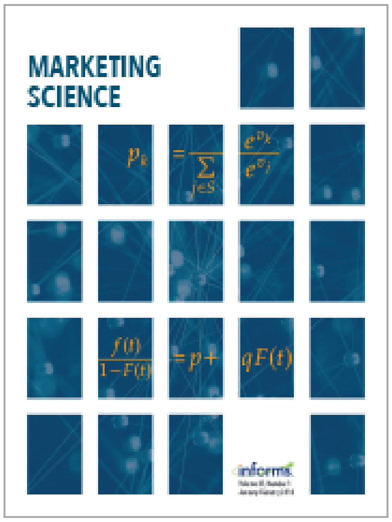

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Competition in Corruptible Markets

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Abstract. Firms seeking business opportunities often face corruptible agents in many markets. This paper investigates the marketing strategy implications for firms competing for business, and for the buyer in a corruptible market. We consider a setting in which a buyer (a firm or government) seeks to purchase a good through a corruptible agent. Supplier firms that may or may not be a good fit compete to be selected by the agent. Only the agent observes whether a firm is a good fit. Corruption arises due to the agent's incentive to select a nondeserving firm in exchange for bribes. Intuitively and as expected, a sufficiently large monitoring of the agent eradicates corruption. Interestingly, however, increasing the monitoring from an initial low level can backfire, making the agent more likely to select a nondeserving firm. This nonmonotonic agent behavior makes it difficult for the buyer to reduce corruption. The implication is that the buyer should choose either to be ignorant or to take drastic measures to limit corruption. Furthermore, we show that unilateral anticorruption controls, such as the Foreign Corrupt Practices Act of 1977, on a U.S. firm seeking business in a corrupt foreign market can actually increase the firm's profits.

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Keywords: marketing strategy • competitive analysis • corruption • business-to-business marketing

1. Introduction

1.1. Overview

Markets differ in the extent of bribery. Although developed economies are not immune to corruption, weak legal enforcements, imperfect regulation, and institutional constraints make developing economies more prone to corruption. According to the 2014 Corruption Perceptions Index published by Transparency International,[1] corruption is perceived to be relatively more prevalent in many of the fast-developing economies compared to developed economies.[2] Corruption creates challenges for domestic as well as foreign firms seeking business opportunities in these markets. In fact, bribery is considered a cost of doing business in many of these markets. Firms face corruption in many different forms when competing for business in corruptible markets.[3] In this paper, we specifically focus on corruption that arises from the agent's willingness to select a nondeserving firm in the procurement setting in exchange for bribes. Corruption affects firms' chances of getting selected and hence firms' pricing and bribing strategies. We investigate the strategic implications for the competing firms and the buyer in a corruptible market. The following examples illustrate some features we capture in the model.

Ceylon Petroleum Storage Terminal Limited (CPSTL), Sri Lanka, Chairman M.R.W. de Soyza instructed the procurement board to purchase undersea buoy hoses from the Italian company Minoli. Note that de Soyza, acting on behalf of CPSTL, selected Minoli, ignoring the report of his technical evaluation committee, which found Minoli to be inferior to a Japanese supplier. The hoses ruptured within four months of installation. Corruption is suspected.[4]

The chairman of the 2010 Commonwealth Games (India) Organizing Committee, Suresh Kalmadi, is facing trial in Delhi on charges of corruption for awarding a timing-scoring–result (TSR) system contract to the Swiss company Timing Omega. The contract was awarded to the Swiss company while officials believed the competing Spain-based firm MSL-Spain was a better choice. It is of interest to note that no direct evidence of bribery has been detected. Kalmadi has already spent over nine months in jail and is currently out on bail.[5]

British Petroleum (BP), like other large oil companies, charters oil tankers from shipping firms (such as Maersk and Frontline). Tanker chartering requires specialized skills and knowledge. Lars Dencker Nielsen, a senior executive in BP's tanker-chartering division, allegedly received cash payments from a shipping magnate in return for awarding multimillion-pound contracts over a five-year period.[6] Bribery of private sector employees is illegal according to the Bribery Act of 2010 in the United Kingdom.

We would like to highlight three features in the above examples. First, the decision to select one firm over another is usually not straightforward. The selection of a firm that is best suited for a particular project requires expertise in the subject matter along with information about the product and the environment in which the product is to be used. Second, the buyers (firms or governments) rely on agents such as experts or bureaucrats to make the selection decision on their behalf. The agents, sometimes but not always, select a nondeserving firm in exchange for bribes. Last, buyers understand an agent's incentives to select a nondeserving firm. Corrupt agents are sometimes caught and punished. We capture these features in our model.[7]

We analyze the firm's incentives for bribing an agent who is expected to select, on behalf of the buyer, a deserving firm from two firms that are competing for a project. Only the agent knows if a particular firm is deserving. The agent is willing to select a nondeserving firm in exchange for a bribe. We refer to the selection of a nondeserving firm as dishonest agent behavior. Dishonest agent behavior hurts the buyer. The buyer understands the agent's incentives and can monitor the agent. Monitoring the agent is costly. On monitoring, the buyer may learn if a nondeserving firm was selected. A dishonest agent, if caught, is punished. Firms compete in bribes to get selected by the agent.

An important point of the analysis is to show that an increase in monitoring does not always result in more honest agent behavior. Indeed, an increase in monitoring can make the agent more dishonest. The intuition is the following. If monitoring is small, both firms offer bribes with probability one. In this case, the agent will be induced to select the deserving firm while at the same time accepting that firm's bribe offer. When monitoring increases, firms become less likely to offer bribes. Yet this implies that the agent now increasingly faces situations in which she will receive a bribe offer only from a nondeserving firm. This may force the agent to select a nondeserving firm more often. Thus, the agent may become more dishonest even as monitoring increases. Finally, when monitoring becomes sufficiently large, the agent will obviously have the incentive to select the deserving firm. In summary, the analysis uncovers a nonmonotonic effect of increasing monitoring. Various scholars have discussed a similar nonmonotonic relationship between monitoring, or expected penalty, and honest behavior (see Akerlof and Dickens 1982 and Bénabou and Tirole 2006). Yet, their explanations draw on the classic work on intrinsic motivation in psychology (see Deci 1972). Our analysis presents a strategic rationale for an increase in dishonest behavior as a result of an increase in monitoring. In our model, the endogenous firm response to an increase in monitoring makes the agent more dishonest.

The nonmonotonic effect of monitoring on agent behavior makes it difficult for the buyer to reduce corruption. We find that the buyer should either choose to be ignorant about corruption or commit to taking drastic measures to limit it. An intermediate level of monitoring hurts the buyer. The policy implication is that a half-hearted effort to rein in corruption can potentially backfire.

The analysis also examines bribery of foreign government officials by U.S. firms competing in overseas markets. During an investigation by the U.S. Securities and Exchange Commission,[8] in the mid-1970s, more than 400 U.S. companies admitted to having made questionable payments to foreign government officials. Congress enacted the Foreign Corrupt Practices Act (FCPA) of 1977 to stop the bribery of foreign officials and to restore public confidence in the integrity of the American business system.[9] This unilateral control on U.S. firms seeking business in foreign markets has been a topic of debate. In the business community, the common belief is that the Act puts American businesses at a competitive disadvantage in international business. The evidence from a majority of empirical studies suggests that the FCPA poses little or no disadvantage (see Graham 1984, Beck et al. 1991, and Wei 2000). On the contrary, Hines (1995) suggests that the FCPA serves to weaken the competitive position of U.S. firms.

We study the effect of a unilateral anticorruption control, such as the FCPA, on a firm's profits. We show that the profits of the controlled U.S. firm can actually increase as a result of a unilateral anticorruption control on it. A unilateral anticorruption control on a firm reduces the bribe the other firm must pay the agent to be selected with certainty. As a result, the agent selects a nondeserving firm with a higher probability, which hurts the buyer. The buyer may therefore strategically set a higher monitoring to discourage bribery by the firm that is not controlled. Because higher monitoring results in higher profits for both firms, a unilateral control can increase profits of the controlled firm. Gillespie (1987) presents evidence of higher monitoring in the Middle East in the post-FCPA era. She also concludes that the potential of the FCPA to hurt U.S. exports remains unproven.

We also evaluate the possibility of (1) the firms being informed of the fit of their products with the requirements of the buyer, (2) a penalty imposed on the firm as well when monitoring detects dishonest agent behavior, and (3) prepurchase monitoring of the agent. We find that the deserving firm prevents the selection of the nondeserving firm by offering a large enough bribe if firms know their types. As a result, the buyer does not find eradicating corruption necessary. Both penalty on the firm and prepurchase monitoring of the agent results in reduced corruption, as firms now find bribing more costly. The basic results presented for the main model including the nonmonotonic agent behavior with changes in monitoring, the buyer's reluctance to set intermediate monitoring, and higher profits for the unilaterally controlled firm, continue to hold. We also demonstrate the robustness of our results to the assumption that reserve prices are endogenous and that penalties are imposed on the agent for accepting a bribe even if the agent selects a deserving firm.

1.2. Related Literature

The literature has studied corruption extensively in many different contexts (see Jain 2001 for a review). Shleifer and Vishny (1993) study the implications of the corruption network's structure on the level of corruption in government agencies. Mookherjee and Png (1995) study the optimal compensation policy for a corruptible inspector charged with monitoring pollution from a factory. Hauser et al. (1997) look at bribery, or side payments, in the context of ratings given by a salesforce to internal sales support.

