Pre-emptive Corruption, Hold-up and Repeated Interactions

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Final version received 8 January 2011.

This paper analyses repeated interactions between a firm and an inspector who monitors regulatory compliance. The firm may offer a bribe to pre-empt the inspection. Corruption is unfeasible in the one-shot game because of inspector hold-up. In an infinitely repeated game, we characterize the set of bribes that can be sustained as equilibrium paths using the trigger strategy. In this model, the most likely bribe-givers are not the firms that benefit the most from the illegal behaviour. Furthermore, strengthening anti-corruption policies has ambiguous welfare effects because it improves compliance only among a subset of firms, and increases monitoring effort.

INTRODUCTION

This paper analyses corruption between an inspector and an agent in a situation where the inspector must exert costly effort to imperfectly monitor the agent. Collusion in the form of bribery, referred to as corruption, may occur before the inspector spends costly monitoring effort (pre-emptively) or after the inspector incurs the cost (ex post). For example, consider Lubin’s (2003) description of corruption between border guards and opium smugglers in Afghanistan. She notes that smugglers either choose to pre-emptively bribe the guards or do so ex post only if they are caught smuggling opium. A static game modelling this situation is analysed by Samuel (2009), who builds on a model first developed by Mookherjee and Png (1995). In this model, the agent is a firm that must incur a cost of compliance, and thus has an incentive to bribe the inspector in charge of monitoring compliance. Mookherjee and Png (1995) study the welfare implications of ex post bribery and examine the effectiveness at curbing corruption of policy parameters such as the inspector’s reward for producing evidence of illegal behaviour by the firm. Samuel (2009) revisits these issues but allows for pre-emptive as well as ex post corruption (see also Motta 2009). However, there is a key issue that neither paper addresses. Corrupt contracts are not enforceable in a court of law and may therefore suffer from the hold-up problem. That is, an inspector who accepted a bribe in exchange for not inspecting or reporting a firm may nonetheless report or fine the firm after receiving the bribe. We therefore believe that repeated play is important in this context because it helps to solve the hold-up problem that exists with both pre-emptive and ex post collusion.

There is a vast literature on the type of bureaucratic or administrative corruption that we analyse in this paper (Bardhan 2005). Becker and Stigler (1974) argue that the privatization of law enforcement eliminates bribery, but Mookherjee and Png (1995) show that it is not always socially optimal because it encourages inspectors to exert too much effort. Furthermore, as long as inspectors and agents are homogeneous, it is always socially optimal to eliminate ex post bribery completely (Mookherjee and Png 1995; Besley and McLaren 1993). However, if inspectors are heterogeneous, then it is not optimal to eliminate ex post bribery (Besley and McLaren 1993). Finally, when bribery can occur either pre-emptively or ex post, then privatizing law enforcement does not necessarily eliminate
bribery, and more importantly, it is not always socially optimal to eliminate pre-emptive bribery, while it is always optimal to eliminate \textit{ex post} bribery (Samuel 2009).\textsuperscript{1}

The articles cited above do not explicitly model the way in which the corrupt contract is self-enforced. However, in the context of corruption, repeated interactions are a natural candidate to consider as an enforcement device. For instance, Mookherjee and Png write:


during a survey to the importance of repeated interactions. Similarly, Mishra (2006, p. 204) points out that ‘in organizations where there are repeated interactions between agents at different levels, [pre-emptive collusion] is the more likely form of collusion’\textsuperscript{2}

Furthermore, there are many situations where the use of repeated game strategies seems like a compelling explanation for the occurrence of bribery in the presence of hold-up. For instance, consider a recent study on bribery in the trucking industry in the Indian state of Gujarat. Trucks may be either over or under the axle-load limit, and the department of transportation authorizes weigh-station inspectors to inspect and fine trucks that violate the load limit. In order to avoid these fines, most truckers pay bribes before their trucks are inspected, i.e. pre-emptively. Indeed, the same study also points out that most of the trucks examined in the survey were those that regularly ‘cross and re-cross the check-posts in Gujarat’ (Center for Electronic Governance, 2002, p. 5). Similarly, Di Tella and Schargrodsky (2003) describe bribery between a hospital purchase manager and a supplier. In their context too, it is likely that repeated interactions matter in enforcing bribe contracts. We feel that a formal analysis of the role played by repeated interactions in enforcing pre-emptive bribery is required because they may affect the analysis of anti-corruption policies.

Repeated interactions are not the only realistic mechanism that can enforce corruption. Alternatively, the party responsible for the hold-up problem may be able to post hostages, as suggested by the literature on incomplete contracts (Williamson 1983). If such a commitment device is available, then bribery may arise in the one-shot game, thus without the use of repeated interactions. Buccirossi and Spagnolo (2006) and Lambsdorff and Nell (2007) show that for occasional one-shot illegal transactions, leniency policies that merely reduce penalties for whistle-blowing firms may endow these firms with the required punishment or commitment device. By procuring hard evidence of the corrupt transaction, the party susceptible to hold-up can use the evidence as a hostage. If the leniency policy is poorly designed, then it may enforce bribe contracts that would otherwise not be feasible because of hold-up (Buccirossi and Spagnolo 2006).\textsuperscript{3} In our model, we do not consider hostage-taking by the firm or imperfectly designed leniency policies, and consequently bribery does not occur in the one-shot game.

In addition to hostage-type mechanisms, reputation may support collusion despite the possibility of hold-up. Indeed, our focus on repeated interactions contrasts with existing papers that use infinite-horizon models of corruption between a supervisor and an agent. These rely on a framework in which interactions are short-lived because supervisors are randomly re-matched with a new agent in every period.\textsuperscript{4} In these random matching environments, equilibrium collusion is supported by reputation (see, for instance, Besley and McLaren 1993; Carillo 2000; Tirole 1992).\textsuperscript{5} In our paper, inspectors...
are homogeneous, but firms differ in their private gain from the illegal activity. In equilibrium, because of hold-up, bribes are supported by a strategy similar to the standard trigger strategy. Thus our approach is close in spirit to Lambert-Mogiliansky et al. (2007), in which heterogeneous entrepreneurs apply to a sequence of infinitely-lived bureaucrats in order to obtain approval for their project. Because each bureaucrat is unable to commit not to extract all of the surplus from the entrepreneur, in the equilibrium of the static game, no bribe is paid and no project is ever approved. In the game with an infinite horizon, strategies similar to the trigger strategy support equilibria in which bribery occurs and projects are approved. A key difference is that in our model, the inspector has an incentive to hold up the firm even when he can extract all of the firm’s surplus. Therefore Lambert-Mogiliansky et al. (2007) do not study the type of opportunistic inspector behaviour that we analyse.6

In our repeated game, pre-emptive bribery equilibria are supported by the trigger strategy of reverting to the one-shot equilibrium to punish deviations from the collusive path. Interestingly, we find that the firms that are most likely to offer pre-emptive bribes are not those that benefit the most from engaging in the illegal activity, nor those that benefit the least. Thus, in contrast with static models where the firm’s profit from engaging in the illegal activity has no effect on the incentives for corruption, in our dynamic model, the firm’s profit matters because it is lost whenever an audit finds evidence of corruption.

The result that the firm’s profit determines whether it will engage in bribery is interesting in light of case study evidence and an empirical finding that different types of firms make different choices with regard to corruption (Lubin 2003; Svensson 2003). Svensson (2003) finds that the firms that are most able to pay, as measured by expected profitability, pay higher bribes. Additionally, in his study, firms with greater refusal power, as measured by a low cost of having to exit the market, are less likely to pay bribes. In our model, conditional on paying a bribe, firms that benefit more from the illegal activity are willing to pay more. Furthermore, firms that benefit very little from the illegal activity have great refusal power since their cost of full compliance is low. It may be argued that the firms that earn the greatest benefit from the illegal activity also have a high degree of refusal power because, even when fined by the regulator, their expected payoff is high. We show that firms at these two extremes of the private benefit distribution are the least likely to pay pre-emptive bribes.

Our analysis also offers a number of comparative statics results that may be useful in assessing the value of anti-corruption policy instruments such as the penalty for bribery and the supervisor’s reward for monitoring. Contrary to the previous literature, our analysis of the feasibility of pre-emptive corruption reveals that an increase in the probability of detecting corruption, and a decrease in the penalties for corruption that leave the expected fines for bribery unchanged, unambiguously reduces the incentives for corruption. This result does not arise in existing static models and suggests that the effects of anti-corruption policies when bribery is an equilibrium in a repeated game are distinct from those in a static game.

Moreover, the welfare effects of anti-corruption policies are not straightforward to characterize because of our result that firms that engage in pre-emptive bribery are not those that benefit the most, nor those that benefit the least from the illegal activity. Rather, the firms that pay pre-emptive bribes are in an intermediate range of the private benefit distribution. As penalties for corruption are raised, fewer firms engage in pre-emptive bribery and this range shrinks. Some of the firms that previously engaged in pre-emptive bribery continue to pursue the illegal activity, facing the risk of detection by the
inspector, while other firms switch from corruption to compliance. For the former firms, increasing penalties for corruption generates higher monitoring cost without lowering the harm associated with the illegal activity, thereby decreasing overall welfare. For the latter, strengthening anti-corruption policies reduces both bribery and the illegal activity, thereby increasing social welfare. Because of this heterogeneity in responses to changes in anti-corruption policies, the overall welfare effects are not as straightforward to characterize as in the one-shot game.

The paper is organized as follows. Section I outlines the one-shot extensive form game, which we refer to as the ‘inspection game’. Section II presents the infinitely repeated game and derives results regarding the sustainability of pre-emptive corruption and comparative statics. Section III discusses the welfare effects of anti-corruption policies in the context of our model. In Section IV, we examine several extensions to our model. Section V concludes. All proofs appear in the Appendix.

