

Corruption under Moral Hazard

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Some corruption of employees will exist when managers are constrained in setting rewards and penalties. Attempts to reduce corruption need to address these constraints. Raising salaries without raising expected penalties will have higher costs than benefits.



Summary findings

In this theoretical analysis, the “principal” can be the head of the tax collection agency (or “government” or even citizens), the “supervisor” can be the tax collector, and the “agent” can be the taxpayer.

The principal, interested in controlling an agent’s socially costly activity (“cheating”), hires the supervisor to save on monitoring costs. The agent may bribe the tax collector to suppress reporting, but bribery can be eliminated by the agency head if he institutes enough investigations and sets rewards high enough and penalties steep enough. When penalties and rewards are constrained, some corruption will exist even under a rational approach to pursuing the agency’s objectives. Anticorruption efforts will have higher costs than benefits unless they successfully address these constraints.

The agency’s implementation costs, and thus the scope for corruption, are defined by constraints on penalties and rewards relative to costs of monitoring and investigation. For example, if the agency head is extremely handicapped in his ability to detect bribery (by a high burden of proof and cost of investigation, and a

civil service pay scale that is too flat and rigid), he cannot really reward good employees or make dishonest employees suffer.

The analysis assumes that the principal can commit in advance to a certain likelihood of being caught engaging in bribery. Creating an independent anticorruption commission (like those in Hong Kong and New South Wales) may be interpreted as a way of making such a commitment. In Hong Kong two-thirds of reports to the commission are made in full name, an indication that it has attained a reputation for independence and efficiency. The “whistleblower act” in the United States (promising rewards and protection for informants), as well as separation of powers and independent courts, also function as commitment.

Corruption exists not only in poorly designed but also in sophisticated systems. It can profitably be reduced only by improving general incentives. Advances in courts, investigations, freedom of the press, and flow of information can allow more performance-based rewards and penalties.

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1 Introduction

"The President, Vice President, and all civil officers of the United States, shall be removed from office on impeachment for, and conviction of (...) bribery..."

United States Constitution, Art. II, Section 4.

Corruption is an important and pervasive a phenomenon. This is illustrated by the fact that the United States even included it in the constitution as grounds for impeachment of the president. Also, corruption is long observed throughout human history. As early as in the fourth century B.C., Kautiliya, Prime Minister of an Indian king, reports wide-spread corruption. In our understanding, *corruption occurs if a party to a (implicit) contract breaks it for private gain by side-contracting with a third person*. Thus, our definition includes collusion in private entities as well as corrupt bureaucracies.¹

The main branch of theoretical literature about collusion within a principal-agent framework focuses on contracts between a principal and a privately informed agent. The principal may employ a supervisor who can obtain information about the agent at lower costs than the principal. This gives rise to the possibility of collusion between the supervisor and the agent. The optimal contract thus maximizes the principal's pay-off by explicitly considering the possibility of side-contracting between the supervisor and the agent. In general, if renegotiation between the agent and the principal is not possible

¹Our definition of corruption goes beyond "the use of public office for private benefit", the definition used by the World Bank. While "corruption" tends to be associated more with abuse of public office, "collusion" is more frequently used as a general term. We will use the expressions interchangeably. Corruption per se is a costly phenomenon only if the joint benefit to the side-contracting parties is lower than the harm suffered by the party left out. While this is the relevant case dealt with in this paper, our definition of corruption deals with a broader set of cases.

after the latter has received the information from the supervisor, a direct mechanism will be optimal. This means that the supervisor will reveal his information truthfully to the principal and collusion does not arise in equilibrium. Tirole [12], Laffont & Tirole [5], Kofman & Lawaree [3] are good examples for these types of models. However, if renegotiation after the principal has received the information cannot be ruled out, the supervisor's anticipation of renegotiation may make the direct mechanism too costly and collusive behaviour may arise in equilibrium (see e.g. Lambert-Mogiliansky [6], Strausz [11]). Yet a number of other possibilities why collusion may be optimal is developed by Tirole [13]. All the above models have in common that the emphasis lies on a given informational asymmetry. Technically speaking, the cited articles cope with adverse selection problems, because the agent's characteristics are exogenous and cannot be changed by the agent's action.

In contrast, Mookherjee & Png [8] consider corruption in a moral hazard framework. They model a factory which emits pollution in order to avoid costs and an inspector who monitors the factory's emission. The inspector discovers the true emission level with a probability that depends on his effort. If he detects the true emission level, the possibility of collusion may arise. If the agent and the supervisor collude, they may be discovered with an exogenously given probability. Polinsky and Shavell [9] employ a model where the (costly) probability of detecting collusion between the agent and the supervisor can be chosen by the principal. However, their model is incomplete as it does not consider the supervisor's incentives directly. Rather, the supervisor is assumed to monitor the agent according a probability which is chosen by the principal.

This is the starting point of our work. Employing a framework similar to Mookherjee and Png, we model three players explicitly. A principal who offers a contract to a supervisor to monitor the action of an agent. The agent is supposed to comply with

regulation but may cheat. If caught cheating, he either has to pay a penalty or bribe the supervisor. If collusion takes place, the agent and the supervisor are detected with a positive probability and both have to pay a fine.

Since the principal chooses the probability of detection of collusion (as well as the conditions of the contract for the supervisor) at the first stage of the game, he can always make collusion unprofitable. Thus, if he chooses not to do so it must be that it is actually optimal to “allow” corruption because preventing corruption completely is more costly. Depending on the parameters chosen by the principal, corruption may occur. In general, if penalties can be chosen freely, the optimal contract is such that corruption never arises. However, if penalties are bounded, then it might be optimal to “allow” some collusion in equilibrium. The reason for this is that in the collusion-inducing regime, the expected bribe stimulates monitoring by the supervisor which in turn lowers incentives for the agent to cheat. If the negative impact of increased cheating on the principal’s pay-off is sufficiently high, then this may overcompensate the benefits of preventing collusion. In our analysis, we characterize the circumstances under which the collusion-inducing regime is optimal.

A necessary condition for corruption to arise is the possibility of profitable side-contracting. In the context of government regulation, the higher the private benefit of avoiding the regulation, the more is at stake for an agent and thus the more likely is bribery. An obvious way to reduce collusion is therefore to reduce regulation. In contrast, in our model we take the regulation as given, and then ask for the optimal implementation within the given framework.

An important aspect is the degree of complexity of the regulation. More complex regulation has two consequences: First, it reduces the observability of the action for

the supervisor thus making it more difficult to find out whether the agent has complied with the regulation or not. We model this by varying the supervisors monitoring costs. Second, as complexity increases, the discretion of the supervisor may increase, leaving more scope for interpretation in whether the agent complied with the rule or not. In our setting, this can be interpreted as an increase of the bargaining power of the supervisor relative to the agent.

The paper is organized as follows: Section two develops the basic model, section three derives the optimal contract in the absence of bounds on penalties or the payment made to the supervisor. Section four deals with upper bounds on penalties or the payment to the supervisor. Section five examines a situation with bounds on penalties and the payment to the supervisor. Section six concludes.

2 The Model

2.1 Basic Framework

There are three persons involved: A principal, an agent and a supervisor. The agent can choose between two actions, a_c and a_n , where a_c stands for “cheating” and a_n for “non-cheating”. What we mean is simply that if the agent chooses “non-cheating” he complies with the rules which reflect the objectives of the principal. The agent’s utility depends on the action chosen, where $\Delta U_A \equiv U_A(a_c) - U_A(a_n) > 0$. That is, in absence of any control mechanism, the agent has an incentive to cheat.²

²In contrast to the standard P-A model, the agent does not receive any wage but simply chooses between the two actions. His “reservation utility” is thus $U_A(a_n)$ because he can always guarantee himself this utility level by complying with the rules.