A relatively smaller literature investigates competition in the presence of corruption. Rose-Ackerman (1975) initiates this work by presenting a model in which corruption results in allocative inefficiency. The inefficiency in her model arises from differences in the bribing capacities of competing firms or from vague preferences of the government. Burguet and Che (2004) allow the agent to manipulate her quality evaluations in exchange for bribes. They find that if the agent has little manipulation power, corruption does not disrupt allocation efficiency but makes the efficient firm compete more aggressively. However, if the agent has substantial manipulation power, corruption facilitates collusion among competing firms and creates allocative inefficiency as bribery makes securing a win costly for the efficient firm. Compte et al. (2005) incorporate corruption in a procurement auction through the possibility of bid readjustment that an agent may provide in exchange for a bribe. They show that corruption facilitates collusion in price between firms and results in a price increase that goes beyond the bribe that the bureaucrat receives. They also show that unilateral anticorruption controls on an efficient firm may restore price competition to some extent. Branco and Villas-Boas (2015) investigate the effect of the degree of competition on corruption in the context of a firm's investment in behaving according to the rules of the market. Sudhir and Talukdar (2015) examine firms' information technology investment incentives in corruption-prone markets.

This paper contributes to the literature on competition in the presence of corruption by presenting a model that captures the roles of corruption. Unlike Rose-Ackerman (1975), we assume firms to be symmetric and the government preference to be well defined. Corruption arises because the buyer does not have the expertise or the information needed to make the purchase decision and delegates the decision to an agent. Compte et al. (2005) exogenously impose corruption; the buyer does not need an agent in their setup. Corruption arises endogenously in our setup, more like Burguet and Che (2004). The existing papers do not explicitly model both the agent and the buyer. In our model, the agent is strategic. She understands the implications of dishonest behavior and does not always accept the higher bribe. The buyer is also strategic. She understands the agent's incentives and tries to discipline her. By accommodating these features, which the existing literature has largely ignored, we are able to gain interesting new insights on competition in the presence of corruption. We show that an agent can become more dishonest as a result of increased monitoring, using a rational agent model. We also provide a formal explanation for the disconnect between the common perception of the FCPA's impact on U.S. firms and the findings of the empirical studies. Our findings have important implications for firms doing business in international markets, as well as governments.

This paper also contributes to the growing theoretical literature in marketing on issues that are closely related to emerging markets. Jain (2008) and Vernik et al. (2011) investigate digital piracy. Koenigsberg et al. (2010) examine package size and price decisions for products that deteriorate over time and provide implications for developing markets such as India. Amaldoss and Shin (2011) investigate how the size of a low-end market influences a firm's profits and quality decisions. Qian et al. (2015) examine the issue of counterfeits. We focus on another key challenge of bribery in this paper.

The existing literature studies the role of verification or auditing in different contexts. Townsend (1979) presents a model in which endowment of a consumption good of one of the players is random, and becomes known to the other player only after a verification cost is borne. Border and Sobel (1987) assume that the principal, who wishes to extract a payment from an agent, does not know the wealth of the agent. The principal may verify the wealth of the agent through costly auditing. Lal (1990) studies how royalty payments and/or use of monitoring can facilitate channel coordination. The franchisor implements costly monitoring to enforce the business format it desires. Gal-Or (1995) examines owners' incentives to monitor the retail outlets, with the objective of maintaining quality standards in franchise chains. In our paper, the buyer implements monitoring with the objective of discouraging the agent from selecting a nondeserving firm in exchange for bribes.

This paper relates to literature on strategic information transmission in the presence of a third party. Scharfstein and Stein (1990) examine the behavior of an advisor who cares about his reputation for accuracy, and show that an advisor's incentive to say the expected thing can result in herd behavior. Durbin and

Iyer (2009) study information transmission to a decision maker from an advisor who values his reputation for incorruptibility in the presence of a third party who offers unobservable bribes to influence the advice. They show that the advisor may send an inaccurate message to bolster his reputation for incorruptibility. Inderst and Ottaviani (2012) present a model of competition in which product providers compete to influence an intermediary's advice to consumers through hidden kickbacks or disclosed commissions. They study equilibrium commissions and welfare implications of commonly adopted policies such as mandatory disclosure and caps on commissions.

The study of lobbying and political campaign contributions has received attention in the literature (see Baye et al. 1993 and Kroszner and Stratmann 2005). Although similar in some ways, important differences exist between lobbying and the problem studied in this paper. Lobbying, mostly having a legal status, does not require monitoring in the way corruptible behavior does. With lobbying, the agent may receive contributions from interested parties before making a policy decision, and reputation may govern the agent's action. Our paper deals with a different problem that is important in the context of procurement settings in many developing markets where firms may offer bribes to sway decisions in their favor. Because such actions may be potentially illegal, monitoring of the agents becomes relevant. In many developing markets, this type of corruption, rather than lobbying as in the United States, is more important. Furthermore, in these developing markets, the agent is typically a government official who may not care as much about her long-lived reputation. This lack of concern in turn makes monitoring as in our model important.

The rest of the paper is organized as follows. The next section presents the model, where we discuss firms' decisions, the agent's decision, and the buyer's decision. Section 3 presents the analysis of the unilateral control setup and its comparison to the model discussed in Section 2. Section 4 presents extensions and discusses the robustness of results. Section 5 summarizes our results.

2. Model

Consider a buyer that needs to buy a single, indivisible good. The suppliers of the product can be one of two possible types: good fit or bad fit. The utility of the buyer who buys the product at price p is given by $V(v_f, p) = v_f - p$, where $v_f = v$ if the product is bought from a supplier with good product fit and $v_f = 0$ if it is bought from a supplier with bad product fit. The buyer does not have the expertise or the information needed to evaluate the product fit. Therefore, firms are identical to the buyer. The maximum price the buyer is willing to pay for the product is $\bar{p}$. This price could come from the buyer's knowledge of selling prices of the same good in other markets or from her own prior experience from purchase of similar products.[10] In the basic model, we present the analysis with exogenous $\bar{p}$ and then in Section 4.1 analyze the model in which $\bar{p}$ is endogenously chosen by the buyer to maximize her profits.

Two firms, i and j, compete to supply the product to the buyer. One of the two firms' products is a good fit, the other's product is a bad fit. The probability that firm i's product is a good fit is 0.5. Firms do not know whether their product is a good fit, perhaps because of their lack of awareness of the intended use of the good, previous training received by the buyer's staff, the environment in which the good will be used, or the firm's lack of experience. In Section 4.2, we present the case in which the firms know whether their product is a good fit. Both firms have the same marginal cost of production, which is set to zero. The firms, instead of participating in the bidding for the project, can engage in an alternative activity, which yields them a payoff $k \geq 0$. Therefore, unless the firms expect to make profits higher than k, they do not participate in the bidding process.[11] To ensure that both firms participate in the market even if corruption is prevalent, we need k to be sufficiently smaller than the price $\bar{p}$ that the buyer is willing to pay ($k < (3\bar{p})/8$).

An agent, such as a bureaucrat, selects one of the two firms on behalf of the buyer. The agent, costlessly and privately, learns that one of the two firms is a fit and the other is a misfit. This learning, although informative, is not perfect. The probability that a firm is actually a fit, given the agent's signal indicates it a fit, is $\rho > 0.5$. The agent is expected to select the firm that her signal indicates a fit. The agent, in exchange for a bribe $b_i \geq 0$ ($b_j \geq 0$) from firm i (firm $j \neq i$), can change her report and select a firm she believes is misfit. Both firms simultaneously and privately submit price bids p_i and p_j, and bribe offers b_i and b_j, to the agent. The buyer observes price bids. From here onward, we refer to the firm for which the agent receives a fit signal as the deserving firm and the other firm as the nondeserving firm. The agent receives the bribe conditional on the firm receiving the order to supply the product.

The buyer understands that the agent may accept the bribe and select a nondeserving firm. To discourage the agent from this behavior, the buyer monitors the agent with probability $\lambda \in [0, 1]$ after the good is purchased.[12] The monitoring λ can be interpreted as the probability with which the agent gets caught and punished after selecting a nondeserving firm. In the real world, this monitoring may be implemented through various mechanisms such as the extent of whistleblower protection, the extent of control on media, the efficiency of the legal system, and the power and staffing level of the investigative agencies, among others. We note that making changes in the level of monitoring is difficult because most of the decisions that determine the level of monitoring are hard to change. Although buyers regularly make purchases, changes in the law, media policy, and so on are rare. We therefore consider monitoring to be a long-term decision. We assume the cost of monitoring $c(\lambda)$ to be continuous and strictly convex with $c(0) = 0$. The buyer, as a result of monitoring, learns the signal that the agent received and infers whether the agent made a dishonest decision in exchange for a bribe. In other words, the buyer uses monitoring to verify if the agent acted in the interest of the buyer or not. The buyer does not observe the bribe transfer, because in most cases, no official record of the bribe transfer exists.[13] When a record does exist, the buyer may not have access to those records.[14] In Section 4.4, we present an extension of the basic model in which we show that all of the main results continue to hold even if we assume that the monitoring reveals not only the selection of a nondeserving firm but also the bribe transfer.

A penalty P is imposed on the dishonest agent.[15] We assume $P > \bar{p}/2$.[16] All parties are risk neutral. The expected penalty imposed on the agent, if she makes a decision inconsistent with her signal, is simply λP. It is to be noted that monitoring λ not only captures verification probability but also the likelihood of punishment. Therefore, the minimum bribe needed for the agent to select a nondeserving firm is λP.