1. THE ONE-SHOT GAME

In this section, we describe the simple extensive form game, a closely related version of which has been analysed by Samuel (2009), which is itself based on Mookherjee and Png (1995). Formally, there are three risk-neutral actors: the principal or the regulator, the inspector (S), and the firm (F). The regulator does not make any strategic decisions, and solely rewards the inspector and applies penalties in accordance with the law. The extensive form is given in Figure 1. In the following, we refer to this extensive-form game as the

Figure 1. Extensive form of the inspection game. N refers to a move by nature, F refers to a move by the firm, and S refers to a move by the inspector.

© The Authors. Economica © 2011 The London School of Economics and Political Science. Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main St, Malden, MA 02148, USA
inspection game. Pure strategies are easily defined, and we denote them by \( \sigma_F \) for the firm and \( \sigma_S \) for the inspector.\(^8\) The players’ expected payoffs in the inspection game are denoted by \( U_F(\sigma_F, \sigma_S) \) and \( U_S(\sigma_F, \sigma_S) \).

The firm determines its level of compliance through its choice between \( W = 0 \), the good or legal technology, and \( W = 1 \), the bad or illegal technology. There is a mass of firms distributed in the interval \([0, w_{\text{max}}]\), where \( w \) is the firm’s private benefit from choosing the bad technology. We assume that although the regulator knows the distribution of \( w \), each firm’s \( w \) is unobservable. Firms that choose \( W = 0 \) are compliant, and they receive no private benefit. The social harm or external cost from choosing \( W = 1 \) (being non-compliant) is equal to \( h \), where \( h > 0 \). Since a given firm maximizes its private benefit, absent regulation, it would always choose the bad technology. With imperfect information regarding the firm’s choice of \( W \) and costly monitoring, the regulator hires inspectors to ensure that firms comply with the regulation.\(^9\) If the firm is found guilty of not complying, it is required to pay a fine \( f \), which is set by the regulator.\(^10\) We focus on the interactions between one firm drawn from the interval \([0, w_{\text{max}}]\) and an inspector. Therefore we treat \( w \) as a parameter. Finally, we assume that the inspector cannot plant evidence on an innocent firm in order to extort a bribe from it. That is, if the firm chooses \( W = 0 \), it does not have to offer a bribe and does not pay any fine. For related analyses of extortion, see Konrad and Skaperdas (1997, 1998) or Choi and Thum (2004).

As in Samuel (2009), on visiting the firm, the inspector immediately observes whether the firm has chosen the good or the bad technology. This knowledge of \( W \) is soft, and not verifiable by a third party. Therefore in order to fine the firm, he must obtain hard, verifiable evidence by exerting effort. In this model, the inspector is not paid directly by the regulator but is given a payment of \( rf \); that is, he is given a fraction \( r \) of the fines that he is allowed to collect (\( r \leq 1 \)). In order to monitor the firm with intensity \( \mu \), the inspector must exert an effort level of \( e(\mu) \). The intensity \( \mu \in [0, 1] \) represents the probability that the inspector will be able to discover and produce verifiable evidence on whether the firm’s choice of \( W \) is equal to 1, or if instead \( W = 0 \). If the inspector discovers that \( W = 1 \), he is authorized to fine the firm and receives a reward of \( rf \). We make the following assumption on \( e(\mu) \).

**Assumption 1.** The cost function \( e(\mu) \) is continuous, strictly increasing, strictly convex and differentiable twice. Furthermore, \( \lim_{\mu \uparrow 1} e'(\mu) = \infty \) and \( e(0) = e'(0) = 0 \).

The inspector is corruptible, so he may accept a bribe from the firm. In any given interaction between a firm and an inspector, there are two stages in which collusion may occur. In the first stage, the firm can offer a pre-emptive bribe, denoted by \( B \), before the inspector has exerted any effort. Alternatively, collusion may occur in the second stage. That is, the inspector first exerts effort and then, if he finds evidence of the firm’s non-compliance, the firm may offer an \emph{ex post} bribe. In the remainder of the paper, we refer to the exchange of any strictly positive bribe as corruption. In both types of corruption, on receiving the bribe, the inspector promises to report that the firm’s technology is \( W = 0 \) and does not fine the firm at all. In the event that either one of the two bribes is exchanged, with probability \( \lambda \) an audit by the regulator may find evidence of corruption, in which case the regulator penalizes both parties for their wrongful transaction.\(^11\) A firm (the bribe-giver) found engaging in collusion in either or both stages is fined a finite amount \( pgf \) in addition to having to pay the fine \( f \). Similarly, the inspector (the bribe-taker) is penalized with a finite fine \( pt \). For simplicity, we assume that the penalties do not depend on the size of the bribes, and thus are the same whether or not both types of corruption occurred.\(^12\)
In order to establish useful notation, consider the optimal choice of monitoring intensity by an inspector who finds that the firm’s technology is $W = 1$, but anticipates that no ex post bribe will be exchanged. In this case, the inspector’s expected payoff is equal to $\mu rf - c(\mu)$. Under Assumption 1 and given $rf > 0$, the optimal choice of monitoring intensity is $\mu_n$ such that $rf = e'(\mu_n)$. The optimal value of $\mu$ is unique and satisfies $0 < \mu_n < 1$. Furthermore, define $e_n \equiv e(\mu_n)$.

Lemma 1 characterizes equilibrium behaviour and establishes the straightforward result that due to hold-up, corruption will not occur in the subgame-perfect Nash equilibrium (SPNE). This result is in sharp contrast to the equilibrium result of Mookherjee and Png (1995) and Samuel (2009) because both assume that hold-up does not arise. Lemma 1 also implies that firms with $w < \mu_n f$ choose $W = 0$ while the rest choose $W = 1$. It is important to recognize that law enforcement is welfare-enhancing even if it does not deter all types of firms from choosing the harmful technology. That is, because it prevents some firms (with $w < \mu_n f$) from choosing the bad technology, it eliminates the harm associated with these firms.

**Lemma 1.** The inspection game has a unique SPNE, and corruption never occurs in equilibrium.

If $w - \mu_n f \geq 0$, then on the equilibrium path, the firm chooses $W = 1$, and the inspector exerts effort $e_n$ and fines the firm an amount $f$ with probability $\mu_n$. In equilibrium, the firm’s expected payoff is equal to $U_F = w - \mu_n f$, and the inspector’s expected payoff is equal to $U_S = \mu_n rf - e_n$.

If $w - \mu_n f < 0$, then on the equilibrium path, the firm chooses $W = 0$ and both the firm and the inspector earn a payoff of zero.

In the analysis below, we show that explicitly modelling how repeated interactions are used to sustain collusive equilibria yields comparative statics results that differ from those obtained in the static models.

### II. AN INFINITE-HORIZON MODEL OF PRE-EMPTIVE CORRUPTION

We now consider the possibility of repeated interactions between the firm and the inspector. The model is a simple infinite-horizon game with complete information and discounting, in which the inspection game analysed in the previous section is repeated unless the regulator decides to put an end to the interaction between the two players.

**The game and definitions**

Suppose now that there are a countably infinite number of periods indexed by $t$, and that in every period, the firm must choose its technology ($W = 1$ or $W = 0$). Following the firm’s choice, the inspector investigates the firm’s actions as in the inspection game of the previous section.

In this game, a path $\tau$ is an infinite sequence of actions $\{(W_s, B_s, A_s, \mu_s, b_s, a_s)\}_{s=0}^{\infty}$. To keep things simple, we assume that for both the firm and the inspector, the observable history at the beginning of period $t > 0$ consists of the sequence $\{(W_s, B_s, A_s, \mu_s, b_s, a_s)\}_{s=0}^{t-1}$. That is, the firm’s choice of $W$ and the inspector’s choice of $\mu$ are observable by both the inspector and the firm. However, we continue to assume that the regulator is unable to observe $\mu$ and thus cannot condition the inspector’s tenure on his choice of $\mu$. Therefore in every period $t$ in which the firm and the inspector interact, the regulator observes any bribe that is exchanged with probability $\lambda$ and terminates the
relationship between the firm and the inspector if either \( B_t \), or \( b_t \), or both are strictly positive. We call a path \textit{stationary} if the players use the same actions in every inspection game on the path, that is, \((W_s, B_s, A_s, \mu_s, b_s, a_s) = (W, B, A, \mu, b, a)\) for every \( s \). Furthermore, there are paths on which some information sets are not reached. When this is so, for simplicity, we omit the actions associated with information sets that are not reached from the definition of the path.

Similar to the component inspection game, if the firm and the inspector exchanged a bribe, then they are caught with probability \( \lambda \) as a result of the audit. This raises an important question regarding payoffs in the continuation of the game following detection for corruption. For simplicity in this part of the paper, we make the following assumption, which we justify below and further discuss in Section IV.

\textit{Assumption 2.}

(i) The probability \( P(t) \) that corruption is detected in period \( t \) is given by

\[
P(t) = \begin{cases} 
\lambda & \text{if } \max\{B_t, b_t\} > 0 \text{ and } A_t = \text{Accept } \text{ or } a_t \neq \text{Reject,} \\
0 & \text{otherwise.}
\end{cases}
\]

(ii) Suppose that corruption is detected in period \( t \). Then both the firm and the inspector earn a payoff of zero in every period \( s \) where \( s > t \).