The supervisor is supposed to monitor the action of the agent. He can do so at costs c_s . If he monitors, he discovers the agent's action with certainty.³ However, he may also opt not to monitor in which case his costs are zero. The supervisor makes a report to the principal. He can report cheating only if he has monitored and found evidence for cheating. If he reports cheating, the agent has to pay a fine P_A^C . If the supervisor hasn't found evidence for cheating (either he has not monitored or the agent has not cheated), the supervisor cannot produce evidence of cheating and the agent cannot be punished.⁴

Depending on the report that the supervisor makes, he receives a payment from the principal. We assume that any positive rent that the supervisor may receive can be extracted from him ex-ante.⁵ Thus, instead of considering the two payments for the different reports explicitly, we only need to focus on the difference between the payment which the supervisor receives when he reports cheating and when he doesn't. We will call this the "reward" r . Also, without loss of generality, the supervisor's reservation utility is normalized to zero.

If the supervisor has monitored and discovered cheating, he can be bribed by the agent. In this case, he reports nothing and receives a bribe b .⁶

The principal derives utility from the agent's action, $U_P(a)$, where $\Delta U_P \equiv U_P(a_n) -$

³In a richer model, one could model the supervisor's probability of finding out the agent's action as an increasing function of monitoring effort and thus costs. However, as we will see, in equilibrium the supervisor is going to monitor with a probability smaller than one. Thus, we have a similar effect.

⁴This is an important simplification, as it rules out the possibility of extortion: in our model, the supervisor can threaten to report cheating only when cheating and monitoring has occurred. A model of extortion can be found e.g. in Lambert-Mogiliansky [6].

⁵Since the agent by assumption has to take one action, he is obliged to "participate". Thus, if he received a rent, it could not be extracted from him ex-ante. However, we will see that in equilibrium, the agent get precisely his "reservation utility" $u_A(a_n)$.

⁶Note that we assume here that the side-contract is enforceable which is in line with the literature. See Tirole [13] for a discussion on enforceable vs. self-enforcing contracts.

$U_P(a_c) > 0$. Importantly, we assume that $\Delta U_P > \Delta U_A$. If this was not the case, then the principal and the agent could raise their joint surplus by direct negotiation and the supervisor becomes redundant (compare with footnote (1)).⁷

The principal can detect collusion (if it occurred) through investigation. He chooses the probability of investigation $\pi \in [0, 1]$ at cost πc_p .⁸ Investigation by the principal will reveal bribing only. It will not separately reveal that the agent has cheated. Obviously, if bribing is detected, then cheating was a precondition. What we exclude is the possibility that cheating is detected by the principal directly if bribing has not occurred.⁹ Also, we assume that the principal can commit ex-ante to the probability with which he is going to investigate. Such commitment is plausible for instance if investment in investigative capacity is needed. Then, once investigation costs are sunk, the principal will always have an incentive to carry out the investigation with all possible intensity. Another way of justifying this assumption is in a repeated game setting.

If the principal has discovered collusion, the supervisor will be fined P_S^B and the agent will be fined P_A^B . All parties are assumed to be risk-neutral.¹⁰

The structure of the game is depicted in Figure 1, omitting pay-offs for notational simplicity: At the first stage of the game, the principal (P) chooses π (as well as penalties and the reward). Then, agent (A) and supervisor (S) choose simultaneously whether to

⁷In contrast, the standard “beneficial grease argument” presupposes that regulation is exogenous. In that cases, as compliance with harmful regulation is circumvented, bribery increases efficiency. However, the possibility to extract bribes from agents may motivate bureaucrats to create obstacles. In that sense, it can be argued that the degree of regulation is endogenous (see for instance Kaufmann & Wei [2]).

⁸To distinguish, we shall call the supervisors action “monitoring” whereas the term “investigation” is reserved for the principal’s action.

⁹As an illustration, consider FBI investigators who are capable to identify corruption in tax authorities, but are not trained to identify tax fraud. Since in principle the FBI could pursue the latter by hiring a supervisor, our assumption amounts to saying that we do not consider multiple supervisors, an assumption in line with the literature.

¹⁰Our results extend to the case with risk aversion

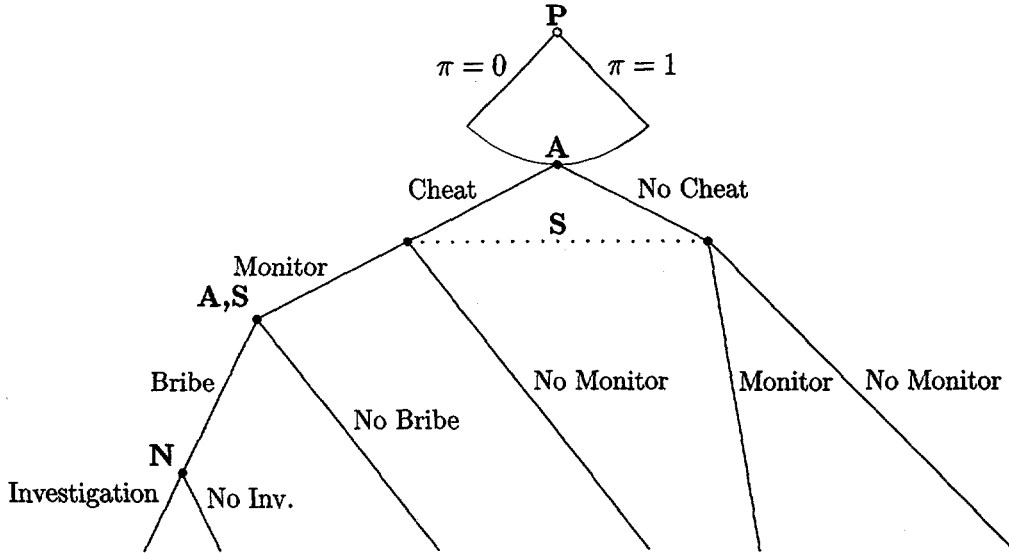


Figure 1: Extensive form of the game

cheat and to monitor. If the agent has cheated and the supervisor has monitored, they then play a cooperative game (A,S) over whether and how to collude. We do not model this explicitly but rather limit ourselves to the outcome which depends on the parameters chosen by the principal in the first stage (see below). Eventually, “Nature” (player N) decides whether investigation is carried out or not with probabilities π and $(1 - \pi)$.