Now, we look at the agent's incentives in the selection process. The agent compares the bribe offers of the two firms. If $b_{\text{non}} > b_{\text{des}} + \lambda P$, where b_{des} and b_{non} are bribe offers of the deserving firm and the nondeserving firm, respectively, the agent selects the nondeserving firm. The agent's payoff in this case is $b_{\text{non}} - \lambda P$. However, if $b_{\text{non}} \leq b_{\text{des}} + \lambda P$, the agent selects the deserving firm, and her payoff simply equals the bribe b_{des} offered by the deserving firm.

A particular firm gets selected by the agent with probability one (zero) if its bribe offer is higher (lower) than the other firm's bribe offer by more than λP. If the difference in bribe offers is weakly less than λP, the agent selects the deserving firm. We assume the agent selects the deserving firm when she is indifferent between selecting a deserving and a nondeserving firm. Firm i's expected profit as a function of the bribes offered by firm i and firm $j \neq i$ can be written as

$$\pi_i(b_i, b_j) = \begin{cases} p_i - b_i & \text{if } b_i > b_j + \lambda P \\ \frac{1}{2}(p_i - b_i) & \text{if } b_j - \lambda P \leq b_i \leq b_j + \lambda P \\ 0 & \text{if } b_i < b_j - \lambda P. \end{cases}$$

Figure 1 summarizes the timing of the actions. In the first stage, nature makes a draw of the fit, from a distribution that is common knowledge, and assigns it to firms. In stage 2, the buyer sets the probability with which the agent will be monitored after making the firm selection. The rationale for setting the monitoring in this stage is twofold. First, monitoring is a long-term decision and is often difficult to change due to the nature of processes that determine the likelihood of a dishonest agent getting caught and punished. Second, the objective of monitoring is to discipline the competing firms and the agent. Monitoring induces firms to not engage in bribery and the agent to select the deserving firm. However, once the agent has made her decision and a firm has been selected, the buyer loses her incentive to monitor. This is where commitment becomes important for the buyer. By setting monitoring before the agent makes the purchase decision using publicly observed mechanisms, the buyer essentially commits to a level of monitoring and induces the agent to act in the desired way.

Subsequently in the third stage, firms submit simultaneous price and bribe bids to the agent. Next, the agent compares the bids and selects one of the two firms. The selected firm receives the accepted price and delivers the good to the buyer. In the next stage, the buyer monitors the agent and imposes a penalty if a dishonest behavior is inferred. Finally, payoffs are realized. We look for a Nash equilibrium in pure as well as mixed strategies. The computation of the mixed-strategy equilibrium is similar to that of Varian (1980) and Narasimhan (1988).

The framework described above has two important features that are missing in the existing literature on competition in the presence of corruption. First, our agent is strategic. She does not always accept the higher bribe. Also, she does not always change her report when she accepts a bribe. A dishonest behavior has implications, and the agent takes accounts for them. The buyer is also strategic. She understands the agent's incentives to cheat. Therefore, dishonest agent behavior bears consequences. The buyer, in equilibrium, sets a monitoring that maximizes her payoffs.

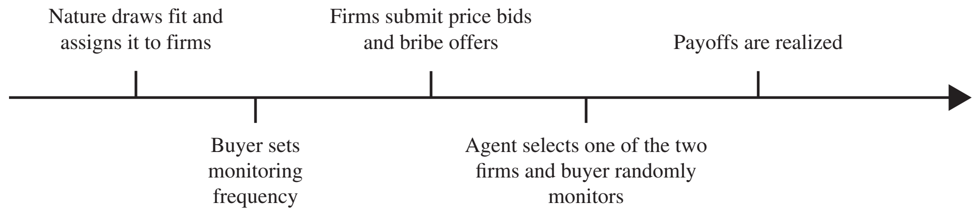
2.1. Price and Bribe Decisions

This section describes the stages of the model that are relevant for the firm's decisions regarding price and bribe offers. The agent selects a firm either because it is deserving or because it offers a sufficiently large bribe. The agent can classify a nondeserving firm as a deserving firm.[17] Given this power of the agent, a firm can always benefit from increasing the price bid, as long as the buyer does not reject the price. Both firms therefore submit the price $\bar{p}$ as their price bid and use bribes to compete for selection by the agent. This leads us to the following result:

Lemma 1. *Both firms submit $\bar{p}$ as their price bid.*

This high-price bid is a typical result in the literature and has been interpreted as corruption-facilitating collusion (see Compte et al. 2005).

Figure 1. Timing of the Actions



Firm i, when confronted with a bribe offer b_j of firm j, responds by making a bribe offer that can have three different implications. First, it can offer a bribe that is higher than b_j by more than λP and be selected with probability one. Second, it can offer a bribe that is different from b_j by, at most, λP and be selected only if it is deserving. Last, it can offer a bribe that is lower than b_j by more than λP and be selected with probability zero. However, we note the following:

Lemma 2. *Firm i responds to a bribe offer b_j of firm j by offering a bribe that is infinitesimally higher than $b_j + \lambda P$ or is* $\max\{0, b_j - \lambda P\}$.

The intuition for this result is as follows. A bribe offer that is just above $b_j + \lambda P$ makes firm i's selection certain. Any higher bribe is wasteful. An offer of $b_j - \lambda P$ makes firm i's selection certain whenever it is deserving. If the firm cannot make its selection certain by bribing even when it is a deserving firm, the firm does not bribe. We do not consider negative bribes, because they are never accepted. Firm i therefore responds to a bribe offer b_j by making an offer as specified in Lemma 2.

Now, we look at the equilibrium in bribes (proofs are in the appendix).

Proposition 1. *If $\lambda \geq \bar{p}/(2P)$, neither firm offers a bribe in equilibrium and the agent selects the firm that is deserving. If $0 < \lambda < \bar{p}/(2P)$, no Nash equilibrium exists in pure strategies. If $\lambda = 0$, both firms offer bribes of $\bar{p}$.*

The intuition behind this proposition is the following. Higher monitoring leads to a higher expected penalty for the agent. Therefore, a firm must offer a higher bribe if it expects to be chosen even when it is nondeserving. A deviating firm's profits decrease with an increase in the monitoring. For sufficiently large monitoring ($\lambda \geq \bar{p}/(2P)$), gains from deviations are completely erased. In this region, a pure-strategy Nash equilibrium exists and firms offer no bribes in equilibrium. Because firms offer no bribes and are selected when they are deserving, the equilibrium profit for both firms is $\bar{p}/2$. This profit does not depend on the monitoring probability chosen by the buyer as long as the probability is larger than $\bar{p}/(2P)$.

If the monitoring probability is lower ($0 < \lambda < \bar{p}/(2P)$), the equilibrium bribe offers are in mixed strategies. Firms respond to the other firm's bribe offer either by offering a higher bribe that is just enough to secure a sure win or by offering a lower bribe that is just enough to have the firm selected whenever it is deserving. The best response for a firm changes from a higher bribe offer to a lower bribe offer when the other firm's bribe offer becomes high enough. This switching happens because profits on overbidding reduce faster than profits on underbidding with the increase in the other firm's bribe offer. The best-response bribe offers start increasing again, and the switching happens for the other firm. The cycle continues.

If monitoring probability λ is set at zero, firms lose their entire surplus to the agent since a higher bribe offer is always a best response for both firms unless both firms offer equal bribes of $\bar{p}$. In this case the agent, being indifferent between selecting a deserving and a nondeserving firm, selects the deserving firm.

We now characterize the equilibrium mixed strategies for $0 < \lambda < \bar{p}/(2P)$. If $b_i > b_j + \lambda P$, firm i is selected with probability one. However, if $b_j - \lambda P \leq b_i \leq b_j + \lambda P$, firm i is selected only when it is deserving. If $b_i < b_j - \lambda P$, the agent does not select firm i. The profit of firm i is given by

$$\pi_i(b_i) = \text{prob}(b_i > b_j + \lambda P)(\bar{p} - b_i) + \text{prob}(b_j - \lambda P \leq b_i \leq b_j + \lambda P)\frac{\bar{p} - b_i}{2},$$

which can be written as

$$\pi_i(b_i) = [F_j(b_i - \lambda P) + F_j(b_i + \lambda P) - \omega_j(b_i - \lambda P)]\frac{\bar{p} - b_i}{2}, \tag{1}$$

where $F_j(b_j)$ is the cumulative distribution function (cdf) for firm j, and $\omega_j(b_j)$ is the density at bribe b_j.

Because the equilibrium bribing strategies depend on the range of monitoring, we specify the mixed-strategy equilibrium in two different parameter spaces.