Part (i) of Assumption 2 implies that when corruption occurs at \( t \), the probability that it is detected at \( t \) given that it was not detected before is constant. Importantly, bribery in period \( t \) cannot be detected in period \( s > t \). That is, the evidence of corruption vanishes at the end of period \( t \). Part (ii) of the assumption would be appropriate if a successful audit producing evidence of bribery put an end to the interaction between the firm and the inspector. For instance, this would be the case if the inspector was dismissed and earned a reservation wage of zero, while the firm is so tightly monitored that it is forced to choose \( W = 0 \) in all subsequent periods. Thus part (ii) is in line with an extension suggested by Mookherjee and Png (1995) as well as Besley and McLaren (1993), who also assume that the inspector is dismissed when caught for bribery. Furthermore, it is also consistent with the literature on \textit{enforcement leverage}, which shows that auditing regimes where detected offenders are placed in tightly monitored groups minimize the cost of obtaining a given level of compliance (Greenberg 1984; Harrington 1988).13

Let \( U_i(t, \tau) \) be player \( i \)'s expected payoff in the inspection game in period \( t \) of the path \( \tau \), for \( i \in \{F, S\} \). When there is no ambiguity, we use the abbreviation \( U_i(t) \) to denote \( U_i(t, \tau) \). We assume that the firm and the inspector discount future payoffs using a common discount factor \( \delta \) satisfying \( 0 < \delta < 1 \).14 Player \( i \)'s discounted cumulative expected payoff in period \( t \) of path \( \tau \) in the infinitely repeated game is thus

\[
V_i(t, \tau) = U_i(t) + \sum_{s=1}^{\infty} \delta^s \prod_{k=t}^{t+s-1} (1 - P(k)) U_i(t + s),
\]

where \( P(k) \) is the probability of termination in period \( k \).

In the special case where \( \tau \) is a stationary path that involves a bribe, \( P(k) = \lambda \) for every \( k \), and \( U_i(t) = U_i \) for every \( t \). Thus individual \( i \)'s expected payoff can be simplified to

\[
V_i(t, \tau) = \sum_{s=0}^{\infty} \delta^s (1 - \lambda)^s U_i = \frac{U_i}{1 - \delta(1 - \lambda)}.
\]
On the other hand, if $\tau$ is stationary, but does not involve a bribe, individual $i$’s expected payoff is

$$V_i(t, \tau) = \sum_{s=0}^{\infty} \delta^s U_i = \frac{U_i}{1 - \delta}.$$  

Since our analysis focuses on stationary paths, we make extensive use of the expected payoff functions defined by the last two equations above.

**Definition 1 (collusive corruption).** A path $\tau^c$ is a collusive path if each player receives a payoff on $\tau^c$ that is at least as great as the discounted sum of its inspection game equilibrium payoff, and at least one player receives a strictly greater payoff.

In this section, we analyse the feasibility of pre-emptive corruption, whereby the firm chooses $W = 1$, and the inspector and the firm exchange a collusive pre-emptive bribe $B$, but the inspector spends no effort on inspection and reports that the firm used the good technology. We focus on stationary paths that are collusive in the sense of Definition 1.

Since corrupt behaviour is not subgame-perfect in the inspection game, to be part of a SPNE of the repeated game, collusive paths must be supported by punishment strategies that make them immune to deviations. The analysis of repeated extensive-form games can be challenging because of the richness of the strategic environment (Mailath and Samuelson 2006, Section 5.4). In particular, constructing optimal punishment strategies may be an arduous task. Therefore in this paper we focus on the following tractable punishment strategies. Let $\tau$ be the initial path. Suppose that player $i$ deviates from $\tau$ at some information set reached in the period-$t$ inspection game on $\tau$. Then we assume that both players behave according to sequential rationality in the continuation of the period-$t$ inspection game (that is, they use actions that are optimal at each of their information sets) and they revert to the one-shot SPNE from period $t + 1$ onwards. Thus a unilateral deviation by player $i$ early on in the period-$t$ inspection game triggers a series of (optimal) deviations in the continuation of this game. From period $t + 1$ onwards, the players employ the extensive-form counterpart of the grim trigger strategy. Below, we formally define such a strategy, which we refer to as an extensive trigger strategy.

**Definition 2 (extensive trigger strategy).** Suppose that the initial path is $\tau$, and for $i \in \{F, S\}$ let $I_{i,t}$ be an information set for player $i$ that is reached in the period-$t$ inspection game on $\tau$. For each $i$, the extensive trigger strategy in the infinite-horizon game specifies the following. Play the actions prescribed by $\tau$ as long as no deviation occurs. If a deviation occurs at information set $I_{j,t}, j \in \{F, S\}$, play the subgame-perfect equilibrium of the subgame starting from the information set that the deviation led to. Then, conditional on not being caught by the regulator in period $t$, from period $t + 1$ onwards, play the SPNE of the inspection game.

It is clear that conditional on not being caught by the regulator in period $t$, following a deviation in period $t$, the firm and inspector’s discounted expected payoffs from $t + 1$ onwards are equal to $\delta U_F^N/(1 - \delta)$ and $\delta U_S^N/(1 - \delta)$, respectively. Also, it is clear that the punishment phase of the strategy is subgame-perfect. Letting $U_F^*$ and $U_S^*$ denote expected payoffs from an optimal one-period deviation from a stationary path $\tau$, and focusing on extensive trigger strategies as defined above, $\tau$ is a stationary perfect equilibrium path if the following two conditions hold:

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determine the players’ payoffs from an optimal deviation from the path $\tau$.

The intensity of collecting a reward. Clearly, it is optimal for the inspector to choose monitoring in-
forward to show that it cannot earn more than $W = 0$ or $W = 1$ and $B < B^c$.

According to Lemma 1, if $w \geq \mu_0 f$, in the SPNE of the component game, the firm chooses the bad technology, and the inspector inspects the firm and imposes a fine $f$ with probability $\mu_n$. Furthermore, the respective players earn payoffs equal to $U^N_F = w - \mu_0 f$ and $U^N_S = \mu_n f - e_n$. Otherwise, the firm chooses $W = 0$ and both players earn a payoff of zero.

To characterize collusive perfect equilibrium pre-emptive bribes, it is necessary to determine the players’ payoffs from an optimal deviation from the path $\tau^c$. To illustrate the incentives involved, suppose that $w \geq \mu_0 f$ holds. First, consider the firm. It is straightforward to show that it cannot earn more than $U^N_F$ by deviating from the path. Indeed, if it chooses $W = 0$, then its payoff is equal to zero, which is less than or equal to $U^N_F$. On the other hand, if it offers $B < B^c$, then given the type of punishment strategies employed, the inspector will optimally accept the bribe, but spend effort $e_n$. Hence the firm obtains a payoff that is less than or equal to $U^N_F$ from the deviation. Second, consider the inspector. An optimal deviation for the inspector consists in holding up the firm by accepting $B^e$, but spending some effort to find hard evidence against the firm in the hope of collecting a reward. Clearly, it is optimal for the inspector to choose monitoring intensity $\mu_n$ to earn $\mu_n f - e_n$ in the continuation of this period’s game. Therefore the inspector’s payoff from an optimal deviation in period $t$ is equal to $B^e + \mu_n f - e_n - \lambda p_t$.

Lemma 2 provides a necessary and sufficient condition for a pre-emptive bribe to be sustainable as a perfect equilibrium. Depending on the size of $w$ ($\geq \mu_0 f$ or $< \mu_0 f$), if either equation (3) or (4) below is satisfied, then there exists a range of bribes that are collusive and can be sustained as a perfect equilibrium using the extensive trigger strategy to punish deviations.

**Lemma 2.** Suppose that $w \geq \mu_0 f$. Then a collusive stationary perfect equilibrium path $\tau^c = \{(1, B^c, 0, 0)\}$ exists if and only if

$$w - \lambda (1 + p_g) f - \lambda p_t \geq \frac{1 - (1 - \lambda) \delta}{1 - \delta} U^N_F + G(\lambda, \delta) U^N_S,$$

where

$$G(\lambda, \delta) = \frac{1 - \delta + \lambda \delta^2 - \lambda^2 \delta^2}{\delta (1 - \delta)(1 - \lambda)}.$$

Suppose that $w < \mu_0 f$. Then a collusive stationary perfect equilibrium path $\tau^c = \{(1, B^c, 0, 0)\}$ exists if and only if

$$w - \lambda (1 + p_g) f - \lambda p_t \geq \frac{1 - \delta (1 - \lambda)}{\delta (1 - \lambda)} (\mu_n f - e_n).$$
The left-hand sides of both (3) and (4) represent the per-period total surplus from corruption, which is equal to the benefit from engaging in the illegal activity minus the expected penalties. The right-hand side of (3) depends on $U_N^f$, the firm’s one-period payoff from refusing to collude, as well as $U_S^N$, the inspector’s one-period deviation payoff. The right-hand side of (4) depends solely on $\mu_r f - e_m^r$, the inspector’s payoff from an optimal deviation, because the one-period SPNE payoffs are equal to zero when $w < \mu_r f$.

At this point, it is important to determine ranges of the parameters for which equation (3) or equation (4) holds so that pre-emptive corruption is a collusive equilibrium. Figure 2 shows three examples of the dependence of equation (3) on the discount factor $\delta$. In the figure, $R$ stands for the right-hand side of equation (3), while $L$ stands for the left-hand side. Note that $L$ does not depend on $\delta$. The three parts of the figure correspond to three different values of $\lambda$. In Figure 2b, $w \geq \mu_r f$ and $\lambda$ is strictly positive but relatively small. In this case, collusion is feasible for values of $\delta$ between $\delta_1$ and $\delta_2$. These critical values of $\delta$ can be shown to be bounded away from 0 and 1, respectively, whenever $\lambda > 0$. Therefore we show that when the probability of an audit is strictly positive, collusion cannot be sustained if the firm and the inspector are either ‘too patient’ or ‘too impatient’. To understand why collusion is not sustainable when the players are extremely patient, note that because of Assumption 2, as $\delta$ goes to 1, their respective cumulated discounted payoffs from collusion are bounded above because of the positive probability of an audit. This is because an audit drives both players’ payoffs to zero forever. However, if the inspector and the firm never exchange a bribe, their cumulated discounted payoffs go to infinity as $\delta$ goes to 1. Hence a collusive bribe does not exist for high values of $\delta$.