Consider first the case where the agent has cheated and the supervisor has monitored. A necessary condition for the supervisor and the agent to collude is that their joint surplus from colluding is positive, or

$$P_A^C \geq r + \pi(P_A^B + P_S^B) \tag{1}$$

where $\pi \in [0, 1]$ is the probability that the principal investigates. The left hand side

denotes the gross gains from collusion, that is the penalty for cheating which is thereby saved. The right hand side are the combined expected costs of collusion, that is the foregone reward and the expected penalties for bribery. Note that we have written the inequality in a way that collusion takes place if eq.(1) is fulfilled with equality.¹¹

We assume that all supervisors are willing to accept and all agents are willing to pay a bribe with certainty if their respective expected pay-offs are thereby raised. Thus, the principal anticipates perfectly for given parameters whether the supervisor and agent will collude or not, provided the agent has cheated and the supervisor has monitored.¹²

The role of the bribe is to distribute the joint surplus so that both can expect to gain from colluding. The supervisor wants at least to be compensated for his expected losses. Thus, if bribing occurs, the bribe can be expressed as

$$b = k[P_A^C - r - \pi(P_A^B + P_S^B)] + r + \pi P_S^B \quad (2)$$

where k is some number $\in [0, 1]$ representing the bargaining power of the supervisor and is given exogenously. A situation where the supervisor can make a take-it-or-leave-it-offer is represented by $k = 1$, i.e. the agent is pushed down to his reservation utility. In contrast, for $k = 0$, the supervisor's rent from colluding is zero. For $0 < k < 1$, both par-

¹¹For technical reasons, i.e. to ensure the existence of the equilibrium, we will assume that in case of indifference the agent and the supervisor will do whatever the principal wants them to do. That is, if the principal wants to implement the collusion-inducing regime, the agent and the supervisor will collude if in principle they are indifferent. Likewise, they will not collude if the principal wants to implement the collusion-proof regime.

¹²The point that we want to make here is that even if all supervisors can be bribed, collusion may be induced in the optimal contract. Clearly, if the fraction of honest supervisors is sufficiently high, an optimal contract will never be collusion-proof if preventing collusion is costly. Kofman & Lawaree [4] construct a model where two types of supervisors, honest and dishonest, exist, whereby the honest type cannot be bribed. They characterize under which circumstances the non-collusion-proof contract is optimal, i.e. how high the fraction of honest supervisors has to be in order to have an optimal contract which is not collusion-proof.

ties receive a positive rent from colluding. We assume that k is known to the principal.¹³

At the first stage of the game, the principal maximizes his expected surplus by choosing appropriate values for π, P_A^C, P_A^B, P_S^B . Thereby, he explicitly considers the game that is subsequently played by the supervisor and the agent. In choosing parameters, the principal takes into account that collusion may or may not arise. In order to solve the principal's maximization problem, we have to examine the collusion-proof and the collusion-inducing regime separately.

2.2 The Collusion-Proof Regime

For collusion not to happen, the supervisor has to have an incentive to report truthfully if he has found evidence that the agent has cheated. Reversing the inequality in eq.(1) yields a condition for bribing not to occur, that is¹⁴

$$P_A^C \leq r + \pi(P_A^B + P_S^B) \quad (3)$$

Let us first consider the second stage of the game, that is, the simultaneous game played by the supervisor and the agent after the principal has chosen penalties, rewards and the probability of investigation. Since now by assumption incentives are such that the supervisor will always report truthfully if he finds the agent cheating, the game can be represented by the following normal form:

¹³This last assumption is not crucial for our results, but it simplifies the notation substantially.

¹⁴Note that the inequality again includes the case of indifference, so that collusion does arise if the agent and the supervisor are indifferent (compare footnote (11)).

		Agent	
		Cheating	No Cheating
Superv.	Monitoring	$U_A(a_c) - P_A^C$ $r - c_s$	$U_A(a_n)$ $-c_s$
	No Monit.	$U_A(a_c)$ 0	$U_P(a_n)$ 0

Figure 2: Collusion-Proofness

For $r > c_s$ and $P_A^C > \Delta U_A > 0$, the unique Nash equilibrium is in mixed strategies.¹⁵ Equilibrium probabilities are given by

$$\sigma_{cp}^* = \frac{c_s}{r} \quad (4)$$

$$\mu_{cp}^* = \frac{\Delta U_A}{P_A^C} \quad (5)$$

where $\sigma \in [0, 1]$ denotes the probability that the agent cheats and $\mu \in [0, 1]$ denotes the probability that the supervisor monitors. The subscript *cp* stands for the collusion-proof regime. While cheating and monitoring occur with positive probability, bribing does not since eq.(3) is satisfied by assumption.

Examining eq.(4), if the supervisor's reward is raised, the equilibrium probability of cheating decreases (in order for the supervisor to remain indifferent between monitoring or not). Similarly, in eq.(5), if P_A^C increases, the equilibrium probability of monitoring is reduced. Since the agent is indifferent between cheating or not, his expected pay-off in both cases is $U_A(a_n)$. The supervisor is indifferent between monitoring or not, thus his expected pay-off is zero.

¹⁵If $P_A^C \leq \Delta U_A$, then "Cheating" is a dominant strategy. It is easily verified that this is never optimal for the principal. Likewise, if $r \leq c_s$, then "No Monitoring" is a dominant strategy. We assume here that parameters are such that this is never optimal for the principal, i.e. the costs of monitoring are sufficiently small. If this was not the case, then the problem would become both trivial and unrealistic.

Let us now go back to the first stage of the game. Since all penalties and rewards are mere transfers, the joint surplus of all three players is given by¹⁶

$$V = \sigma[U_P(a_c) + U_A(a_c)] + (1 - \sigma)[U_P(a_n) + U_A(a_n)] - \mu c_s - \pi c_p \quad (6)$$

Subtracting the agent's and the supervisor's expected pay-off in the collusion-proof regime and rearranging, the principal's expected pay-off is

$$V^P = U_P(a_n) - \sigma_{cp}^*[\Delta U_P - \Delta U_A] - \mu_{cp}^* c_s - \pi c_p \quad (7)$$

Thus, the principal's problem in the collusion-proof regime is given by

$$\max_{P_A^C, P_A^B, P_S^B, r, \pi} V^P = U_P(a_n) - \sigma_{cp}^*[\Delta U_P - \Delta U_A] - \mu_{cp}^* c_s - \pi c_p \quad (P1)$$

$$\text{s.t. } r \geq P_A^C - \pi(P_A^B + P_S^B) \quad (NCC)$$

where σ_{cp}^* and μ_{cp}^* are given by (4) and (5). As we want to compare the solution to this problem with the collusion-inducing regime, we defer the solution to the subsequent sections.

2.3 The Collusion-Inducing Regime

Collusion will arise if the agent and the supervisor can make themselves better off (eq.(1)). For a given probability π of investigation by the principal, the pay-offs of the agent and the supervisor are as follows, where the bribe is given by eq.(2):

¹⁶Note that the joint surplus as given by eq. (6) is defined for *all* regimes, not only the collusion-proof

		Agent	
		Cheating	No Cheating
Superv.	Monitoring	$U_A(a_c) - b - \pi P_A^B$ $b - c_s - \pi P_S^B$	$U_A(a_n)$ $-c_s$
	No Monitoring	$U_A(a_c)$ 0	$U_A(a_n)$ 0

Figure 3: Collusion

The mixed strategy equilibrium is determined by the following equations:¹⁷

Agent:

$$U_A(a_c) - \mu[b + \pi P_A^B] = U_A(a_n) \quad (8)$$

Supervisor:

$$\sigma[b - \pi P_S^B] - c_s = 0 \quad (9)$$

Substituting for b , equilibrium probabilities μ^* and σ^* are given by

$$\mu_c^* = \frac{\Delta U_A}{kP_A^C + (1-k)[\pi(P_A^B + P_S^B) + r]} \quad (10)$$

and

$$\sigma_c^* = \frac{c_s}{k[P_A^C - \pi(P_A^B + P_S^B)] + (1-k)r} \quad (11)$$

regime.

¹⁷Again we rule out by assumption parameter values such that "Cheating" or "No Monitoring" are dominant strategies.

where the subscript c stands for the collusion-inducing regime.

