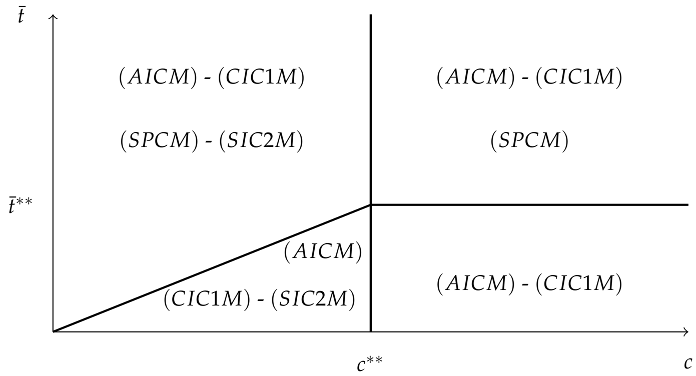

Figure .7: Truthful-Monitoring