Clearly, this reasoning does not apply if $\lambda = 0$ or $w < \mu_r f$. Thus in this case, as shown in Figures 2a and 2c, collusion is feasible if and only if the discount factor is sufficiently

\[ \left( \frac{\lambda}{1-\lambda} \right) (\mu_r f - e_m) \]

\[ R \]

\[ L \]

\[ 0 \]

\[ \delta \]

\[ 1 \]

\[ w < \mu_r f \text{ and } \lambda > 0 \]

\[ a \]

\[ b \]

\[ c \]

\[ \text{FIGURE 2. The range of } \delta \text{ values for which collusive pre-emptive collusion is feasible is the range for which the curve } R \text{ (right-hand side of (3) or (4)) is below the line } L \text{ (left-hand side of (3) or (4)).} \]

© The Authors. Economica © 2011 The London School of Economics and Political Science. Published by Blackwell Publishing, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main St, Malden, MA 02148, USA
high. When \( w \geq \mu_{nf} \), the fact that for \( \lambda = 0 \) there is a non-empty interval of discount factors for which pre-emptive corruption is sustainable implies that, by continuity of \( L \) and \( R \), such a range of discount factors always exists for \( \lambda \) strictly positive as long as \( \lambda \) is sufficiently small. If \( \lambda \) is relatively high, collusion is unfeasible for every value of \( \delta \).

We next examine the range of values of \( w \) where pre-emptive corruption is feasible.

**Proposition 1.** Suppose that equation (3) holds, with a strict inequality when \( w = \mu_{nf} \). Then there exist finite values of the private benefit from engaging in the illegal activity \( w < \mu_{nf} \) and \( \bar{w} > \mu_{nf} \) such that collusive pre-emptive corruption is feasible if and only if the firm’s benefit is in \([\underline{w}, \bar{w}]\). Therefore firms that obtain a large benefit from engaging in the illegal activity, or those that obtain a small benefit from engaging in the illegal activity, do not engage in pre-emptive corruption.

Figure 3 graphically illustrates the above result and shows how the feasibility of collusion depends on the firm’s private benefit from the illegal activity assuming that \( p_r, p_s \) and \( \lambda > 0 \) are sufficiently low. The figure depicts how the difference between the left-hand and right-hand sides of (4) (for \( w < \mu_{nf} \)) and (3) (for \( w \geq \mu_{nf} \)) change with \( w \), assuming that (3) holds when \( w = \mu_{nf} \). To construct Figure 3, we rely on the fact that

\[
\frac{1 - (1 - \lambda)\delta}{(1 - \lambda)\delta} < G(\lambda, \delta),
\]

which implies the discontinuity at \( w = \mu_{nf} \). Firms that will engage in pre-emptive bribery are those for which \( w \) is between \( \underline{w} \) and \( \bar{w} \), where

\[
\underline{w} \equiv \lambda(1 + p_s)f + \lambda p_t + \frac{1 - (1 - \lambda)\delta}{(1 - \lambda)\delta}(\mu_{nf}f - e_n)
\]

and \( \bar{w} \) is the solution in \( w \) to (3) satisfied with an equality. Clearly, \( \underline{w} = 0 \) is possible.

It is worthwhile to contrast this result with those from static models of bribery. In static models, \( w \) has no effect on corruption because it is earned whenever the firm chooses \( W = 1 \), which is a necessary condition for corruption. Furthermore, its value
does not influence the inspector’s choice of monitoring intensity. The value of $w$ matters in this game because the firm has to forego $w$ when it is detected by the regulator after having bribed the inspector. Firms with higher values of the private benefit from engaging in the illegal activity have more to lose from detection and thus will refrain from bribing the inspector. This result is interesting in light of Svensson (2003), who studies a cross-section of Ugandan firms that pay bribes to public officials. He finds that officials often price discriminate by altering the size of the bribe according to the profitability of the firm. Similarly, Lubin (2003) finds that small firms engage in different forms of corruption as compared to large firms.

The result in Proposition 1 depends on Assumption 2(ii), or a weaker but similar assumption, being satisfied. The proposition implies that bribery may not be feasible with firms enjoying a large private benefit from the illegal activity. This is because these firms can guarantee an expected discounted payoff of $(w - \mu_{af})/(1 - \delta)$ by refusing to collude. However, by colluding, firms run the risk of being caught for corruption, which results in the loss of $w$ forever. Were we to make the opposite assumption, namely that a successful audit for corruption does not imply the loss of $w$, then the feasibility of corruption would be weakly increasing in $w$. In Section IV, we discuss several ways of justifying assumptions similar to Assumption 2(ii).

**Comparative statics**

Our analysis of pre-emptive corruption yields comparative statics results that are summarized in Proposition 2 below. In Proposition 2, we assume that (4) holds at $w = \mu_{af}$, which ensures that the range of firms that are willing and able to pay equilibrium pre-emptive bribes is non-empty. For the results in Proposition 2, we say that a change in a parameter makes collusive pre-emptive bribery more difficult if it reduces the size of this range. Loosely speaking, referring to Figure 3, a change in policy parameters makes corruption more difficult if it leads to a smaller difference between $\bar{w}$ and $w$. Alternatively, a change in policy parameters makes corruption more difficult if it reduces the difference between the left-hand and right-hand sides of (3) and (4), thereby reducing the set of equilibrium bribes for a given $w$.

Note that our approach to derive comparative statics results differs from that used in Besley and McLaren (1993), Mookherjee and Png (1995) or Samuel (2009). These authors focus on specific bribes, *ex post* or pre-emptive, obtained from solving the Nash bargaining problem between the firm and the inspector. Instead, we are interested in how the set of bribes that allow the two proponents to earn discounted expected payoffs in excess of their static game payoffs is affected by changes in important policy parameters.

**Proposition 2.** Suppose that equation (4) holds with a strict inequality when $w = \mu_{af}$. Then, *ceteris paribus*, the following hold.

(i) If $(\partial \mu_n)/\partial \mu_n - \partial \mu_n$, the elasticity of monitoring intensity by the inspector ($\mu_n$) to a change in his reward $r$, is sufficiently high, then an increase in $r$ facilitates pre-emptive corruption.

(ii) Increases in $\lambda$ (the probability that corruption is detected), $p_t$ or $p_f$ (the fines for corruption) unambiguously make pre-emptive corruption more difficult.

(iii) An increase in $\lambda$ and a decrease in either $p_g$ or $p_f$ that leaves expected fines $\lambda[p_t + (1 + p_g)f]$ unchanged unambiguously makes pre-emptive corruption more difficult.
From a policy standpoint, parts (ii) and (iii) in this proposition suggest that although
the probability that corruption is detected and the penalties for corruption may be viewed
as substitutes, increasing the probability of detection is more effective at deterring collu-
sion than increasing the fines. In previous papers, the probability of detecting corruption
and the penalties from corruption are perfectly substitutable (i.e. an expected-fine-neutral
change in these policy parameters has no effect on corruption). Thus a policy-maker can
choose between increasing the penalties or the probability of detection. In our model, \( \lambda \)
has a dynamic effect that is absent in static analyses because being detected implies
foregoing a entire stream of positive payoffs.

The model’s prediction regarding the effect of the inspector’s reward on the feasibility
of pre-emptive corruption may be sharpened slightly by writing the elasticity of intensity
to \( r \) as a function of the parameters of the model. First, using the first- and second-order
conditions that characterize \( \mu_n \), we obtain \( \partial \mu_n / \partial r = f' e''(\mu_n) > 0 \). Furthermore, \( rf = e'(\mu_n) \). Therefore

\[
\frac{\partial \mu_n}{\partial r} \cdot \frac{r}{\mu_n} = \frac{rf}{e''(\mu_n)\mu_n} = \frac{e'(\mu_n)}{e''(\mu_n)\mu_n}.
\]

That is, the elasticity depends on the first and second derivatives of the cost-of-effort
intensity. There are simple specifications of the cost-of-effort function satisfying Assump-
tion 1 for which the elasticity of optimal effort to \( r \) can be quite large—possibly suffi-
ciently large for the result that an increase in \( r \) facilitates pre-emptive corruption to occur.
For example, for every \( a > 1 \), the parametric form \( e(\mu) = \mu^a/(1 - \mu) \) satisfies all the
conditions in Assumption 1. Furthermore, for every \( a \in (1, 2) \), there exists a range of
values of \( \mu \) for which the ratio \( e'(\mu)/(e''(\mu)\mu) \) is well above 1.

Again, some of the results in the above proposition depend on part (ii) of
Assumption 2. However, for these results, it is sufficient that the inspector be sus-
pended for at least one period and earn a payoff below its one-shot SPNE payoff
after being caught for corruption. Even if the firm can guarantee that it will receive \( w \)
forever whether or not bribery is detected, results (ii) and (iii) in Proposition 2 con-
tinue to hold because of the punishment that detection for corruption imposes on the
inspector.

III. WELFARE DISCUSSION

In our model, the feasibility of pre-emptive corruption has important welfare implica-
tions. To analyse the welfare effects of policy changes that affect the feasibility of corrup-
tion, consider an economy made up of firms that differ solely with respect to their \( w \).
Recall that there is a continuum of firms distributed on an interval \([0, w_{\text{max}}] \). Denote the
c.d.f. of \( w \) by \( \Psi(w) \). Whether \( w_{\text{max}} \) is greater or less than \( h \) will differ across industries.\(^{16}\)
In any given period, the contribution to social welfare of a firm that chooses \( W = 1 \) and
is monitored at intensity level \( \mu \) is \( w - h - e(\mu) \), while a firm that chooses \( W = 0 \) has a
contribution of zero.