A number of interesting observations can be made here. Consider first a rise in P_A^C . The direct effect on the cheating probability is zero because even if the agent is found cheating, he never actually pays the fine. However, raising the penalty for cheating raises the bribe which has to be paid by the agent if he is caught cheating. As bribing becomes more expensive, for a given probability of monitoring the agent will no longer be indifferent between cheating and not cheating but instead prefer the latter one. Thus, in the new equilibrium, the probability of monitoring must have declined for the agent again to be indifferent between his two possible actions. Likewise, for a given probability of cheating, as the bribe increases, it is now more profitable for the supervisor to monitor rather than not to do so. Thus, in the new equilibrium the probability of cheating must have decreased.

Raising penalties for bribery has similar effects. Increasing P_A^B lowers the bribe. However, cheating becomes less attractive for a given probability of monitoring because the bribe decreases by less than the expected penalty for the agent increases. This makes cheating less attractive thereby lowering the equilibrium probability of monitoring. Also, for a given probability of cheating the smaller bribe discourages monitoring and hence raises the equilibrium probability of cheating. A higher P_S^B , though raising the bribe, reduces the probability of monitoring and increases the probability of cheating in the same way as P_A^B .

The principal's objective function is now identical to eq.(7) with the exception that equilibrium probabilities for cheating and monitoring are different. Also, the inequality of the constraint is now reversed, since the principal implements a regime in which it pays for the supervisor and the agent to collude. Summarizing, the principal's problem

is

$$\max_{P_A^C, P_A^B, P_S^B, r, \pi} V^P = U_P(a_n) - \sigma_c^* [\Delta U_P - \Delta U_A] - \mu_c^* c_s - \pi c_p \quad (\text{P2})$$

$$\text{s.t. } r \leq P_A^C - \pi(P_A^B + P_S^B) \quad (\text{CC})$$

where σ_c^* and μ_c^* are given by eqs.(10) and (11).

We are now able to compare both the collusion-inducing and the collusion-free case and can characterize the optimal regime for the principal.

3 Optimal Contracts without Bounds

For unbounded penalties and rewards, we are going to replicate a result within our framework which was first put forward by Becker [1]:

Lemma 1 *In the collusion free regime, a solution to the principal's problem does not exist. The principal's supremum pay-off is given by*

$$V^P = U_P(a_n) \quad (12)$$

and can be approximated arbitrarily closely for $r \rightarrow \infty, P_A^C \rightarrow \infty$. Hence cheating and monitoring occur in equilibrium with arbitrarily small probability while investigation occurs with zero probability. Moreover, the principal's pay-off can never be higher under any other regime.

Proof:

It is clear by inspecting the principal's objective function in (P1) or (P2) that a utility higher than $U_P(a_n)$ cannot be attained. Raising r prompts the agent to cheat with

lower probability. This leaves the expected reward and thus the equilibrium probability for monitoring unaltered.¹⁸ Similarly, increasing the penalty for cheating prompts the supervisor to lower his probability of monitoring. This leaves the expected penalty and thus the equilibrium probability for cheating unaltered.

As long as r is strictly higher than P_A^C , the condition for collusion-proofness is fulfilled for any $\pi \in [0, 1]$. Since the principal's objective function is monotonically decreasing in π in the collusion-free regime, the optimal level of (costly) investigation for the principal is zero. Thus, if the principal has complete discretion over fines, in the limit cheating, monitoring and investigation do not occur in equilibrium. An immediate consequence of this is the following:

Corollary 1 *Let the first best be defined as the maximum of the joint surplus of all three actors given by eq.(6). For unbounded penalties and rewards, the first best outcome can never be reached. It can be approximated arbitrarily closely by letting penalties and rewards go to infinity.*

Proof:

First, we need to establish that the first best cannot be reached under *any* regime. To see this, note that the first best levels of σ , μ , and π are all zero since $\Delta U_P - \Delta U_A > 0$ by assumption. This is because investigation as well as monitoring are wasteful activities in themselves (justified only if they sufficiently reduce cheating), and therefore do not occur in the first best which is thus given by $U_P(a_n)$. As we have ruled out parameter values such that “no cheating” and “no monitoring” is an equilibrium at the second stage of the game (for both regimes), it is not possible that $\sigma^* = 0 \wedge \mu^* = 0$ in equilibrium.

¹⁸The expected reward is $\sigma^* \mu^* r = \mu^* c_s$ and the expected penalty for cheating is $\sigma^* \mu^* P_A^C = \sigma^* \Delta U_A$.

Thus, the maximum joint surplus can be never be attained but only approximated arbitrarily closely.

4 Optimal Contracts with Bounds on Penalties or Reward

4.1 Bounds on Penalties

In many real world circumstances, the principal does not have complete discretion over penalties. Here, consider the case where penalties are bounded from above, that is, $P_A^C \leq \bar{P}_A^C$, $P_A^B \leq \bar{P}_A^B$ and $P_S^B \leq \bar{P}_S^B$.¹⁹ These upper bounds might exist for a variety of reasons that we may discuss, but will not model explicitly. One consideration is that the agent's wealth will be a natural upper limit for monetary fines.²⁰ Second, society might impose (or respect) bounds on moral grounds; it can be hard to justify for instance a death sentence for bribery. Third, bounds for penalties might be induced on efficiency grounds if higher penalties need to be reserved for the deterrence of more severe crimes.²¹ Fourth, if cheating and colluding is detected with error, then penalties may be bounded to contain the implications of erroneous convictions.

Imposing bounds on penalties as additional constraints, the principal's maximization

¹⁹Clearly, for penalties to make "sense" $\bar{P}_A^B > \bar{P}_A^C$ must be satisfied.

²⁰For an explicit consideration of non-monetary penalties (i.e. imprisonment), see e.g. Polinsky and Shavell [9].

²¹See e.g. Shavell [10] for details.

problem can be summarized as follows:

$$\begin{aligned}
\max_{P_A^C, P_A^B, P_S^B, r, \pi} \quad & V^P = U_P(a_n) - \sigma^*[\Delta U_P - \Delta U_A] - \mu^* c_s - \pi c_p && \text{(P1') or (P2')} \\
\text{s.t.} \quad & P_A^C \leq \bar{P}_A^C \\
& P_A^B \leq \bar{P}_A^B \\
& P_S^C \leq \bar{P}_S^B \\
& r \underset{\geq}{\leq} P_A^C - \pi(P_A^B + P_S^B) && \text{(NCC) or (CC)}
\end{aligned}$$

where σ^* and μ^* are given by eqs. (4) and (5) in the collusion-proof case and by (10) and (11) in the collusion case. Also, the inequality in the last constraint (NCC or CC) again depends on the regime considered.

Let us now state our first result for this case:

Proposition 1 *For bounded penalties and an unbounded reward, a solution to the principal's problem does not exist.*

(a) *In the collusion-proof regime, The principal's supremum pay-off is given by*

$$V^P = U_P(a_n) - \frac{\Delta U_A}{\bar{P}_A^C} c_s \quad (13)$$

and can be approximated arbitrarily closely for $r \rightarrow \infty$. Thus, cheating occurs with arbitrarily small probability whereas monitoring occurs with a positive probability which is determined by the upper bound of the penalty.

(b) *The principal's expected pay-off is never higher in the regime where collusion occurs compared to the collusion-free environment.*

Proof:

(a) In the collusion-proof case, the principal's objective function is monotonically decreasing in μ^* and σ^* . Since $\frac{\partial \sigma^*}{\partial r} < 0$ and $\frac{\partial \mu_{cp}^*}{\partial P_A^C} < 0$, in the optimum, $P_A^C = \bar{P}_A^C$ and $r \rightarrow \infty$.