Suppose $0 < \lambda \leq \bar{p}/(4P)$. In this range, both firms prefer to offer bribes. Let firm i's bribe offer be b_i such that $\bar{p} \geq b_i \geq \lambda P$. Consistent with Lemma 2, firm j responds by making a bribe offer of either $b_i + \lambda P$ or $b_i - \lambda P$. A bribe offer of $b_i + \lambda P$ yields an expected profit of $\bar{p} - (b_i + \lambda P)$, whereas a bribe offer of $b_i - \lambda P$ yields an expected profit of $\frac{1}{2}(\bar{p} - (b_i - \lambda P))$ for firm j. A comparison of the profits in the two options reveals that firm j, in response to b_i, is better off offering a bribe of $b_i + \lambda P$ if $b_i < \bar{p} - 3\lambda P$, whereas it is better off offering $b_i - \lambda P$ if $b_i > \bar{p} - 3\lambda P$. Firm j is indifferent about overbidding or underbidding if firm i offers a bribe of exactly $\bar{p} - 3\lambda P$. The same holds for firm i. Because both firms prefer to underbid in response to any bribe offer higher than $\bar{p} - 3\lambda P$, a bribe higher than $\bar{p} - 2\lambda P$ will never be offered. Also, because both firms prefer to overbid in response to any bribe offer lower than $\bar{p} - 3\lambda P$, a bribe lower than $\bar{p} - 4\lambda P$ will never be offered. The support of bribe offer distribution is therefore $[\bar{p} - 4\lambda P, \bar{p} - 2\lambda P]$. The bribing equilibrium, which is in mixed strategies, is described in Proposition 2.

Proposition 2. *If* $0 < \lambda \le \bar{p}/(4P)$,

(a) *the equilibrium bribing strategy for firm* j *is given by*

$$F_j(b_j) = \begin{cases} \dfrac{3\lambda P}{\bar{p} - b_j - \lambda P} - 1 & \text{if } \bar{p} - 4\lambda P \le b_j < \bar{p} - 3\lambda P, \\ \dfrac{3\lambda P}{\bar{p} - b_j + \lambda P} & \text{if } \bar{p} - 2\lambda P \ge b_j \ge \bar{p} - 3\lambda P, \end{cases} \tag{2}$$

and

(b) *both firms make profits of* $3\lambda P/2$.

The equilibrium bribe distribution, for both firms, is continuous and has a mass point at the bribe level $\bar{p} - 3\lambda P$, at which the best response switches from a bribe higher by λP to a bribe lower by λP. The best-response bribe offer changes by exactly $2\lambda P$ (which is the range of support), and the mass point appears in the middle of the support of equilibrium bribe distribution. In equilibrium, both firms offer positive bribes with probability one. The equilibrium is unique by construction, and it is straightforward to show, by contradiction, that the bribing strategies specified in Proposition 2 constitute a Nash equilibrium.

It is of interest to look at how the equilibrium bribing strategies and profits respond to a small change in monitoring. An increase in monitoring requires that firms overbid their rivals by a larger amount if they wish to be selected with certainty. Given that both firms still offer bribes with probability one, it might appear counterintuitive to see that profits are increasing in monitoring λ. The intuition for this result is the following. Because firms must overbid by a larger amount to get selected with probability one, they become less willing to do so. Firms become indifferent to overbidding or underbidding the rival firm at lower bribes. As a consequence, lower bribes are offered in equilibrium, which results in higher profits for both firms. We can express each point in the support of the distribution in Equation (2) in the form $\bar{p} - a\lambda P$, where $2 \ge a \ge 4$. Therefore, the probability at each point in the support of bribe distribution is independent of λ.

We now look at the intermediate range of monitoring $\bar{p}/(4P) \le \lambda \le \bar{p}/(2P)$. Given $\lambda \le \bar{p}/(2P)$, both firms prefer to offer bribes if the other firm is not offering a bribe. Firms prefer to overbid by λP on any rival firm's bid that is smaller than $\bar{p}/2 - \lambda P$. Because $\lambda \ge \bar{p}/(4P)$, the alternative strategy, as per Lemma 2, is to offer no bribes, but it yields lower profits. Firms also prefer to underbid on any rival firm's bid that is larger than λP. Because firms prefer to overbid only in response to bribe offers smaller than $\bar{p}/2 - \lambda P$, a bribe higher than $\bar{p}/2$ is not offered. If a firm makes a bribe offer $b \in (\bar{p}/2 - \lambda P, \lambda P)$, it must be in response to a bribe offer higher than $\bar{p}/2$. However, because no bribe offers are larger than $\bar{p}/2$, no bribe offers are made in the interval $(\bar{p}/2 - \lambda P, \lambda P)$. The support of the bribe-offer distribution therefore is $[0, \bar{p}/2 - \lambda P] \cup [\lambda P, \bar{p}/2]$. The equilibrium bribing strategies and profits in this range of monitoring are given in Proposition 3.

Proposition 3. *If* $\bar{p}/(4P) \le \lambda \le \bar{p}/(2P)$,

(a) *the equilibrium bribing strategy for firm* j *is given by*

$$F_j(b_j) = \begin{cases} \dfrac{\bar{p} + 2\lambda P}{2(\bar{p} - b_j - \lambda P)} - 1 & \text{if } 0 \le b_j < \dfrac{\bar{p}}{2} - \lambda P, \\ \dfrac{\bar{p} + 2\lambda P}{2\bar{p}} & \text{if } \dfrac{\bar{p}}{2} - \lambda P \ge b_j \ge \lambda P, \\ \dfrac{\bar{p} + 2\lambda P}{2(\bar{p} - b_j + \lambda P)} & \text{if } \lambda P \ge b_j \ge \dfrac{\bar{p}}{2}, \end{cases}$$

and

(b) *both firms make profits of* $(\bar{p} + 2\lambda P)/4$.

The distribution is continuous in its support. Two mass points exist for each firm, one at $b = 0$ and the other at $b = \bar{p}/2 - \lambda P$. This equilibrium is also unique; it can be easily shown that the bribing strategies specified in Proposition 3 constitute a Nash equilibrium. Firms do not offer bribes with probability one in this range of monitoring. As monitoring is increased, firms offer bribes with smaller probability, in response to the higher amount by which they must overbid other firms' bribes to be selected with certainty. The firm's profits are increasing in monitoring but at a smaller rate compared to the rate of increase in the $0 < \lambda \le \bar{p}/(4P)$ case. The lower bound on bribes, at zero, causes profits to increase at a slower rate. We also note that no discontinuity exists in the bribe-offer distribution or the firm profits at the boundaries of this parameter space.

2.2. Agent's Selection Decision

Having described the price and bribe offer decisions in the entire range of monitoring, we now examine the agent's behavior in response to the firm's strategies. We are interested in an agent's decision to select a nondeserving firm because it is this decision that hurts the buyer. The agent does not always select a nondeserving firm when she accepts a bribe. If the difference of bribes offered by the two firms is smaller than the expected loss the agent incurs on selecting a nondeserving firm, the agent simply selects and accepts the bribe from the deserving firm. Because firms do not know whether they are deserving, they cannot condition their bribe payments on their fit. The agent selects a firm with certainty only when the bribe offers are different by more than λP. However, selecting a firm with certainty does not imply that the agent is selecting a nondeserving firm. Note that the firms are deserving with probability 0.5. We can write the probability Pr with which the agent selects a nondeserving firm as

$$Pr = \tfrac{1}{2}\text{prob}(|b_i - b_j| > \lambda P). \tag{3}$$

The probability Pr is computed using the equilibrium bribe distributions specified above. We obtain the following results.

Proposition 4. *The probability with which the agent selects a nondeserving firm*

(a) *is strictly positive and independent of monitoring* λ, *if* λ *is sufficiently small* $(0 < \lambda \le \bar{p}/(4P))$,

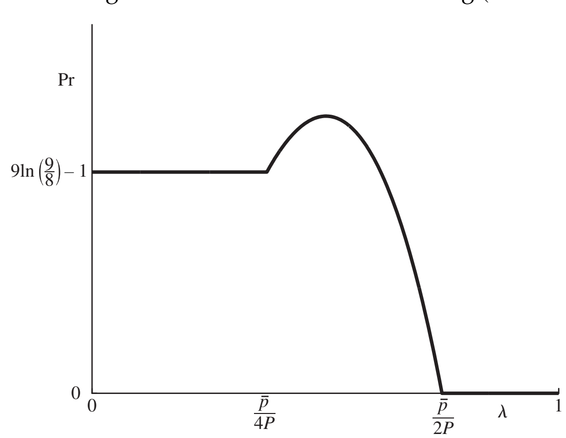
(b) *first increases and then decreases to zero at* $\lambda = \bar{p}/(2P)$, *if* λ *is increased beyond* $\bar{p}/(4P)$, *and*

(c) *is zero* $\forall\, \lambda \ge \bar{p}/(2P)$.

These results are also presented graphically in Figure 2. We note two observations that were discussed earlier. First, an increase in monitoring λ increases the agent's cost of selecting a nondeserving firm. Firms respond to higher monitoring by offering smaller or no bribes. Yet, an increase in monitoring has no effect on an agent's decision to select a nondeserving firm when monitoring is sufficiently small. Even more puzzling is the increase in Pr with monitoring in the intermediate range.

The intuition for the above results is the following. If monitoring is sufficiently small $(0 < \lambda \le \bar{p}/(4P))$, both firms offer strictly positive bribes with probability one. When both firms offer bribes, the agent often selects the deserving firm and accepts the bribe offered by it. Because both firms offer bribes for sure in this range of monitoring, the probability with which the agent selects a nondeserving firm does not change. If monitoring probability is increased beyond $\bar{p}/(4P)$, firms become less likely to offer bribes. The agent may now face situations in which she receives a bribe offer only from a nondeserving firm. Therefore, the selection of a nondeserving firm becomes more likely. As monitoring is further increased, firms become less likely to offer bribes. Therefore, the probability with which the agent selects a nondeserving firm also decreases. For a sufficiently large monitoring $(\lambda \ge \bar{p}/(2P))$, firms do not offer bribes and therefore the agent does not select a nondeserving firm.