Since there are multiple equilibria in the repeated game, in the discussion below we
assume that if pre-emptive collusive corruption is feasible given the firm’s \( w \), then the firm
and the inspector collude by exchanging some bribe out of the feasible set of bribes.
Otherwise, they play the SPNE of the one-shot game (see Lemma 1). When the condition
in the statement of Proposition 1 is satisfied, collusion is feasible with some types of firms,
but not all. Figure 4 shows the various behaviours that arise depending on the value of $w$. In the remainder of the paper, we refer to firms with $w < \mu_f$ as potential offenders, and those with $w \geq \mu_f$ as regular criminals since they always choose the bad technology, i.e., $W = 1$.

The behaviour of the two marginal types $\underline{w}$ and $\bar{w}$ will be affected by changes in the penalty levels ($p_g$ and $p_t$), the probability of detection $\lambda$, or even $r$, the inspector’s reward. In turn, such policy changes will impact social welfare. Based on Figure 4, overall social welfare or total surplus is equal to

$$TS(r, f, \lambda, p_t, p_t) = \int_{\underline{w}}^{w_{\max}} (w - h)d\Psi(w) - (1 - \Psi(\bar{w}))e_n.$$  

This expression is increasing in $\bar{w}$ and decreasing in $\underline{w}$. Intuitively, any policy change that lowers the value of $\bar{w}$ makes corruption more difficult, while it does not affect the firm’s choice of technology. This is because regular criminals choose $W = 1$ even when they do not bribe the inspector (Figure 4). However, lowering $\bar{w}$ increases monitoring costs because when pre-emptive corruption occurs, no monitoring effort is spent. On the other hand, a policy change that raises the value of $\underline{w}$ does have an impact on the firm’s choice of technology. That is because making pre-emptive corruption unfeasible for potential offenders implies that they will choose $W = 0$ (Figure 4). Also, in this case, making corruption more difficult does not raise monitoring costs since the firm chooses the good technology when it does not collude with the inspector.

It is straightforward to show that an increase in either $p_g$ or $p_t$, or both, will lower $\bar{w}$ and raise $\underline{w}$. Thus in our model, strengthening anti-corruption policies by increasing $p_g$, $p_t$, or both has a positive welfare impact only among potential offenders, that is, firms with a low $w$, while such policy changes have a negative welfare impact on regular criminals with a high $w$. The effect of an increase in $r$ is different. Increasing $r$ has an ambiguous effect on $\bar{w}$, while it unambiguously raises $\underline{w}$. Furthermore, raising the inspector’s reward also causes an increase in $e_n$, the one-shot SPNE level of monitoring effort.

We therefore find that a change in penalties for corruption and a change in the inspector’s reward for fining the firm impact welfare in different ways. On the one hand, contrary to an increase in $p_g$ or $p_t$, raising the inspector’s reward may increase the scope for socially beneficial corruption. On the other hand, it also increases monitoring efforts with firms at the top of the distribution of private benefits. Unfortunately, in our model, it is not possible to obtain a sharper prediction regarding the effectiveness of $r$ at improving the welfare outcome without imposing additional structure on the effort cost function.

![Figure 4](https://example.com/figure4.png)

**Figure 4.** Typology of behaviour and monitoring effort as a function of the firm’s level of private benefit $w$. 

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IV. EXTENSIONS

In this section we consider the robustness of our previous results by relaxing and extending the benchmark model of Sections I and II. For the sake of brevity, we present only the key intuition of these extensions, and make formal derivations available on request.

Relaxing Assumption 2

The role played by Assumption 2 is important both in Proposition 1 and in Proposition 2. We now discuss issues concerning part (ii) of Assumption 2, which states that the continuation payoffs following detection for corruption are zero. One way to justify a payoff of zero for the inspector is to assume that following detection for bribery, the inspector is fired. Inspector dismissal is consistent with Besley and McLaren (1993) as well as an extension suggested by Mookherjee and Png (1995), but not developed by these authors. Carillo (2000) assumes that an inspector who is caught for bribery is suspended for a finite number of periods before resuming his job, but he also analyses the case in which the inspector is dismissed once and for all. The literature provides less guidance regarding the firm. In Motta and Polo’s (2003) analysis of oligopoly competition with a leniency policy, following a successful investigation by antitrust authorities, guilty firms may resume collusion within one period of the investigation. Furthermore, as mentioned in Section II, the literature on enforcement leverage shows that auditing regimes where detected offenders are placed in tightly monitored groups minimize the cost of obtaining a given level of compliance (Greenberg 1984; Harrington 1988).

However, it should be clear that making the opposite assumption, namely that the firm and the inspector continue to play the inspection game in every period following detection, will dramatically alter the results in Propositions 1 and 2. Contrary to Proposition 1, under this alternative assumption, the feasibility of corruption is weakly monotonic in $w$. Furthermore, a change in penalties and probability of detection that does not affect the regulator’s expected revenue has no effect on the feasibility of corruption. Hence some of the key results in Proposition 2 do not hold. The result in Proposition 1 requires that a regular criminal ($w_{nf}$) foregoes at least part of $w$ for at least one period on being caught for corruption. Results (ii) and (iii) in Proposition 2 require that either the firm or the inspector be held to an expected payoff below the one-shot SPNE payoff for at least one period.

We believe that a sensible way to relax Assumption 2(ii) is to assume that by engaging in bribery, the firm risks seeing $w$ be reduced to $\alpha w$, $\alpha < 1$, for a finite number of periods, while the inspector runs the risk of being dismissed forever. On completing the periods of punishment, the firm is matched with a new inspector identical to the previous one. It is then possible to show that the qualitative results in Proposition 1 do hold even if there is only one period of punishment for the firm. Therefore, as in our analysis, in this simple extension the feasibility of corruption is decreasing in $w$ for regular criminals.

Finally, we note that there are other realistic situations in which the firm’s continuation payoffs following detection for corruption are zero. Consider a more general model where inspectors differ in their ability to generate verifiable evidence of the illegal activity. In the one-shot inspection game’s SPNE, a firm with relatively high $w$ may be compliant with a high-ability inspector, but engage in both bribery and the illegal activity when matched with a low-ability inspector (because the bribe demanded by a high-ability inspector may be too large). In this case, for a firm that is currently matched with a low-ability inspector, detection for corruption can possibly result in re-matching with a
high-ability inspector. Because bribery is not feasible with a high-ability inspector, the firm becomes compliant and earns a payoff of zero forever. Clearly, this argument will apply to a range of firms with an intermediate value of $w$. Firms with very large $w$ will never forego their private benefit because they are able to engage in the illegal activity (with or without corruption) with both types of inspectors. Hence in this model, the feasibility of corruption may be non-monotonic in $w$, but contrary to the result in Proposition 1, there exists a threshold of the private benefit above which further increases in $w$ facilitate collusion.

**Bribery in the one-shot game**

In this subsection we consider an extension to our benchmark model where the probability that the inspector and the firm are caught engaging in bribery is higher, conditional on the inspector exerting costly effort. This assumption reflects Mookherjee and Png's (1995) original intuition that when the inspector and the firm interact to exchange a bribe, with probability $\lambda$ information about bribery 'leaks out' to the government. Since exerting costly effort requires the inspector to interact with the firm again, when effort is exerted to find hard evidence after a bribe is exchanged, there is a second stage at which information may leak out again. This extension may also reflect the possibility that the firm and supervisor have a low probability of being penalized for bribery as long as they remain on the collusive path, but a higher probability of being penalized if either of them deviates.\(^{17}\) We denote this probability by $\tilde{\lambda}$, therefore $\tilde{\lambda} > \lambda$.

A straightforward calculation (using backward induction) shows that if $p_i(\tilde{\lambda} - \lambda) \geq U^N_S$, then hold-up does not occur in the one-shot game, and therefore, pre-emptive bribery is feasible.\(^{18}\) If $p_i(\tilde{\lambda} - \lambda) < U^N_S$, then the fine $p_i$ is not large enough to dissuade the inspector from holding up the firm. Thus if $p_i$ is large enough, bribery may be supported even in a one-shot game with the potential for hold-up.

The implications of the above extension are similar to results that arise from using a 'hostage' mechanism to support bribery in a one-shot game (as in Buccirossi and Spagnolo 2006). Indeed, Buccirossi and Spagnolo further show that a poorly designed leniency policy that does not support bribery in a one-shot game may support bribery in a repeated game because it reduces the agent's short-term gains from deviation. Similarly, in this extension with $\tilde{\lambda} > \lambda$, if repeated interactions occur, then the firm and the inspector may use a trigger strategy to support a collusive path, and the qualitative results of Propositions 1 and 2 still hold. However, now $\tilde{\lambda}$ increases the cost of deviating. Thus *ceteris paribus*, bribery is now feasible for a larger range of $w$ than in the benchmark game. For similar reasons, an increase in $\tilde{\lambda}$ now raises the incentives for bribery. Also, it is also straightforward to show that collusion can now be supported for a larger range of $\delta$ values relative to the benchmark model.\(^{19,20}\)

**Ex post bribery and pre-emptive corruption with public randomization**

So far, we have focused on pre-emptive corruption and have ignored the possibility of *ex post* corruption. Intuitively, it seems that *ex post* corruption should never occur when pre-emptive corruption is feasible. Indeed, *ex post* corruption requires costly effort, while pre-emptive corruption does not require any effort. However, with *ex post* corruption, in every period, the probability of being detected for corruption is lower than under pre-emptive corruption because a bribe is exchanged with probability $\mu$ only. This suggests that there may be ways in which the firm and the inspector can reduce the probability of
getting caught by reducing the frequency of bribe exchange, while avoiding costly supervision effort. This would, of course, require that the firm and the inspector are able to observe the realization of a public signal.