(b) The proof is relegated to the appendix.

In the collusion-proof regime, the expected reward for monitoring will not change with r since the probability of cheating decreases proportionally as the reward increases, thus leaving the equilibrium probability of monitoring unaltered. Similarly, increasing the penalty for cheating will reduce the probability of monitoring while leaving the probability for cheating unaltered. However, this can only be done up to the upper bound, hence monitoring occurs with positive probability.

The intuition for the second part of the proposition is as follows. By inspection of the principal's objective function it is clear that in both regimes the optimal reward is as high as possible. However, if the reward is too high compared to the penalties, bribery becomes unprofitable. Thus, to ensure the collusion-inducing regime, the reward may not be set above an upper level, which implies that cheating occurs with strictly positive probability. In contrast, by letting the reward go to infinity, the collusion-proof regime is implemented and cheating only occurs with arbitrarily small probability. It is this latter difference in cheating which causes the difference in the principal's pay-offs in the two regimes.

4.2 Bounds on the Reward

Now let us consider the case where penalties are unbounded, but the reward is bounded. It is not difficult to argue that in many contexts, a salary for civil servants which steeply

depends on their success on catching potential cheaters is difficult to get accepted for several reasons. For instance, in Washington, D.C., New York, Oslo and other cities, citizens have demanded change when too steep incentives made issuers of parking tickets overzealous. Also, for large government contracts possible bribes can be substantial, so that the rewards necessary to deter all collusion could be beyond the scope of a government budget and a civil service employment contract. On the other hand, in some countries, even minor offences as petty theft can lead to a loss of limb, and in China corruption may lead to death penalty. So, in the limit penalties can be thought of as unbounded.

The problem which the principal is facing is similar to (P1') or (P2') with the exception that now the reward is bounded. Thus

$$\begin{aligned} \max_{P_A^C, P_A^B, P_S^B, r, \pi} \quad & V^P = U_P(a_n) - \sigma^*[\Delta U_P - \Delta U_A] - \mu^*c_s - \pi c_p & (14) \\ \text{s.t.} \quad & r \leq \bar{r} \\ & r \geq P_A^C - \pi(P_A^B + P_S^B) & (\text{NCC}) \text{ or } (\text{CC}) \end{aligned}$$

where σ^* and μ^* are again given by eqs.(4) and (5) in the collusion-proof case and by eqs.(10) and (11) in the collusion case. The inequality of the last constraint depends on whether the principal wants to implement the collusion-proof (NCC) or the collusion-inducing (CC) regime.

Note that in the collusion-proof regime, it is optimal to reduce π as long as NCC is

not violated. Solving NCC for π yields

$$\pi \geq \frac{P_A^C}{P_A^B + P_S^B} - \frac{\bar{r}}{P_A^B + P_S^B} \quad (15)$$

As we show in the Lemma 2 of the appendix, it is always optimal to set all penalties as high as possible for both regimes. Thus, in the limit, the principal will let go all fines to infinity. As the fines for bribery go to infinity, it is clear that the second term in (15) vanishes while the first term will either stay constant, converge to a constant, or go to zero or infinity depending on how fines go to infinity. Since π can only take on values between zero and one, as the first term increases beyond one, then the regime will necessarily be one of collusion.

Now, our result in this context can be stated as follows:

Proposition 2 *For unbounded penalties and a bounded reward, a solution to the principal's problem does not exist.*

(a) *Collusion-proof regime: The principal's supremum pay-off is given by*

$$V^P = U_P(a_n) - \frac{c_s}{\bar{r}}(\Delta U_P - \Delta U_A) \quad (16)$$

This supremum can be approximated arbitrarily closely as $P_A^C \rightarrow \infty, P_A^B \rightarrow \infty, P_S^B \rightarrow \infty$ and $\frac{P_A^C}{P_A^B + P_S^B} \rightarrow 0$. Monitoring and investigating occurs with arbitrarily small probability whereas cheating occurs with a positive probability which is determined by the upper bound of the reward.

(b) *Collusion-inducing regime: The principal's supremum pay-off is given by*

$$V^P = U_P(a_n) \quad (17)$$

and can be approximated arbitrarily closely as $P_A^C \rightarrow \infty$. Monitoring and cheating occurs with arbitrarily small probability while investigation occurs with zero probability. Hence, first best can be attained arbitrarily closely.

Proof:

(a) Consider first the reward. Since the principal's utility increases monotonically in τ , the optimal reward must be equal to its upper bound. A similar argument holds for P_A^C , thus in the optimum, it will go to infinity. However, to ensure that the NCC holds, bribing penalties will also have to go to infinity in a way that $\frac{P_A^C}{P_A^B + P_S^B} \leq 1$. Moreover, if the penalty for cheating relative to bribing penalties goes to zero, an arbitrarily small probability of investigation will suffice to ensure collusion-proofness. Hence, in the limit, monitoring and investigation do not occur.²²

(b) Both the equilibrium probability of monitoring and cheating decrease monotonically in P_A^C , thereby raising the principal's utility. Thus in optimum, the penalty for cheating will go to infinity. Setting $\pi = 0$ ensures collusion is profitable for $P_A^C \geq \bar{r}$ while investigation costs are zero. An immediate corollary is the following:

Corollary 2 *The principal's expected pay-off in the collusion-inducing regime can always be made strictly higher than in the case of a collusion-proof contract.*

The intuition is as follows: In the collusion-free regime, the equilibrium probability of cheating is determined by the reward to the supervisor. Since this reward is bounded by assumption, it follows that cheating occurs with positive probability which lowers welfare and thus the principal's utility. In contrast, in the collusion-inducing regime,

²²If for efficiency or justice reasons beyond the scope of the model the principal does not want to let the ratio go to zero, additional investigation costs of $\pi^* c_p$ would arise where π^* is given by the minimum amount of investigation necessary to ensure collusion-proofness.

both the probability of monitoring and cheating are linked to the cheating penalty via the potential bribe. Thus, as this penalty grows, so does the bribe which reduces cheating and monitoring probabilities.

In the collusion-inducing regime, the bribe is a subtle way of increasing the supervisor's reward if his "official reward" r is bounded for some reasons. Via the bribe, the agent's cheating is lowered because otherwise the supervisor would find it profitable always to monitor. This effect is identical to the one present in a collusion-free regime with an increased reward. In addition, an increased bribe also reduces the supervisor's monitoring because otherwise the agent would never find it profitable to cheat. This second effect is similar to increasing the cheating penalty in the collusion-proof regime. The bribe thus plays a double function. A raise works like increasing the penalty for cheating and the reward to the supervisor at the same time.

5 Optimal Contracts with Bounds on Penalties and the Reward

So far, we have considered a number of special cases, namely that either penalties and/or the reward can be made arbitrarily high. However, under reasonable circumstances (and we have made a case in the previous sections) both penalties and the reward to the supervisor are bounded. Therefore, it is interesting to derive the optimal contract in such an environment. In particular, we are interested in whether the principal will find it optimal to allow for some degree of collusion.

Consider first the optimal reward. Inspecting the principal's objective function in the collusion-proof case, it is clear that cheating decreases monotonically in r , so the principal's utility increases monotonically in the supervisor's reward. In the collusion-

inducing regime, both cheating and monitoring decrease in the reward again implying monotonicity.