Figure 2. Probability with Which the Agent Selects a Nondeserving Firm as a Function of Monitoring $(0 < \lambda \le 1)$



In various contexts, researchers have widely reported insensitivity to or an increase in dishonest behavior as a result of increased monitoring, or penalty. Mazar et al. (2008) find the dishonesty of test takers insensitive to monitoring. Several studies originating from Deci (1972) show in experiments that an increase in monitoring can result in more dishonest behavior. Gneezy and Rustichini (2000) observe the performance of test takers first declined, then improved, and then became stable with an increase in the monetary compensation. They also offer possible behavioral explanations. Also related to our work is a study by Schulze and Frank (2003), who show that an increase in monitoring can make an agent making a procurement decision on behalf of a principal more dishonest as a result of monitoring. Akerlof and Dickens (1982) and Bénabou and Tirole (2006) draw on the behavioral literature and present models to derive these results. We present a rational-agent model to show that dishonesty can be insensitive to or can even be increasing in the monitoring. This result has important implications for buyers and firms in markets where corruption is prevalent.

2.3. Monitoring Decision

If a firm is a fit, the agent finds it deserving only with probability ρ. Therefore, if the agent makes an honest decision to select the deserving firm, she selects a fit firm only with probability ρ. The payoff of the buyer is v with probability ρ and zero with probability $1-\rho$. Similarly, if the agent selects a nondeserving firm, the buyer gets a payoff of v with probability $1-\rho$ and a payoff of zero with probability ρ. The probability Pr with which the agent selects a nondeserving firm is discussed in the previous section. We can write the expected payoff of the buyer as

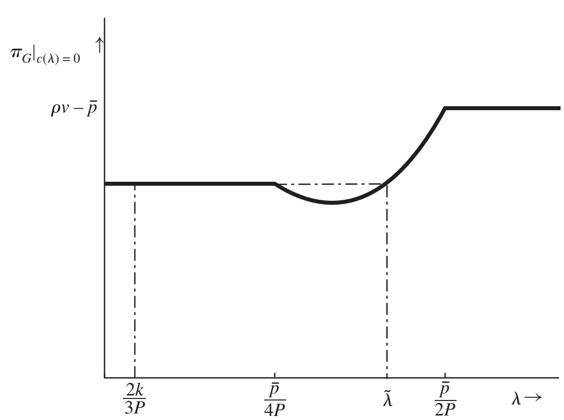
$$\pi_G = (1-\rho)vPr + \rho v(1-Pr) - \bar{p} - c(\lambda). \tag{4}$$

We first look at $\pi_G|_{c(\lambda)=0}$. At $\lambda = 0$, both firms make bribe offers of $\bar{p}$ and the agent always selects the deserving firm. Therefore, the buyer's payoff at zero monitoring is $\rho v - \bar{p}$. The expressions of Pr as given in the proof of Proposition 4 are substituted in Equation (4) to get

$$\pi_G|_{c(\lambda)=0} = \begin{cases} \left[3\rho - 1 - 9(2\rho-1)\ln\frac{9}{8}\right]v - \bar{p} \quad \text{if } 0 < \lambda \le \frac{\bar{p}}{4P} \\ (4\rho-1)\frac{v}{2} + \frac{\bar{p}[(2\rho-1)v - 4\lambda P]}{4\lambda P} - \frac{2(2\rho-1)\lambda P v}{\bar{p}} \\ -\frac{(\bar{p}+2\lambda P)^2(2\rho-1)v}{4\lambda^2 P^2}\ln\frac{(\bar{p}-\lambda P)(\bar{p}+2\lambda P)}{\bar{p}^2} \\ \quad \text{if } \frac{\bar{p}}{4P} \le \lambda \le \frac{\bar{p}}{2P} \\ \rho v - \bar{p} \quad \text{if } \lambda \ge \frac{\bar{p}}{2P}. \end{cases} \tag{5}$$

Note that λ enters $\pi_G|_{c(\lambda)=0}$ only through the probability Pr with which the agent selects a nondeserving firm. It is now straightforward to understand how $\pi_G|_{c(\lambda)=0}$ changes with monitoring λ. For $0 < \lambda \le \bar{p}/(4P)$, the probability Pr does not depend on λ; therefore, $\pi_G|_{c(\lambda)=0}$ also does not depend on λ. For $\bar{p}/(4P) \le \lambda \le \bar{p}/(2P)$, the probability Pr first increases and then decreases to zero; therefore, $\pi_G|_{c(\lambda)=0}$ first decreases and then increases to its maximum value at $\lambda = \bar{p}/(2P)$. For $\lambda \ge \bar{p}/(2P)$, it stays at its maximum value, which is $\rho v - \bar{p}$. These results are presented in Figure 3. We now look at the buyer's choice of λ under cost of monitoring $c(\lambda)$. The buyer does not set zero monitoring, because if it did, the firms would not participate in the bidding. In fact, to ensure firms' participation, the buyer must set a monitoring at least infinitesimally higher than $2k/(3P)$. An implicit assumption is that the buyer makes nonnegative profits when it sets monitoring at $2k/(3P)$. If not, the buyer sets monitoring probability at zero, and the firms do not participate in the auction. Any monitoring $\lambda > 2k/(3P)$ for which $\pi_G|_{c(\lambda)=0} \le \pi_G(\lambda = 2k/(3P))|_{c(\lambda)=0}$ is not optimal, because

Figure 3. Buyer's Payoff with Monitoring (for Costless Monitoring)



$c'(\lambda) > 0$ for every $\lambda > 0$. Also, because $c'(\lambda) > 0$, optimal λ cannot be larger than $\bar{p}/(2P)$. Increasing λ beyond $\bar{p}/(2P)$ offers no extra benefit to the buyer because the agent behaves as desired at all $\lambda \ge \bar{p}/(2P)$. Therefore, the buyer chooses optimal λ from the set $\{2k/(3P), (\tilde{\lambda}, \bar{p}/(2P)]\}$, where $\tilde{\lambda} \in (\bar{p}/(4P), \bar{p}/(2P))$ is the monitoring at which $\pi_G|_{c(\lambda)=0} = \pi_G(\lambda = 2k/(3P))|_{c(\lambda)=0}$. We see the buyer as making one of two choices. She either accepts corruption with little anticorruption enforcement or limits corruption, partially or fully, by setting a $\lambda \in (\tilde{\lambda}, \bar{p}/(2P)]$. The buyer's decision to ignore or limit corruption depends on her expected gain from limiting corruption in comparison to ignoring it. We represent this gain by Δ defined as

$$\Delta \equiv \left(\pi_G - \pi_G\left(\lambda = \frac{2k}{3P}\right)\right)\Bigg|_{c(\lambda)=0}. \tag{6}$$

Further examination of the $\pi_G|_{c(\lambda)=0}$ function leads us to the following proposition:

Proposition 5. *If $c(\lambda) - c(2k/(3P)) > \Delta\ \forall\ \lambda \in (\tilde{\lambda}, \bar{p}/(2P)]$, the buyer allows corruption with almost no anticorruption enforcement ($\lambda^* = 2k/(3P)$); otherwise, she limits corruption by setting a monitoring probability $\lambda^* \in (\tilde{\lambda}, \bar{p}/(2P)]$.*

The buyer sets the monitoring either at a low value or at a sufficiently large value. An intermediate level of monitoring does not make the buyer any better, because the agent selects the nondeserving firm with the same or higher probability. A buyer setting a higher monitoring expects the agent to select the nondeserving firm with a lower probability. This more honest agent behavior in response to increased monitoring is observed only when $\lambda \in (\tilde{\lambda}, \bar{p}/(2P))$. The buyer setting a higher monitoring incurs a higher cost. If the cost is higher than the benefit the buyer enjoys from more honest agent behavior, the buyer sets monitoring at $2k/(3P)$. If not, the buyer sets a sufficiently large monitoring and limits corruption. When the buyer allows corruption, the firm's profit equals k. However, if the buyer limits corruption, firms make expected profits of $(\bar{p} + 2\lambda^* P)/4$. If the buyer eliminates corruption by setting monitoring at $\bar{p}/(2P)$, the firms make expected profits of $\bar{p}/2$, which is the highest profit the firms can make in this symmetric setup.

We next look at the role of $c(\bar{p}/(2P))$, which is relevant to the analysis presented in Section 3. Corruption is eradicated at the monitoring $\lambda = \bar{p}/(2P)$. The buyer eradicates corruption only if the cost at $\lambda = \bar{p}/(2P)$ is smaller than the increase in profit the buyer enjoys as a result of honest agent behavior compared to the small monitoring of $2k/(3P)$. Therefore, we get

$$c\left(\frac{\bar{p}}{2P}\right) - c\left(\frac{2k}{3P}\right) < (2\rho-1)\left[9\ln\frac{9}{8} - 1\right]v. \tag{7}$$

This equation, although necessary, is not sufficient for corruption eradication. A $\lambda \in (\tilde{\lambda}, \bar{p}/(2P))$ may exist that dominates eradication. While the condition $c(\bar{p}/(2P)) - c(2k/(3P)) > (2\rho - 1)[9\ln(9/8) - 1]v$ implies that corruption is not eradicated, Equation (7) implies that the buyer limits the corruption, partially or completely.