We show that whenever pre-emptive corruption arises without the use of public randomization, there exists a collusive scheme with public randomization that is preferred by the inspector and is no worse from the firm’s standpoint. This collusive scheme is also preferred to ex post bribery. Thus if such a randomization scheme is available, ex post bribery is unlikely to ever occur.

V. CONCLUSION

Collusive contracts are typically not legally enforceable and therefore are easily susceptible to hold-up. Repeated interactions, however, may explain the occurrence of bribery in many of these situations. Our paper therefore uses a repeated game with hold-up to study effectiveness of anti-corruption policies suggested by Mookherjee and Png’s (1995) model.21

Similar to Mookherjee and Png (1995) and Samuel (2009), we examine the impact of the probability of detecting bribery, and the subsequent penalties on bribe-givers and bribe-takers, on the feasibility of corruption. In their one-shot games, the probability of detecting corruption and the penalties for corruption are perfectly substitutable. Therefore an expected-fine-neutral change leaves the incentives for corruption unchanged. However, this is not true in the repeated game, where an expected-fine-neutral change in these policy parameters unambiguously makes corruption more difficult. Consequently, an increase in the probability of detection (λ) is more effective at deterring collusion than an increase in the penalties (holding expected fines constant). This finding may be particularly useful in situations where political constraints make it difficult to increase penalties and where limiting repeated interactions between bureaucrats and firms is impossible because implementing a staff-rotation policy is too costly. Our model suggests that in such cases, raising the probability of detection will be more effective in deterring corruption.

Although increasing penalties and the probability of detection make corruption more difficult, the welfare implications of such changes are ambiguous because of our result that the firms that are most likely to offer bribes are not those that benefit the most or the least from the illegal activity. In particular, when the penalties for bribery are raised, monitoring is increased and bribery reduced among regular criminals. Since regular criminals always pursue the illegal activity irrespective of whether they pay a bribe, raising the penalty for bribery does not lower the harm associated with their illegal actions even though it generates higher monitoring costs. Thus raising the penalties for bribery produces a net welfare loss from regular criminals. By contrast, bribery encourages some potential offenders to choose the illegal activity when they would otherwise not have done so. Thus raising the penalties for bribery reduces both bribery and the illegal activity among potential offenders, and produces a net welfare gain from these firms. Consequently, raising the penalties for bribery has an ambiguous effect on welfare.

Increasing the inspector’s reward for truthful reporting has a similarly ambiguous effect on welfare. Indeed, on the one hand, increasing the inspector’s reward discourages potential offenders both from engaging in corruption and from engaging in the illegal behaviour, leading to a net welfare gain. On the other hand, it may also increase the fraction of regular criminals who offer a pre-emptive bribe, thereby reducing inspection costs, which could lead to a net welfare gain. Thus increasing the inspector’s reward for truthful reporting may not lead to less corruption although it may increase welfare.
In addition to studying the effectiveness and welfare implications of these anti-corruption policies, our model may also explain an empirical result that cannot be easily reconciled with the one-shot games of Mookherjee and Png (1995) and Samuel (2009). In Svensson’s (2003) empirical analysis of bribery among firms in Uganda, the likelihood of paying a bribe as well as the size of the bribe differ across types of firms (i.e. highly profitable or less profitable firms). Similar findings are also discussed in Lubin’s (2003) case study. In our model, firms that engage in pre-emptive bribery are not those that benefit the most nor those that benefit the least from pursuing the illegal activity, but those in between. However, among those that do engage in pre-emptive bribery, firms that stand to gain more from the illegal activity pay higher bribes. Thus the incentives for bribery and the size of bribe depend on the magnitude of a firm’s gain from the illegal activity, as in Svensson’s empirical study.22

Finally, our analysis of pre-emptive bribery with randomization is noteworthy given that most of the literature has focused exclusively on ex post bribery and collusion (e.g. Mookherjee and Png 1995; Polinsky and Shavell 2001; Acemoglu and Verdier 2000; Strausz 1997). Furthermore, the optimality of pre-emptive corruption is consistent with Mishra’s (2006) intuition that bribery is more likely to occur pre-emptively than ex post when repeated interactions occur. Interestingly, there also appears to be suggestive evidence of this type of randomized pre-emptive corruption in the case of the Gujarat trucking industry discussed earlier. Survey results from the Center for Electronic Governance (2002) indicate that inspectors at weigh stations randomly select truck drivers to be charged a bribe. Our results suggest that regulators must consider this possibility when determining anti-corruption policies.

APPENDIX

Proof of Lemma 1

We solve for the subgame-perfect Nash equilibrium (SPNE) of the extensive form game in Figure 1 using backward induction. To this effect, note first that for every \( B > 0 \), if the inspector chose \( \mu > 0 \) and successfully produced evidence, after which the firm offered \( b > 0 \), then the inspector will choose \( AR \) since this maximizes his expected payoff. Consequently, \( b = 0 \) is optimal for the firm. It follows that on the equilibrium path, the inspector will choose \( \mu \) to maximize \( \mu r f - c(\mu) \), that is, the inspector chooses \( \mu = \mu_n \). But then it is clear that \( \mu = \mu_n \) is optimal for every \( B \geq 0 \). It thus follows that a firm that chose \( W = 1 \) will always choose \( B = 0 \). We have thus established that if the firm chooses \( W = 1 \), then it will offer \( B = 0 \). The inspector then chooses \( \mu = \mu_n \) and produces evidence with probability \( \mu_n \). If the inspector finds evidence, then the firm chooses \( b = 0 \). Therefore the firm’s expected payoff from choosing \( W = 1 \) is equal to \( w - \mu_d f \). Finally, the firm will choose \( W = 1 \) if and only if \( w - \mu_d f \geq 0 \). (We note that since we focus on pure strategies, if the firm is indifferent between \( W = 0 \) and \( W = 1 \), we assume that it chooses \( W = 1 \).)

We have thus shown that the paths described in the statement of Lemma 1 are the equilibrium paths depending on the value of \( w \). Since in both cases backward induction has produced a unique solution, we conclude that the equilibrium is unique.

Proof of Lemma 2

The proof consists in determining a range of bribes \( \mathcal{B}^c \), which, if exchanged on a path \( \tau^c = \{1, \mathcal{B}^c, 0, 0\} \), yield collusive payoffs in the sense of Definition 1. Then we provide conditions under which bribes in this range satisfy the necessary and sufficient incentive compatibility constraints (1) and (2).

Suppose that \( w \geq \mu_d f \) holds. Consider the path \( \tau^c = \{1, \mathcal{B}^c, 0, 0\} \). We derive a lower bound \( \mathcal{B} \) and an upper bound \( B \) for the bribe \( \mathcal{B} \) so that \( \tau^c \) is a collusive path in the sense of Definition 1. We have

\[
V_S(\tau^c) = \frac{\mathcal{B}^c - \lambda P_1}{1 - (1 - \lambda) \delta},
\]
For $\tau$ to be collusive, Definition 1 requires

$$\frac{B^c - \lambda p_t}{1 - (1 - \lambda) \delta} \geq \frac{U^n_S}{1 - \delta}$$

and

$$\frac{w - B^c - \lambda (1 + p_g) f}{1 - (1 - \lambda) \delta} \geq \frac{U^n_C}{1 - \delta}$$

with at least one strict inequality. Rearranging the above inequalities yields

$$B^c \geq \lambda p_t + \left[1 - (1 - \lambda) \delta\right] \frac{U^n_S}{1 - \delta} \equiv \bar{B}$$

and

$$B^c \leq w - \lambda (1 + p_g) f - \left[1 - (1 - \lambda) \delta\right] \frac{U^n_C}{1 - \delta} \equiv \underline{B}.$$
strategy, he earns a payoff of $U^N_S$ in period $t$ and $U^N_S$ in every period thereafter. Suppose that instead, he accepts the bribe but invests $\mu > 0$. It is clear that it is optimal for the inspector to invest $\mu$ in this case. Therefore in period $t$, the inspector’s payoff from such a deviation is equal to $B' + U^N_S - \dot{p}_t$, and he earns $(1 - \lambda)\delta U^N_S/(1 - \delta)$ in the continuation of the game. Hence the latter deviation is more profitable than the former if and only if

$$(A2) \quad B' + U^N_S - \dot{p}_t + (1 - \lambda) \frac{\delta U^N_S}{1 - \delta} \geq \frac{U^N_S}{1 - \delta},$$

which is equivalent to

$$B' \geq \dot{p}_t + \frac{\delta \lambda U^N_S}{1 - \delta}.$$ 

Note that the right-hand side of this last inequality is strictly less than $\underline{B}$. Hence, since $B' \geq \underline{B}$ by assumption, $(A2)$ holds.

To prove the if part of the first case of Lemma 2, suppose that equation (3) holds and consider the path $\tau^* = \{1, B^*, 0, 0\}$, where $B^* = \dot{p}_t + \lambda(\delta U^N_S)$. We now show that $\tau^*$ is a collusive perfect equilibrium path.