As the reward is increased gradually, it eventually reaches a level where collusion becomes unprofitable. This is because at sufficiently high levels of r , the bribe has to be so high to compensate the supervisor for the foregone reward that it is cheaper to pay the cheating penalty. This “critical value” of r is defined by $r = P_A^C - \pi(P_A^B + P_S^B)$, i.e. the transition of the collusion-inducing regime to the collusion-free regime.

The principal’s objective function is continuous in r even at this “critical value”. To see this, note that

$$\lim_{r \rightarrow [P_A^C - \pi(P_A^B + P_S^B)]} \sigma_c^* = \sigma_{cp}^* \quad (18)$$

and

$$\lim_{r \rightarrow [P_A^C - \pi(P_A^B + P_S^B)]} \mu_c^* = \mu_{cp}^* \quad (19)$$

In words, at the critical value for r where collusive behaviour becomes unprofitable, equilibrium probabilities in the collusion-inducing and the collusion-proof regime are identical, ensuring continuity in the objective function.

Since the principal’s objective function is continuous and monotonically increasing in r for both regimes and continuous at the point of transition, the optimal reward must be equal to its upper bound regardless of the regime implemented.

A similar argument holds for penalties. In Lemma 2 in the appendix we show that optimal penalties are at their upper bounds irrespective of the regime. Again, it is

easy to show that monitoring and cheating probabilities in the collusion-proof regime converge to those in the collusion-inducing regime as the cheating (bribing) penalty attains its “critical value”. Hence the principal’s utility is continuous and monotonically increasing in P_A^C (P_A^B, P_A^S) over the entire domain.

Thus, with the reward and penalties given by their upper bound, we only need to consider the change in the principal’s objective function as π changes.

First, similar to above, notice that as π is raised sufficiently, the regime eventually becomes collusion-free. This is because a higher probability for detecting collusion increases expected penalties for bribery which will eventually outweigh the gains. Again, the principal’s objective function is continuous in π . Similar to above, note that as the investigation probability approaches its “critical value” $\tilde{\pi} \equiv \frac{\bar{P}_A^C - \bar{r}}{\bar{P}_A^B + \bar{P}_S^B}$, $\lim_{\pi \rightarrow \tilde{\pi}} \sigma_c^* = \sigma_{cp}^*$ and $\lim_{\pi \rightarrow \tilde{\pi}} \mu_c^* = \mu_{cp}^*$. Again, the objective function is continuous at the point of transition of the two regimes.

We have thus established that we only need to examine the principal’s objective function as a function of π , and that moreover it is continuous in the investigation probability.

Consider first the collusion-proof regime. The first derivative of the objective function with respect to π is given by

$$\frac{\partial V^P}{\partial \pi} = -c_p \quad \text{if } \bar{r} \geq \bar{P}_A^C - \pi(\bar{P}_A^B + \bar{P}_S^B) \quad (20)$$

Thus, in an collusion-proof environment, the marginal utility of an additional “probability unit” of investigation is negative. Since collusion does not occur, increased π does not yield any additional benefits while causing additional investigation costs. Thus the

optimal investigation probability in this environment is such that agent and supervisor are just indifferent between colluding or not.²³

$$\pi_c^* = \frac{\bar{P}_A^C - \bar{r}}{\bar{P}_A^B + \bar{P}_S^B} \quad (21)$$

Now consider the case where the principal wants to implement a regime which gives rise to collusion. The first derivative with respect to π in the case is

$$\begin{aligned} \frac{\partial V^P}{\partial \pi} = & \left[-\sigma_c^{*2} \frac{k}{c_s} (\Delta U_P - \Delta U_A) + \mu_c^{*2} \frac{(1-k)}{\Delta U_A} c_s \right] (\bar{P}_A^B + \bar{P}_S^B) - c_p \\ \text{if } & \bar{r} \leq \bar{P}_A^C - \pi(\bar{P}_A^B + \bar{P}_S^B) \end{aligned} \quad (22)$$

It is easy to show that the second order conditions for a maximum are fulfilled for all values of π implying that the objective function is strictly concave within the collusion-inducing regime.

Due to this latter property, it suffices to consider the first derivative at the point of transition $\tilde{\pi}$. If it is positive at this point, the optimal regime is collusion-free and $\pi^* = \tilde{\pi}$. In contrast, if the slope of V^P is negative at this point, the optimal regime is one of collusion.

Evaluating the first derivative of V^P at $\tilde{\pi}$ and reformulating yields

$$-\frac{c_s}{\bar{r}^2} k (\Delta U_P - \Delta U_A) (\bar{P}_A^B + \bar{P}_S^B) + \frac{\Delta U_A}{\bar{P}_A^{C2}} (1-k) c_s (\bar{P}_A^B + \bar{P}_S^B) - c_p \stackrel{?}{\leq} 0 \quad (23)$$

The marginal utility of investigation at $\tilde{\pi}$ thus only consists of exogenously given pa-

²³Recall that we have assumed that in case of indifference, the agent and the supervisor do what the principal wants them to do. If they did not, an equilibrium would not exist in this case.

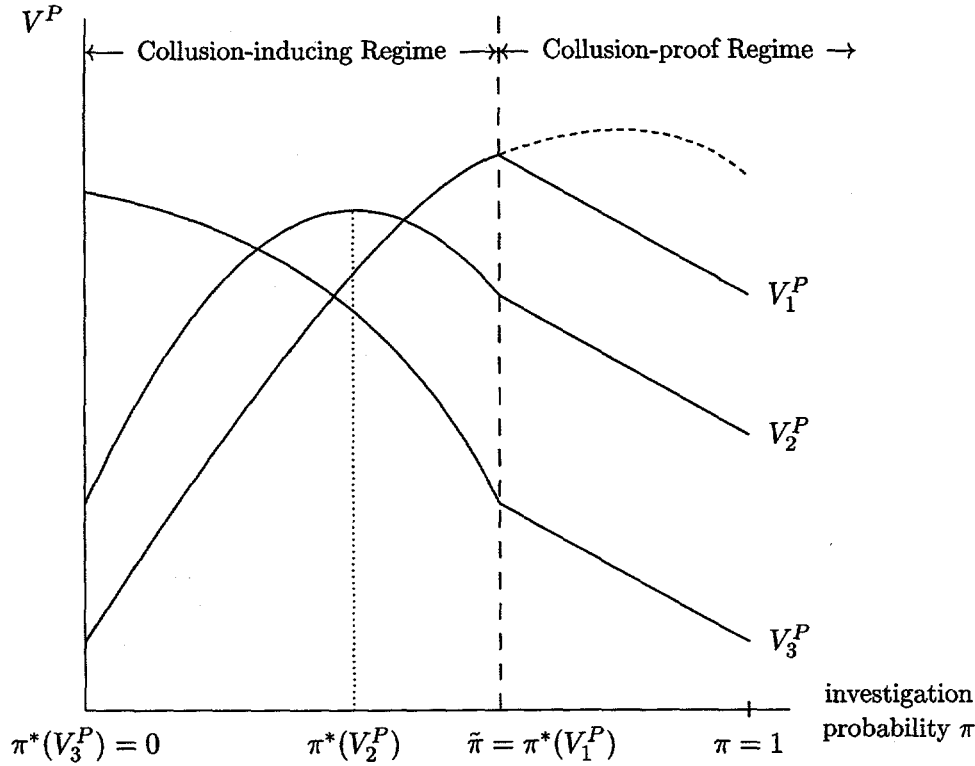
rameters. It is the sum of three terms, each describing three distinct effects. The first term, which is negative, is the effect due to change of the equilibrium probability of cheating. Cheating increases in π , because a larger π raises expected fines which lowers the gains from colluding. Thus, the direct impact of a higher investigation probability is to reduce the supervisor's expected pay-off from monitoring. To re-establish equilibrium, the cheating probability must increase which in turn reduces the principal's expected pay-off.