The buyer either chooses to be ignorant or commits to taking drastic measures to limit corruption. Setting an intermediate level of monitoring is not optimal for the buyer, because it does not reduce corruption.[18] Singapore and Hong Kong were once corruption infested. However, because they implemented drastic measures to combat corruption, they have almost completely eradicated it. The efforts to limit corruption in many other emerging economies appear half-hearted. The impact on the prevalence of corruption is therefore little, if any.

3. Unilateral Control

In this section, we consider that one of the firms, say, firm i, as required by the law in its home country, does not offer bribes to the agent. The structure and timing of the game is exactly as in the previous section. As before, both firms make a price bid of $\bar{p}$. The firm j either does not offer a bribe or it offers a bribe just over λP. We assume that if firm j is indifferent between offering and not offering a bribe, it does not offer a bribe. If firm j does not offer any bribe, the agent selects the deserving firm. Both firms make an expected profit of $\bar{p}/2$ in this case. However, if firm j offers a bribe that is infinitesimally higher than λP, the agent selects firm j with probability one. If firm j offers a bribe, it makes a profit of $\bar{p} - \lambda P$ and firm i makes zero profit.

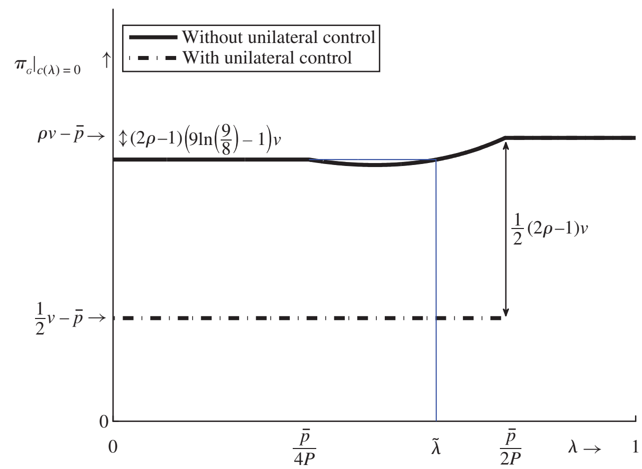
If $\lambda \geq \bar{p}/(2P)$, both firms offer no bribes in equilibrium. A possible deviation for the firm j is to offer a bribe of λP and make a profit of $\bar{p} - \lambda P$. However, given $\lambda \geq \bar{p}/(2P)$, the deviation is not more profitable than the equilibrium strategy. Similarly, if $\lambda < \bar{p}/(2P)$, firm j offers a bribe of λP in equilibrium. The buyer gets her valuation v with probability ρ if the agent selects the deserving firm, whereas she gets v only with probability $\frac{1}{2}$ if the agent selects firm j with certainty. The payoff of the buyer is

$$\pi_G^u = \begin{cases} \rho v - \bar{p} - c(\lambda) & \text{if } \lambda \geq \dfrac{\bar{p}}{2P}, \\ \frac{1}{2}v - \bar{p} - c(\lambda) & \text{if } \lambda < \dfrac{\bar{p}}{2P}. \end{cases}$$

These payoffs, assuming $c(\lambda) = 0$, are shown in Figure 4. We can now look at the buyer's decision to set monitoring.

The buyer either eliminates corruption by setting monitoring at $\bar{p}/(2P)$ or sets monitoring at zero. The buyer can set the monitoring at zero since in the absence of bribe competition from firm i, the profits

Figure 4. (Color online) Buyer's Payoff with Monitoring, With and Without Unilateral Anticorruption Control (for Costless Monitoring)



of firm j actually increase with a decrease in monitoring probability. Because $c'(\lambda) > 0$, the buyer does not set any other monitoring. The buyer's decision to set monitoring depends only on the cost of monitoring at $\lambda = \bar{p}/(2P)$. If $c(\bar{p}/(2P)) < (\rho - \frac{1}{2})v$, the buyer sets monitoring at $\bar{p}/(2P)$ and eliminates corruption. However, if $c(\bar{p}/(2P)) \geq (\rho - \frac{1}{2})v$, the buyer sets monitoring at zero. A comparison of firm i's profits with and without unilateral control leads us to the following proposition:

Proposition 6. *A unilateral control on bribing on a firm in a corrupt but competitive market may increase its profits if $c(\bar{p}/(2P)) \leq (9\ln(9/8) - 1)(2\rho - 1)v + c(2k/(3P))$, would definitely increase its profits if $(9\ln(9/8) - 1)(2\rho - 1) \cdot v + c(2k/(3P)) < c(\bar{p}/(2P)) < \frac{1}{2}(2\rho - 1)v$, and decreases its profits if $c(\bar{p}/(2P)) \geq \frac{1}{2}(2\rho - 1)v$.*

One striking result in the above proposition is that a unilateral anticorruption control can actually benefit the firm that is being restricted from offering a bribe. A unilateral control on one firm eliminates competition in bribes. The firm that is not controlled can offer just λP and be selected with certainty. As a result the selection of a nondeserving firm by the agent becomes more likely. The increase in the likelihood of selection of the nondeserving firm hurts the buyer. Therefore, the buyer may strategically set a higher monitoring to discourage bribery by the firm that is not controlled. The increase in the monitoring results in higher profits for the unilaterally controlled firm. In some cases, a unilateral control on the firm can make it worse off. This happens if, in the absence of unilateral control, the buyer sets a nonzero monitoring, but with unilateral control, the buyer sets zero monitoring. If the buyer's decision to set monitoring does not change as unilateral control is introduced, the profits of the controlled firm remain unchanged.

The firm that is not controlled benefits from the unilateral control on the other firm. For the controlled firm, the benefit comes as a result of the buyer setting higher monitoring. The firm that is not controlled also benefits when the buyer sets zero monitoring. Without unilateral control, most of the surplus transfers to the agent in the process of competitive bribing. Yet with unilateral control on the other firm, a firm makes higher profits as it offers a bribe of only λP. We think that claims about the competitive disadvantage the controlled firm faces originate from this comparison in which the buyer sets monitoring at zero. If the buyer sets monitoring at zero, the firm that is not controlled is selected by the agent and makes higher profits than the controlled firm, which is not selected. The profits of the controlled firm are also lower than its profits in the case of no unilateral control. This is because in the case of no unilateral control, the buyer sets a small monitoring of $2k/(3P)$ instead of zero to ensure participation of both firms in the bidding process.

The higher profits for the controlled firm result from the buyer's choice of higher monitoring. There is some evidence of such increased monitoring. Gillespie (1987) finds evidence of this in the Middle East after 1977. Unsurprisingly, most empirical studies find no evidence of competitive disadvantage posed by the FCPA of 1977. We also note that enforcement of the FCPA has increased drastically in recent years.[19] It is interesting to note the recent anticorruption efforts in some of the emerging economies. Brazil enacted the Freedom of Information Law of 2011, which is a step toward reducing corruption. Russia signed the Organisation for Economic Co-operation and Development (OECD) Anti-Bribery Convention in 2012. An anticorruption movement started in India in 2010 that seeks strong legislation and enforcement against corruption. China implemented a stricter antibribery law in 2011. We have no reason to believe that these efforts are only in response to the increased FCPA enforcements. However, we believe this increase in FCPA enforcement will make U.S. firms better off as foreign governments take measures to limit corruption.

4. Extensions and Robustness of Results

4.1. Endogenous Reserve Price

In the analysis presented thus far, we assumed the maximum price the buyer is willing to pay (the reserve price) to be exogenous. In this section, we endogenize the reserve price set by the buyer. All details of the model remain the same, except that the buyer specifies a reserve price $\bar{p}$ before the firms submit their bids. The firms' equilibrium bribing and pricing strategies are as described in Section 2.1, and the agent's responses to these firm strategies are as described in Section 2.2. Therefore, in this section, we only discuss the buyer's reserve price and monitoring decisions.

The buyer sets a reserve price to maximize her profits, while ensuring that the firms' expected profits are high enough that they participate in the bidding process. First, we find the minimum reserve price at which the firms are willing to participate in the bidding. Recall that the firms participate in the bidding process only if their expected profits are at least infinitesimally higher than k. If monitoring probability λ is small ($\lambda < 2k/(3P)$), firms would want to offer bribes with probability one and would make expected profits of $(3\lambda P)/2$. However, because $\lambda < 2k/(3P)$, the firms' expected profits would be smaller than k. Therefore, if the monitoring probability is sufficiently small, the equilibrium bribes that the firms would want to offer are so large that they would expect to make profits lower than their reservation profits and, as a result, choose not to participate in the bidding. On the other extreme, if monitoring λ is sufficiently large ($\lambda > k/P$), corruption is eradicated and firms' expected profits are $\bar{p}/2$. Therefore, if monitoring is large enough, firms participate in bidding as long as $\bar{p}$ is infinitesimally larger than $2k$. In the intermediate range of monitoring ($2k/(3P) \le \lambda \le k/P$), since the firm's profits are $(\bar{p}+2\lambda P)/4$, the minimum $\bar{p}$ satisfying firms' participation constraint is $4k-2\lambda P$.