First, we show that $B^*$ is a collusive bribe, that is, $B^* \in [\underline{B}, \bar{B}]$. A straightforward calculation shows that

$$B' \leq \bar{B} \iff w - \lambda(1 + p_Z)f - \dot{p}_t \geq \left(1 - \frac{1 - \lambda}{1 - \delta}\right) U^N_p + G(\lambda, \delta)U^N_S,$$

which holds since (3) holds by assumption. We now show that $B' > \underline{B}$ by straightforward calculations:

$$B^* > \underline{B} \iff G(\lambda, \delta) > \frac{1 - (1 - \lambda)\delta}{1 - \delta}$$

$$\iff \frac{1 - \delta + \lambda \delta^2 - \lambda^2 \delta^2}{\delta(1 - \delta)(1 - \lambda)} > 1 - \delta + \lambda \delta$$

$$\iff 1 - \delta + \lambda \delta^2(1 - \lambda) > (1 - \delta)\delta(1 - \lambda) + \lambda \delta^2(1 - \lambda)$$

$$\iff 1 > \delta(1 - \lambda),$$

which follows from $\delta, \lambda < 1$.

Now we show that $\tau^*$ is a perfect equilibrium path. If $\tau^*$ is a perfect equilibrium path, then both (1) and (2) must hold on $\tau^*$. Since $B^* \geq \underline{B}$, $B^* > \lambda p_t + \delta \lambda U^N_S/(1 - \delta)$. Thus in any period $t$ of $\tau^*$, (1) can be written as

$$(A3) \quad \frac{B' - \dot{p}_t}{1 - (1 - \lambda)\delta} \geq B^* - \dot{p}_t + U^N_S + (1 - \lambda) \frac{\delta U^N_S}{1 - \delta}.$$ 

A straightforward calculation shows that equation (3) is satisfied with equality by definition of $B^*$, so that (1) is satisfied on $\tau^*$. Now, to show that (2) is satisfied on $\tau^*$, we need to show that

$$V_F(\tau^*) = \frac{w - B^* - \dot{p}(1 + p_Z)f}{1 - (1 - \lambda)\delta} \geq \frac{U^N_F}{1 - \delta},$$

since an optimal deviation from $\tau^*$ yields a payoff of $U^N_F/(1 - \delta)$ to the firm. However, this is equivalent to $B' \leq \bar{B}$, which holds if and only if (3) holds.
Now consider the only if part of the first case statement. Suppose that (3) does not hold. Then from the above arguments, \( B' > B \). However, it is straightforward to check that by definition, \( B^\ast \) is the lowest bribe that the inspector will find profitable to accept without deviating by investing \( \mu = \mu_n \). Indeed, no bribe \( B' \) in the interval \([B, B^\ast)\) is immune to a deviation whereby the inspector accepts \( B' \) and then invests \( \mu_n \). Hence \( B' \geq B^\ast \) is necessary on a stationary perfect equilibrium path. But then, from \( B^\ast > B' > B \), we find that no such path satisfies the definition of a collusive path. Hence we have shown that (3) is necessary and sufficient for a collusive stationary perfect equilibrium path to exist.

Now suppose that \( w \geq \mu_n f \) does not hold. We wish to determine conditions under which there exists a collusive stationary path \( \tau' = \{1, B', 0, 0\} \) that is a stationary perfect equilibrium path. This is similar to the proof for the case \( w \geq \mu_n f \), therefore we simply point out the relevant differences between the two proofs. First, \( U^F_0 = 0 \) since in the one-shot SPNE the firm chooses \( W = 0 \). Therefore using reasoning similar to that employed in the case \( w \geq \mu_n f \), the bribe \( B' \) is a collusive bribe if the following two conditions are satisfied (with a strict inequality in at least one of them):

\[
\frac{B' - \lambda p_t}{1 - (1 - \lambda)\delta} \geq 0 \iff B' \geq \lambda p_t,
\]

\[
\frac{w - \lambda(1 + p_g)f - B'}{1 - (1 - \lambda)\delta} \geq 0 \iff B' \leq w - \lambda(1 + p_g)f.
\]

Now we turn to incentive compatibility constraints. Under the extensive trigger strategy, choosing \( W = 0 \) is also the firm’s optimal deviation from the initial path. This deviation earns the firm a payoff of zero. Hence if \( B' \) is collusive, the firm has no incentive to deviate. However, if the firm has conformed to the path and offered \( B' \), an optimal deviation by the inspector consists in choosing \( \mu = \mu_n \). Then, under the extensive trigger strategy, no ex post bribe is offered and thus the inspector earns \( B' + \mu_n rf - e_n - \lambda p_t \) from the deviation. Hence the inspector’s incentive compatibility constraint is given by

\[
\frac{B' - \lambda p_t}{1 - (1 - \lambda)\delta} \geq B' - \lambda p_t + \mu_n rf - e_n,
\]

which implies that

\[
B' \geq \lambda p_t + \frac{1 - (1 - \lambda)\delta}{(1 - \lambda)\delta}(\mu_n rf - e_n) \equiv B' > \lambda p_t.
\]

It follows that \( \tau' = \{1, B', 0, 0\} \) is a collusive stationary perfect equilibrium path if and only if

\[
B' \leq w - \lambda(1 + p_g)f \iff w - \lambda(1 + p_g)f - \lambda p_t \geq \frac{1 - (1 - \lambda)\delta}{(1 - \lambda)\delta}(\mu_n rf - e_n),
\]

where the second inequality is equation (4).

Proof of Proposition 1
To prove Proposition 1, we first show that when (3) is satisfied at \( w = \mu_n f \), there exists a range of values of \( w \) for which (4) is satisfied, and a range of values of \( w \) for which (3) is satisfied. To this effect, substitute for \( w = \mu_n f \) in (3) and notice first that \( w = \mu_n f \) implies \( U^F_K = 0 \), and second that the inspector’s SPNE payoff in the inspection game is \( U^\lambda_S = \mu_n rf - e_n \). Therefore the only difference between (3) and (4) when \( w = \mu_n f \) is the term in front of \( \mu_n rf - e_n \). A straightforward calculation shows that

\[
\frac{1 - (1 - \lambda)\delta}{(1 - \lambda)\delta} < G(\lambda, \delta),
\]

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which implies that at \( w = \mu_{af} \), (3) implies (4). By continuity in \( w \), both equations will hold in (distinct) neighbourhoods of \( \mu_{af} \).

The remainder of the proof is straightforward. To the right of \( w = \mu_{af} \), (3) applies because \( w \geq \mu_{af} \) holds. In this case, recall that \( U_{pf}^N = w - \mu_{af} \), while \( U_{sf}^N \) does not depend on \( w \). Letting \( L \) be the left-hand side of (3) and \( R \) its right-hand side, we show that \( L - R \) decreases with \( w \). We have

\[
\frac{\partial L}{\partial w} - \frac{\partial R}{\partial w} = 1 - \frac{1 - (1 - \lambda)\delta}{1 - \delta} < 0
\]

if and only if \( \lambda \delta > 0 \). Since (3) holds at \( w = \mu_{af} \) by assumption, it follows that (3) holds in an interval \([\nu_{af}, \bar{w}]\), where \( \bar{w} \) is the solution of \( L - R = 0 \). Finally, note that because \( L - R \) is linear in \( w \), \( L - R = 0 \) admits a unique and finite solution \( \bar{w} \). Finally,

\[
\frac{A4}{w} \equiv \frac{1 - \delta(1 - \lambda)}{\lambda \delta} \mu_{af} - \frac{(1 - \delta)G(\lambda, \delta)}{\lambda \delta} (\mu_{af} - e_n) - \frac{1 - \delta}{\delta} (1 + p_\xi f) - \frac{1 - \delta}{\delta} p_t.
\]

To the left of \( w = \mu_{af} \), (4) applies because \( w \geq \mu_{af} \) does not hold. Since in this case the left-hand side of (4) is the only element that depends on \( w \), it is straightforward to see that (4) will be satisfied in a half-open open interval of the form \([\mu_{af}, \bar{w}]\), where

\[
\frac{A5}{w} \equiv \lambda(1 + p_\xi) f + \lambda p_t + \frac{1 - \delta(1 - \lambda)}{\delta(1 - \lambda)} (\mu_{af} - e_n) \geq 0.
\]

Proof of Proposition 2

To prove Proposition 2, we begin with result (i). There are two cases to consider.

Case 1. Suppose that (4) holds but (3) does not hold at \( w = \mu_{af} \). In this case, collusion is feasible only with firms with \( w \in [\nu_{af}, \bar{w}] \). We show that if \( (\partial \mu_n / \partial r)(r / \mu_n) \) is sufficiently high, then an increase in \( r \) increases the difference \( \mu_{af} - w \).

Using the definition of \( w \) given by equation (5), we have

\[
\mu_{af} - w = \mu_{af} - \lambda(1 + p_\xi) f - \lambda p_t - \frac{1 - \delta(1 - \lambda)}{\lambda \delta} (\mu_{af} - e_n).
\]

Therefore

\[
\frac{\partial(\mu_{af} - w)}{\partial r} > 0 \iff \frac{\partial \mu_{af}}{\partial r} > \frac{1 - (1 - \lambda)\delta}{(1 - \lambda)\delta} \mu_{af}
\]

or

\[
\frac{\partial \mu_n}{\partial r} \mu_n > \frac{[1 - (1 - \lambda)\delta] r}{(1 - \lambda)\delta}.
\]

This establishes the result in Case 1.

Case 2. Suppose that (4) and (3) hold at \( w = \mu_{af} \). In this case, collusion is feasible with firms with \( w \in [\nu_{af}, \bar{w}] \). We show that if \( (\partial \mu_n / \partial r)(r / \mu_n) \) is sufficiently high, then an increase in \( r \) increases the difference \( \bar{w} - w \).