The second term in eq. (23) which is positive, is the effect due to monitoring, which is declining in π . As π increases, total gains from collusion decline. This decreases the agent's expected profit from cheating. To re-establish equilibrium, the monitoring probability must fall, which in turn raises the principal's expected pay-off.

Finally, the third term is simply the direct effect due to the higher cost of investigation.

The principal's problem can be represented graphically:

Optimal Level of Investigation



The figure represents three alternative scenarios for the principal's expected pay-off as a function of the probability of investigation π . The vertical dashed line separates region of π in which the agent and the supervisor collude (to the left) and do not collude. Thus, if the supervisor chooses $\pi < \tilde{\pi}$, he induces collusion, whereas for $\pi > \tilde{\pi}$, he institutes the collusion-proof regime. As pointed out earlier, within the latter, the principal's objective function is strictly concave in π while it is linear and monotonically decreasing in the collusion-proof regime (the slope is given by $-c_p$). A priori, it is not clear which regime is optimal; it depends on the parameters as pointed out above. V_1^P , V_2^P and V_3^P illustrate the three interesting cases. If the marginal utility of π is strictly positive at $\tilde{\pi}$ as for V_1^P , the optimal degree of investigation $\pi^*(V_1^P) = \tilde{\pi}$, and collusion

does not arise in equilibrium. In contrast, if the marginal pay-off is negative at $\tilde{\pi}$, then there are two cases in which collusion arises in equilibrium. Either we have an interior solution as depicted by V_2^P , where the optimal level of investigation is strictly positive ($\pi^*(V_2^P)$). In the other case, the optimal π is zero as in case V_3^P .

Using eq.(23), we are now able to interpret under which circumstances it is optimal for the principal to institute a regime which induces corruption.

First, and most obvious: The higher the costs of investigation, the more likely is collusion in the optimum.

Second, the higher the penalty for cheating, \bar{P}_A^C , the more likely is the collusion-inducing regime. The higher the penalty for cheating, the larger the gains from collusive behaviour and thus the equilibrium probability of monitoring. This implies that the effect of π will be smaller since μ_c^* is monotonically decreasing and strictly convex in π . Examining eq.(23), if the beneficial effects of π in terms of reduced monitoring is small, the two other effects will dominate, and the marginal utility of π at $\tilde{\pi}$ is negative. Thus, π will be set at a lower level, inducing collusion. Using a similar argument, one can show that higher \bar{r} makes collusion less likely.

Third, the higher the social loss from cheating ($\Delta U_P - \Delta U_A$) relative to the agent's gain from cheating (ΔU_A), the more likely is the collusion-inducing regime. In this case, it is more worthwhile to prevent cheating. The effect of raising π is to reduce the attraction of monitoring and thereby to increase cheating. Thus, when social losses from cheating are high, it may be optimal to choose the collusion-inducing regime, since greater expected bribes increase monitoring and thereby lowers cheating.

Fourth, the higher the penalties for bribery, the higher are the indirect costs (increased cheating) and benefits (reduced monitoring) of π . If the effect on cheating

dominates, then this may reduce the optimal π to a level that induces collusion.

Fifth, the higher the bargaining power of the supervisor, the more likely is the collusion-inducing regime. In the extreme, suppose the supervisor can make a take-it-or-leave-it offer, so that $k = 1$. In this case, the supervisor fixes the agent to being just indifferent between colluding or paying the fine for cheating. Examining eq.(23), $k = 1$ eliminates the effect of π on monitoring, without which the marginal utility of investigation is negative. This is because as π is raised, total gains from collusion are reduced, but since the entire gains accrue to the supervisor, the agent will not be worse off by higher investigation. Thus, the equilibrium probability of monitoring does not change while the probability of cheating increases even more in π implying that investigation has only costs (direct and indirect). In this extreme case, the optimal π is even zero. In contrast, complete bargaining power by the agent makes the collusion-proof regime more likely, but does not in the limit ensure collusion proofness. For $k = 0$, investigation only yields indirect benefits (reduced monitoring) while it still involves direct costs, so the marginal utility can be positive or negative at $\tilde{\pi}$.

Finally, let us compare some of the model's predictions with real world observations. This should not be considered serious econometric evidence, but examples that may provide support for our assumptions and predictions.

We assumed that the principal can commit ex-ante to a probability of investigation, and thus considered a Stackelberg structure. Creating an independent anti-corruption commission, such as the ones in Hong Kong or New South Wales, can perhaps be interpreted as a way of committing to a certain intensity of investigations. We know from standard models that the intensity of investigation will be higher in the Stackelberg case than in the (simultaneous move) Cournot case, and hence corruption will be lower

in the presence of an independent commission. Actually, we find both Australia and Hong Kong have low corruption indices. According to the Transparency International 1998 Corruption perception index, out of 113 countries, Australia ranked 11 (4 places ahead of Germany and 6 ahead of the USA), while Hong Kong ranked 16 (2nd best country in Asia after Singapore and ahead of USA).

Singapore's top civil servants are among the best paid worldwide. Thus, Singapore should be exceptionally placed to use promotions and salary increases to reward effort and loyalty. In the context of our model, this corresponds to a high "reward", hence we would expect the probability to observe corruption in equilibrium as relatively low. Again using the Transparency International 1998 Corruption perception index, Singapore ranks 7th and is thus the country with the lowest corruption index in Asia.²⁴

Going from country evidence to industry prose, two industries known for corruption is gastronomy/catering trade and construction. In both, a rationale for government "approval" can be the need to protect the public from hidden quality flaws. When it comes to complying with set standards, very often compliance cannot be measured in objective and verifiable terms. This scope for discretion corresponds to a high bargaining power of the supervisor our model. Therefore, we would expect the scope for corruption to be great in these industries, in all countries.

²⁴Notice that we in this argument associate pay increases at promotions with rewards, the general civil service pay level is then irrelevant. If, in contrast, loss of job or pension is interpreted as part of a bounded penalty for corruption, then the general pay level is relevant (see for instance Leite & Weidmann [7])

6 Conclusions

We study the interaction between a principal who wants an action to be implemented, an agent who may choose that action or may cheat, and a supervisor who is hired to monitor the agent's action. We consider the principal's investigation of collusive behaviour between the agent and the supervisor as well his choice of penalties and rewards. Through these choices, the principal influences expected pay-offs of the agent and the supervisor and thereby effectively decides whether they will collude (collusion-inducing regime) or not (collusion-free regime). Our model shows that investigation of potential bribery has a strong impact on the incentives to cheat and to monitor. The mechanisms differ in the two regimes. In the collusion-free regime, the only function of investigation is to guarantee that collusive behaviour is unprofitable by making expected fines for bribery sufficiently high. In contrast, in the collusion-inducing regime, the intensity of investigation affects the size of expected bribes and in turn influences optimal cheating and monitoring.

If penalties and the reward to the supervisor are unbounded, the principal institutes the collusion-proof regime. Also, the probability of monitoring and cheating becomes negligible, ensuring that first best can be attained arbitrarily closely. For a unbounded reward and bounded penalties, the collusion-free regime is still optimal. In contrast, for unbounded penalties and a bounded reward collusion arises in optimum. In both cases, the first best cannot be achieved, although in the latter case it can be attained arbitrarily closely.