Next, we examine the reserve price set by the profit-maximizing buyer. If valuation of the buyer is sufficiently small ($v \le (8\lambda P)/(3(2\rho-1)(1-8\ln(9/8)))$), the buyer's payoff as given by Equation (5) is monotonically decreasing in $\bar{p}$. In this case, the profit-maximizing reserve price is the minimum $\bar{p}$ (as described above) at which the firms participate in the bidding. Whereas if valuation is larger ($v > (8\lambda P)/(3(2\rho-1)(1-8\ln(9/8)))$), the buyer's payoff is nonmonotonic in $\bar{p}$ with a local maximum at $4\lambda P$. In this case, the profit-maximizing reserve price is the minimum $\bar{p}$ at which the firms participate in the bidding unless the buyer can make higher profits by increasing $\bar{p}$ to $4\lambda P$. If the buyer can indeed increase her profits by increasing $\bar{p}$, she sets the reserve price at $4\lambda P$.

Having described the buyer's reserve price decision, we look at the monitoring decision. We find that as in the case of the model with the exogenous reserve price presented earlier, the buyer either ignores corruption by setting a small monitoring ($2k/(3P)$) or limits corruption by setting a high-enough monitoring in the range $(\tilde{\lambda}, k/P]$. A monitoring in the intermediate range is not optimal. The intuition for this result is the same as in the case of the basic model. We also find that the buyer responds to the unilateral control on a firm by changing her monitoring strategy in the same manner as in the basic model. The main results about the buyer's reluctance to set monitoring in the intermediate range and a possibly higher monitoring set by the buyer in response to a unilateral anticorruption control on one of the firms are robust and preserved in this extension. However, because in this extension with the buyer endogenously setting the reserve price the buyer can extract all of the surplus from the firms, the expected profits of the firm remain unchanged regardless of whether it is subjected to the unilateral control.

4.2. Informed Firms

In the basic model, we assumed that only the agent is informed about the fit of the products with the requirements of the buyer. Our rationale in making this assumption was that firms are often unaware of the buyer's exact requirements. Even if they are aware, they may not know how these requirements translate into technical specifications of the product. Here, we consider another extension to the basic model in which if the firms choose to participate in the bidding, they will also be informed of the fit. Thus, no information asymmetry exists between the agent and the firms.

The agent prefers to select the deserving firm unless the bribe the nondeserving firm offers exceeds the bribe the deserving firm offers, by more than λP. The deserving firm offers a bribe just over $\bar{p} - \lambda P$ and ensures that the agent selects it even if the nondeserving firm offers the entire $\bar{p}$ as a bribe. Therefore, the agent will always select the deserving firm and the buyer in turn will choose to be ignorant about corruption. The nonmonotonic agent behavior result, presented in the basic model, disappears. This is because, in this section, we examine a polar case in which we require both the agent and the competing firms to have exactly the same information about the product fit. The result presented in Proposition 4 about the agent's behavior needs the agent to have an informational advantage about the product fit.[20] However, the result about the controlled firm possibly benefiting from the anticorruption control on it continues to hold in this setup. The presence of unilateral anticorruption control makes the selection of a nondeserving firm likely. As in the case of the basic model, the strategic buyer may respond by setting a higher monitoring to discourage the bribery by the firm that is not controlled. Therefore, the unilateral anticorruption control may result in higher profits for the controlled firm.

4.3. Monitoring Before Purchase

In 2012, India's Supreme Court ordered the government to cancel over 100 licenses granted to mobile phone companies in what is described as one of India's largest scandals.[21] More recently, the Zambian government terminated a US$210 million closed-circuit television camera contract with China's ZTE in the wake of allegations of corruption.[22] The point to note is that in some situations, the buyer might be able to cancel the purchase order or license after the agent makes the purchase recommendation. Here, we discuss a model in which the buyer, instead of monitoring the agent after the purchase, monitors the agent after recommendation but before the purchase. The buyer expects the agent to recommend a deserving firm for the purchase. However, the agent is willing to recommend a nondeserving firm in exchange for bribes. The agent recommends a firm in exchange for bribes, but the recommended firm does not always get the order. If the buyer discovers dishonest agent behavior, no firm receives the order and a penalty P is imposed on the agent.[23] The timing of the game is the same as before, except that the monitoring takes place after the agent's purchase recommendation, and a purchase is not made if the recommendation is found to be dishonest. We compare the results to those presented in Sections 2 and 3.

A firm's incentive to bribe the agent becomes smaller because the bribe does not always translate into a purchase. Firms offer bribes with probability one only when monitoring is smaller than $\bar{p}/(\bar{p}+4P)$ and do not offer bribes for any monitoring larger than $\bar{p}/(\bar{p}+2P)$. Bribe offers, when made, are smaller in expectation. As a result, expected profits for firms are weakly higher for any monitoring set by the buyer. The probability with which the agent selects a nondeserving firm changes nonmonotonically with the monitoring, similar to Proposition 4. However, the probabilities and the thresholds are smaller. Corruption is reduced as a result of lower incentives for firms to bribe the agent.

Now, we examine the buyer's decision to set monitoring. As in Proposition 5, the buyer either chooses to be ignorant about corruption by setting a small, nonzero monitoring or commits to taking strong steps to reduce corruption by setting high monitoring. The buyer's expected profits are weakly higher than the case of ex post monitoring presented in the basic model. Therefore, if the buyer could choose the timing of monitoring, she would select it to be before the purchase. However, note that monitoring may be a lengthy process and that it may not always be possible to hold the selection of the firm until the outcome of monitoring is determined.

A unilateral anticorruption control on one of the firms can result in higher profits for the controlled firm. Although the conditions under which the controlled firm makes higher profits, as a result of the unilateral anticorruption control, are different, the intuition is the same as that described in Section 3. All of the main results presented in the basic model are robust to this extension.

4.4. Bribes Observable On Monitoring

In the basic model, we assumed that the buyer does not receive any direct evidence of bribery through monitoring. Bribery is inferred once the selection of a nondeserving firm is established through monitoring. The rationale for making this assumption was that in most corruptible markets, bribe transfers do not take place through formal channels and can be difficult to prove in court. Bribes are often received in cash or as nonmonetary benefits. They are sometimes received by relatives of the agent and may also be transferred to the agent's foreign bank accounts, to which buyers or law enforcement in that market may have no access. In this extension of the basic model, we relax the above assumption. We assume the buyer, through monitoring, not only discovers if a nondeserving firm was selected but also if a bribe was transferred. A penalty P_b is imposed on the agent if it is discovered that the agent accepted a bribe, and an additional penalty P is imposed on the agent if it is discovered that the agent selected a nondeserving firm. Other assumptions are the same as in the basic model.

The agent does not accept any bribe offer smaller than λP_b. Also, a firm is selected regardless of whether it is deserving, only if it offers a bribe that is higher than $\lambda(P + P_b)$. As in the basic model, the bribe offer must also exceed the other firm's offer by more than λP. The consequence of the buyer's ability to detect bribes and hence impose additional penalties on the agent is that firms become less likely to engage in bribery. They offer bribes with probability one only when monitoring probability is smaller than $\bar{p}/(4P + P_b)$, and do not offer bribes at all when it is larger than $\bar{p}/(2(P + P_b))$. Corruption is reduced.

As in the case of the basic model, the probability Pr with which the agent selects a nondeserving firm changes nonmonotonically with the monitoring. The probability Pr does not depend on monitoring for $\lambda < \bar{p}/(4P + 2P_b)$. It increases with monitoring as λ increases beyond $\bar{p}/(4P + 2P_b)$. The probability Pr reduces as λ approaches $\bar{p}/(2(P + P_b))$ and is zero for $\lambda \geq \bar{p}/(2(P + P_b))$. The implication is that there exists an intermediate range of λ in which the buyer does not set monitoring. The buyer either sets a small monitoring and allows corruption or a large monitoring and limits corruptions. Because a firm's profits are higher when the buyer limits corruption compared to when the buyer allows corruption, a unilateral anticorruption control on a firm may still result in higher profits for the controlled firm. We find that all three main results presented in the basic model are robust to this extension.

4.5. Penalty on the Firm

One can argue that the law should punish both the agent and the nondeserving firm that gets selected in the exchange for bribes. In this extension, we assume a penalty P_f is imposed on the firm when a dishonest agent behavior is discovered. All other assumptions remain the same. An immediate consequence of the penalty on the firm is that firms become less likely to bribe. They offer bribes with probability one only if $\lambda \leq \bar{p}/(4P + P_f)$, and do not offer bribes for all $\lambda \geq \bar{p}/(2P + P_f)$. Bribe offers are smaller in expectation. As a result, the firms' profits are weakly higher for any λ set by the buyer. As in Proposition 4, the probability with which the agent selects a nondeserving firm changes nonmonotonically with the monitoring. However, the probabilities and the thresholds are smaller. Corruption is reduced as a result of the added cost of bribery to the firms. It is however interesting to note that a penalty on the firm is not as effective in reducing corruption as the penalty on the agent. This is because the penalty on the agent hurts the firm whenever its bribe offer is accepted, whereas the penalty on the firm hurts only when its offer is accepted and the firm is nondeserving.

The result about the buyer's reluctance to set monitoring in the intermediate range continues to hold. The buyer either chooses to be ignorant about corruption or commits to taking drastic measures to limit it. However, the presence of a penalty on the firms does not require the measures to be as drastic as in the basic model. The result that unilateral anticorruption control can benefit the firm that is being restricted from offering a bribe also continues to hold.