Using the definition of \( \bar{w} \) given by equation (A4), we have

\[
\frac{\partial(\bar{w} - w)}{\partial r} = \frac{1 - \delta(1 - \lambda) \delta}{\lambda \delta} \partial \mu_n - \frac{1 - \delta(1 - \lambda) \delta}{\lambda \delta} \mu_{af}. \]
Therefore, after rearranging terms,
\[
\frac{\partial (\hat{w} - w)}{\partial r} > 0 \iff \frac{\partial \mu_n r}{\partial r} \mu_n > \left[ \frac{\lambda}{1 - \lambda} + \frac{(1 - \delta)G(\lambda, \delta)}{1 - (1 - \lambda)\delta} \right] r.
\]
This establishes the result in Case 2.

We now turn to results (ii) and (iii). Note that \( \ln f \) does not depend on \( \lambda, p_g \) or \( p_t \). Hence these results are most easily proved by considering equations (3) and (4) for \( w = \mu_f \) and \( w < \mu_f \), respectively. Denote the left-hand side of each equation by \( L \) and its right-hand side by \( R \). In this case, a small change in a parameter \( x \) makes collusion more difficult if and only if \( \partial (L/R) / \partial x < 0 \).

First, consider firms with \( w = \mu_f \). If (3) does not hold at \( w = \mu_f \), then a small change in \( \lambda, p_t \) or \( p_g \) has no effect on the feasibility of corruption among firms with \( w = \mu_f \). Suppose then that (3) holds when \( w = \mu_f \), and consider the effect of \( \lambda \) on \( L/R \) for (3). A straightforward calculation yields
\[
\frac{\partial (L - R)}{\partial \lambda} = -p_t - (1 + p_g)f - \frac{\delta}{1 - \delta} U^N - \frac{\delta^2 (1 - \lambda)^2 + 1 - \delta}{\delta (1 - \delta) (1 - \lambda)^2} U^S,
\]
which is clearly negative. A similar calculation establishes the result for \( w < \mu_f \) by applying the same reasoning to equation (4). Hence we have established (ii) in the statement of Proposition 2.

Now consider result (iii). Note that simultaneous small changes \( dp_t < 0, dp_g < 0 \) and \( d\lambda > 0 \) that keep expected fine revenue constant must satisfy
\[
\lambda dp_t + \lambda dp_g + [p_t + (1 + p_g)f] d\lambda = 0.
\]
Hence such a change will lead to \( dL = 0 \) for both (3) and (4). However, \( \partial R/\partial \lambda > 0 \), while \( R \) depends on neither \( p_g \) nor \( p_t \). Hence the proposed change results in \( dR > 0 \) and \( d(L - R) = -dR < 0 \), that is, it makes pre-emptive bribery more difficult. Hence we have established result (iii) in Proposition 2.

ACKNOWLEDGMENTS

We wish to thank two anonymous referees, Alexander Fink, Nicola Lacetera, Ajit Mishra, Justin Sydnor and Joel Watson, as well as seminar participants at Case Western Reserve University, Jawaharlal Nehru University, the Delhi School of Economics, the Annual Meetings of the Midwest Economics Association in Cleveland (March 2009), the American Law and Economics Association in San Diego (May 2009) and the Southern Economic Association in San Antonio (November 2009) for helpful comments. Samuel is grateful to Loyola University for financial support.

NOTES

1. In contrast to these papers where penalties and fines are exogenous, Polinsky and Shavell (2001) endogenize these parameters and allow inspectors to extort bribes from compliant citizens and receive bribes in exchange for not sanctioning non-compliant citizens. They find that although bribery should always be sanctioned, extortion should not. For an extensive review of results in the economics of law enforcement, in particular the analysis of socially optimal fines and enforcement probabilities, the reader is referred to Polinsky and Shavell (2007).
2. Klochko and Ordeshook (2003) also argue that ‘close interpersonal monitoring’ is essential for the sustainability of corruption. Some of the models of private contract enforcement analysed in Dixit (2004) include both random matching and repeated interactions.
3. Other studies, some of them employing models with infinitely repeated interactions, note similar side effects of leniency programmes. Optimal leniency policies that avoid these pitfalls have been characterized

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(Spagnolo 2004; Harrington 2008). We refer the reader to Section 7.3 in Spagnolo (2008), which provides a comprehensive and thorough review of the theory of leniency programmes.

4. In the literature on extortion, Konrad and Skaperdas (1997) examine how criminal gangs credibly pre-commit to punish the agents that they extort so as to ensure that bribes are paid. They show that investments in making threats credible are supported in equilibrium if the gang interacts with a sufficiently large number of agents.

5. Tirole (1992) sets up a dynamic environment that bears much resemblance to ours, although he uses modelling techniques typically associated with models of reputation. However, he does not include costly inspector effort or penalties for bribery, and does not consider the possibility that the inspector could hold up the agent. Instead, he focuses on the relationship between the regulator’s expected payoff and the inspector’s salary, while we focus on the comparative statics of policy parameters like the penalties for corruption and the probability of detection.

6. We note the distinction between the use of the term ‘hold-up’ in this paper and in some of the existing literature. Specifically, in Choi and Thum (2004) and Lambert-Mogiliansky et al. (2007), hold-up refers to the behaviour of bureaucrats who refuse to officially approve otherwise qualified business projects unless they are paid a bribe (extortion), while Lambert-Mogiliansky et al. refer to the practice of demanding a bribe to approve unqualified projects as ‘capture’. Thus in our paper, corruption occurs in the form of what they identify as capture, while we refer to hold-up as the practice of reneging on the promise made in any corrupt contract, pre-emptive or ex post.

7. Contrary to Polinsky (1980), these models explicitly account for the non-observability of enforcement effort and law-enforcer moral hazard.

8. We note the distinction between the use of the term ‘hold-up’ in this paper and in some of the existing literature. Specifically, in Choi and Thum (2004) and Lambert-Mogiliansky et al. (2007), hold-up refers to the behaviour of bureaucrats who refuse to officially approve otherwise qualified business projects unless they are paid a bribe (extortion), while Lambert-Mogiliansky et al. refer to the practice of demanding a bribe to approve unqualified projects as ‘capture’. Thus in our paper, corruption occurs in the form of what they identify as capture, while we refer to hold-up as the practice of reneging on the promise made in any corrupt contract, pre-emptive or ex post.

9. Since the regulator, she can credibly commit to monitor the firm ex ante.

10. In this model, the fine $f$ is finite and it is treated as a parameter. In general, if a welfare-maximizing regulator can choose both $f$ and the probability of enforcement optimally, then $f$ may not be finite because such a regulator will want fines to be maximal (Becker 1968; Polinsky and Shavell 2007). We feel that endogenizing the fine is beyond the scope of this paper. Therefore, as in Mookherjee and Png (1995) and Samuel (2009), we assume that the fine $f$ is finite and exogenous either because of limited liability or because the regulating agency does not have the power to choose these fines. For these and other assumptions, see Samuel (2009).

11. Here, $x$ is fixed, as in Becker and Stigler (1974) and in most papers that build on their model, including Samuel (2009). See Besley and McLaren (1993) for a short discussion of the effect of endogenizing the probability of detection in a similar model.

12. Clearly, in both Mookherjee and Png (1995) and our model, all corruption could be eliminated by setting the penalties sufficiently high. However, this may imply setting fees at arbitrarily high levels, which would likely be unfeasible in reality. Furthermore, because these fees may have to fit any situation involving corruption, they are generic and cannot depend on $w$ or $h$. These assumptions are similar to Mookherjee and Png (1995).

13. The assumption of zero continuation payoffs is critical but it is not essential to our results. What is critical is that detection for corruption forces the supervisor’s payoff below the SPNE expected payoff for at least one period, and that a firm’s private benefit be reduced to $w(x \times 1)$ for at least one period.

14. This discount factor may also include the probability that the game continues each period. Thus the game does not necessarily require that both players live for an infinite number of periods.

15. Specifically, for a bribe $B$, the finite upper bounds on the payoffs are $(B - x_p)/\lambda$ for the inspector and $x(1 + \lambda) B - \lambda$ for the firm.

16. Polinsky and Shavell (2001), for instance, assume that the range of $w$ values is unbounded, so that $w_{\text{max}}$ is infinity while $h$ is finite.

17. We are indebted to an anonymous referee for suggesting this interpretation.

18. In this case, firms with $w > \lambda(1 + p) B + B$ choose $W = 1$ and pay a pre-emptive bribe, and the rest choose $W = 0$.

19. Results similar to those derived in this subsection apply if we incorporate a ‘hostage’ mechanism where the inspector commits the first illegal act in the stage game by illegally allowing the firm to choose $W = 1$ before the firm actually chooses its technology, and before the firm pays the bribe. By committing the first illegal act, the inspector is able to offer a ‘hostage’ to the firm, which enforces the bribe contract.

20. We also considered an extension of our model where the firm may choose to report the inspector for bribery. Thus conditional on exchanging a bribe, the firm and the supervisor simultaneously choose to ‘report the inspector’ and ‘hold up the firm’, respectively. It is possible to show that if the reward to the firm from ‘reporting the supervisor’ is sufficiently large, then bribery may be feasible in the one-shot game.

21. Our results would differ if instead of repeated interactions, reputation was the mechanism by which hold-up is avoided. We examined a straightforward change to our model that would turn it into a model of reputa-
tion. One of our key results is altered, namely, how the feasibility of collusion depends on $w$. In this simple model of reputation, the feasibility of corruption is monotonically increasing in $w$. However, because the inspector’s repeated game payoff is affected by the loss from being fired for taking a bribe, $\lambda$ continues to be a more effective deterrent of corruption than $p_k$ or $p_N$.

22. However, one must be cautious in interpreting these findings in light of our results. For the firms in Svensson’s (2003) analysis, it is not possible to tell whether bribery was the result of capture or extortion. This paper focuses on capture and does not analyse extortion.

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