In the interesting case of bounds on both penalties and the reward to the supervisor, the principal still has the option of preventing collusive behaviour simply by engaging in

a sufficiently high level of investigation. However, it may be optimal not to do so. The reason is that direct and indirect costs of additional investigation (through an increased level of cheating) may outweigh the benefits (lower level of monitoring).

Collusion in equilibrium depends on these bounds as follows. Collusion is more likely the higher the penalty for cheating and the lower the reward for the supervisor, the higher the gain to the principal relative to the losses of the agent from “No Cheating”, the higher the bargaining power of the supervisor and the higher the costs of investigation.

A practical implication of our model is that the presence of collusive behaviour may not be a “policy error”, but rather reflects an optimal policy in a constrained setting. Our work gives some indications what the relevant constraints are and thus how to improve the policy environment.

Our analysis highlights that corruption may occur in the pursuit of overall efficiency. While corruption can be eliminated completely, the model allows us to evaluate the costs and benefits.

Clearly, the model is only a first attempt to model the channels through which investigation by the principal may affect the behaviour of the other players. A number of aspects has not been considered, and should be incorporated in subsequent research. We consider the important insight of our model is that within a framework of moral hazard, it can be optimal for the principal to implement a scheme with some corruption.

Appendix

Proof of Proposition 1 (b):

Let us first derive the following useful lemma:

Lemma 2 *Optimal penalties will be at their upper bounds.*

Proof: Consider the penalties for bribing first. By inspection of the objective function of the principal and the equilibrium probabilities for cheating and monitoring, it is clear that bribing penalties always work in the same direction as does π with the exception that π causes additional costs of c_s .²⁵ Therefore, it is clear that if the principal wants to induce a positive expected penalty for bribery, it is optimal for him to raise bribing penalties to its maximum value and adjust the probability of investigation accordingly. Now consider P_A^C . Since in the collusion-proof regime $\frac{\partial \mu_{cp}^*}{\partial P_A^C} < 0$ and in the collusion-inducing regime $\frac{\partial \mu_c^*}{\partial P_A^C} < 0$ and $\frac{\partial \sigma_c^*}{\partial P_A^C} < 0$, it is again straightforward to see that the optimal penalty for cheating must be at the upper bound regardless of the regime implemented.

Thus, the principal's maximization problem in the collusion-inducing regime can be simplified as follows:

$$\max_{r, \pi} V^P = U_P(a_n) - \sigma_c^*[\Delta U_P - \Delta U_A] - \mu_c^* c_s - \pi c_p \quad (\text{P2}')$$

$$\text{s.t. } r \leq \bar{P}_A^C - \pi(\bar{P}_A^B + \bar{P}_S^B) \quad (\text{CC})$$

²⁵This is despite the fact that in the collusion-inducing regime, the fine for the principal and the agent have opposing effects on the bribe paid. While raising the agent's penalty has a negative effect on the bribe, a higher penalty for the principal raises the bribe.

where

$$\mu_c^* = \frac{\Delta U_A}{k\bar{P}_A^C + (1-k)[\pi(\bar{P}_A^B + \bar{P}_S^B) + r]} \quad (24)$$

and

$$\sigma_c^* = \frac{c_s}{k[\bar{P}_A^C - \pi(\bar{P}_A^B + \bar{P}_S^B)] + (1-k)r} \quad (25)$$

The following lemma will again prove useful:

Lemma 3 *The optimal reward in the collusion-inducing regime is given by*

$$r^* = \bar{P}_A^C - \pi^*(\bar{P}_A^B + \bar{P}_S^B) \quad (26)$$

Proof: Since $\frac{\partial \mu_c^*}{\partial r} < 0$ and $\frac{\partial \sigma_c^*}{\partial r} < 0$, the optimal reward in the collusion case must be as high as possible without preventing collusion. The highest possible reward is thus given by eq.(26) since otherwise collusion does not occur.

Now determine the optimal value for π : Let $\theta \equiv \bar{P}_A^B + \bar{P}_S^B$, then

$$\frac{\partial \mu_c^*}{\partial \pi} = -\mu_c^{*2} \frac{(1-k)\theta}{\Delta U_A} < 0 \quad (27)$$

and

$$\frac{\partial \sigma_c^*}{\partial \pi} = \sigma_c^{*2} \frac{k\theta}{c_s} > 0 \quad (28)$$

However, if the Collusion Constraint held with equality before, as π increases the CC is not fulfilled any longer. Due Lemma 3, the optimal reward must thus change in order

to re-establish equality of the CC. The change is given by

$$\frac{dr^*}{d\pi} = -\theta \quad (29)$$

and

$$\frac{\partial \mu_c^*}{\partial r} = -\mu_c^{*2} \frac{(1-k)}{\Delta U_A} < 0 \quad (30)$$

$$\frac{\partial \sigma_c^*}{\partial r} = -\sigma_c^{*2} \frac{(1-k)}{c_s} < 0 \quad (31)$$

Hence,

$$\begin{aligned} \frac{d\mu_c^*}{d\pi} &= \frac{\partial \mu_c^*}{\partial \pi} + \frac{\partial \mu_c^*}{\partial r} \frac{dr^*}{d\pi} \\ &= -\mu_c^{*2} \frac{(1-k)\theta}{\Delta U_A} + \mu_c^{*2} \frac{(1-k)}{\Delta U_A} \theta = 0 \end{aligned} \quad (32)$$

and

$$\begin{aligned} \frac{d\sigma_c^*}{d\pi} &= \frac{\partial \sigma_c^*}{\partial \pi} + \frac{\partial \sigma_c^*}{\partial r} \frac{dr^*}{d\pi} \\ &= \sigma_c^{*2} \frac{k\theta}{c_s} + \sigma_c^{*2} \frac{(1-k)}{c_s} \theta = \sigma_c^{*2} \frac{\theta}{c_s} > 0 \end{aligned} \quad (33)$$

Therefore, in optimum,

$$\frac{dV^P}{d\pi} = -\sigma_c^{*2} \frac{\theta}{c_s} (\Delta U_P - \Delta U_A) - c_p < 0 \quad (34)$$

This implies that $\pi^* = 0$. The intuition is as follows. The principal may consider a marginal increment in the probability of investigation at costs c_p . This reduces the equilibrium probability of monitoring and raises the probability of cheating for reasons pointed out in the text. At the same time, the condition which guarantees collusion is not fulfilled anymore, hence the reward must decline. This raises both the probability of cheating and monitoring. The net effect on these two changes on the equilibrium probability of monitoring is zero while it is positive on the equilibrium probability of cheating. Thus, as investigation costs and cheating go up, the principal's surplus is unambiguously lowered by additional investigation. Since this result holds for all π , it must be the case that in optimum, the principal does not monitor in the collusion-inducing regime.

The principal's utility is thus given by

$$V_P^* = U_P(a_n) - \sigma_c^*(\Delta U_P - \Delta U_A) - \mu_c^* c_s \quad (35)$$

Since in equilibrium, the CC is fulfilled with equality, eqs. (24) and (25) simplify to

$$\mu_c^* = \frac{\Delta U_A}{P_A^C} \quad (36)$$

and

$$\sigma_c^* = \frac{c_s}{P_A^C} \quad (37)$$

and therefore

$$V_P^* = U_P(a_n) - \frac{c_s}{P_A} \Delta U_P \quad (38)$$

Comparing eq.(38) with eq.(13) reveals that the expected gain for the principal is always strictly smaller in the collusion-inducing regime compared to the collusion-proof case if penalties are restricted since $\Delta U_P > \Delta U_A$ by assumption. ■

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