5. Conclusion

This paper studies competition in a corruptible market. The buyer lacks the expertise or the information needed to evaluate firms. An agent selects the firm for the buyer. This creates the scope of corruption. Sometimes the agent selects a nondeserving firm in exchange for bribes. Both the buyer and the agent are strategic. We examine the competitive bidding behavior of the ex-ante symmetric firms. Bribery is eliminated if monitoring of the agent is sufficiently large. The expected penalty to the agent is so large that firms find it unprofitable to offer such a large bribe. The agent selects the deserving firm.

If monitoring is not sufficiently large, the bribe-offer equilibrium is in mixed strategies. The agent selects a nondeserving firm if its bribe offer is sufficiently larger than that of the deserving firm. Otherwise, the agent accepts the deserving firm's bribe offer and selects it. We find that an increase in monitoring does not always result in more honest agent behavior. It sometimes backfires. This agent behavior originates as a result of the endogenous bribe offers made by firms. The nonmonotonic agent behavior in response to changes in monitoring, or anticorruption efforts, makes it difficult for the buyer to reduce corruption. If bribery is prevalent, a small change in the monitoring does not reduce corruption. The buyer must take drastic measures if she wishes to curb corruption.

We find that a unilateral anticorruption control on a firm, such as the FCPA of 1977, can result in higher profits for the controlled firm. A direct effect of the anticorruption control is that it makes the foreign government worse off by making the selection of a nondeserving firm by the agent more likely. The foreign government may strategically set a higher monitoring. The controlled firm's profits may increase as a result. We resolve the disconnect between the prevailing perception about the FCPA in the business community and findings of the empirical studies. Higher monitoring set by the foreign government in response to the FCPA is the key to the controlled firm's higher profits. There is some evidence of an increase in anticorruption enforcements by foreign governments in response to the FCPA.

The findings of this work have important implications for firms conducting business in emerging markets, buyers in these markets, and the U.S. government. U.S. firms should note that the debate about the competitive disadvantage the FCPA poses may be misplaced. Also, although governments in the emerging economies may not be interested in reducing corruption, supporting the anticorruption efforts is in the firms' best interest. Buyers should either ignore corruption or take drastic measures to limit it. The implication for the U.S. government is that the unilateral anticorruption control should be aggressively enforced, because it not only reduces corruption, but may also increase profits of U.S. firms. The model can be applied to various settings where an agent makes a decision, such as awarding certification, issuing permits, law enforcement, or procurement, on behalf of a principal and the principal lacks the expertise or the information to make the same decision. There are some questions that may be considered in future research in the area. We assume both firms offer the same exogenous quality. It may be of interest to investigate firms' incentives to engage in bribery if they endogenously set quality. We also assume the agent has no reputational concerns. An examination of the agent's incentives to select a nondeserving firm in the presence of reputational concerns can potentially lead to interesting insights.

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Appendix
Proof of Proposition 1

(i) If $\lambda \geq \bar{p}/(2P)$, profit of each firm in equilibrium is $\bar{p}/2$. The best possible deviation for a firm is to make a bribe offer of λP and get selected with probability one. The firm's profit under this deviation is $\bar{p} - \lambda P$. However, deviation is not profitable given $\lambda \geq \bar{p}/(2P)$. The agent also has no profitable deviations. Hence, no bribes are offered in equilibrium. The agent selects a deserving firm.

(ii) Now, we show that no pure-strategy Nash equilibrium exists for $0 < \lambda < \bar{p}/(2P)$.

Suppose (b_i^*, b_j^*) is a pair of Nash equilibrium strategies. Then, no other $b_i (i = 1, 2)$ exists such that $\pi_i(b_i, b_j^*) > \pi_i^*(b_i^*, b_j^*)$. We show such a b_i exists.

If $b_i^* = b_j^*$, any of the firms can strictly benefit by cutting the bribe offer by small ε.

If $b_i^* > b_j^*$ (the proof for $b_i^* < b_j^*$ is analogous).

Case (1) $b_i^* > b_j^* + \lambda P$

Because firm i gets selected with probability one, $\pi_i(b_i^*, b_j^*) = \bar{p} - b_i^*$.

There exists an ε such that $b_i = b_i^* - \varepsilon$ and $b_i > b_j + \lambda P$. Firm i can make larger profits by offering b_i.

Case (2) $b_i^* \leq b_j^* + \lambda P$

The agent picks firm i only when it is deserving (i.e., with probability 0.5). Equilibrium profits in this case are $\pi_i^*(b_i^*, b_j^*) = \frac{1}{2}(\bar{p} - b_i^*)$.

There exists an ε such that $b_i = b_i^* - \varepsilon$ and firm i is selected by the agent whenever it is deserving. This generates strictly higher profits for firm i.

Therefore, no Nash equilibrium exists in pure strategies.

(iii) If $\lambda = 0$, both firms offer $b_i = b_j = \bar{p}$ and make zero profits in the equilibrium. There are no profitable deviations. The agent is indifferent between selecting a deserving and nondeserving firm.

Proof of Proposition 2

We prove Proposition 2 in the following steps.

Step 1. *If firm i offers $\bar{p} - 3\lambda P$, firm j would be indifferent between overbidding and underbidding.*

Suppose firm i bids $\hat{b}_i$. Firm j can bid $\hat{b}_i + \lambda P$ (+ infinitesimally small ε) and get selected with probability one, or bid $\hat{b}_i - \lambda P$ and get selected with probability $\frac{1}{2}$. Firm j would be indifferent if

$$\frac{1}{2}[\bar{p} - (\hat{b}_i - \lambda P)] = \bar{p} - (\hat{b}_i + \lambda P),$$
$$\hat{b}_i = \bar{p} - 3\lambda P.$$

If $b_i > \bar{p} - 3\lambda P$, firm j offers $b_j = b_i - \lambda P$, whereas if $b_i < \bar{p} - 3\lambda P$, firm j offers $b_j = b_i + \lambda P$.

Step 2. *$f(b_i) = 0$ for $b_i > \bar{p} - 2\lambda P$ and for $b_i < \bar{p} - 4\lambda P$.*

Suppose $b_i > \bar{p} - 2\lambda P$. This can happen only if firm i offers $b_j + \lambda P$ in response to $b_j > \bar{p} - 3\lambda P$. However, for any $b_j > \bar{p} - 3\lambda P$, as established in Step 1, firm i responds by offering $b_j - \lambda P$. Now, suppose $b_i < \bar{p} - 4\lambda P$. This implies firm i must be offering a bribe of $b_j - \lambda P$ in response to $b_j < p - \bar{3}\lambda P$. Yet, following Step 1, firm i should be offering $b_j + \lambda P$. Both cases lead to contradiction.

Step 3. *The equilibrium bribing strategy sets S_i^* and S_j^* are convex.*

We prove this by contradiction. Suppose an interval $I = (b^k, b^h)$ exists, where $\bar{p} - 4\lambda P < b^k < b^h < \bar{p} - 2\lambda P$ and firm i offers $b_i \in I$ with probability zero.

Claim 1. *Firm j offers $b_j \in (I + \lambda P) \cup (I - \lambda P)$ with probability zero.*

(a) If $b^h \leq \bar{p} - 3\lambda P$, $f(b_j) = 0$ for $b_j \in I - \lambda P$ (from Step 2).

Suppose firm j offers $b' \in I + \lambda P$ with positive probability. Because $f(b_i) = 0$ for $b_i \in I$, firm j can offer $\inf(I + \lambda P)$ and make a higher profit than when offering any $b' \in I + \lambda P$. Therefore, $f(b_j) = 0$ for $b_j \in (I + \lambda P) \cup (I - \lambda P)$.

(b) Now, if $b^k > \bar{p} - 3\lambda P$, $f(b_j) = 0$ for $b_j \in I + \lambda P$ (from Step 2).

Suppose firm j offers $b' \in I - \lambda P$ with positive probability. Because $f(b_i) = 0$ for $b_i \in I$, firm j can offer $\inf(I - \lambda P)$ and make a higher profit than offering any $b' \in I - \lambda P$. Therefore, $f(b_j) = 0$ for $b_j \in (I + \lambda P) \cup (I - \lambda P)$.

(c) Last, if $b^h > \bar{p} - 3\lambda P > b^k$, firm j will be better off offering $\inf(I + \lambda P)$ instead of any $b_j \in (I + \lambda P)$. If $b_j \in (I - \lambda P)$, because $f(b_i) = 0$ for $b_j < \bar{p} - 4\lambda P$, it must be that $b_j \in [\bar{p} - 4\lambda P, b^h - \lambda P)$. Note that $\forall\, b_i < b^k$ firm j prefers to make a bribe offer $b_j = b_i + \lambda P > \bar{p} - 3\lambda P$, and $\forall\, b_i > b^h$ firm j prefers to make a bribe offer $b_j = b_i - \lambda P > b_h - \lambda P$. Therefore, given $b_i \notin I$ and firm j offers $b_j \in [b^h - \lambda P, b_k + \lambda P]$.

Therefore, $f(b_j) = 0$ for $b_j \in (I + \lambda P) \cup (I - \lambda P)$.

Claim 2. *Firm i offering $b_i \in I$ with probability zero and firm j offering $b_j \in (I + \lambda P) \cup (I - \lambda P)$ with probability zero constitutes a contradiction.*

Let us represent $\tilde{b} \equiv \inf(b > b^h)$.

Using Equation (1), we can write

$$\pi_i(\tilde{b}) = [F_j(\tilde{b} + \lambda P) + F_j(\tilde{b} - \lambda P) - \omega_j(\tilde{b} - \lambda P)]\frac{\bar{p} - \tilde{b}}{2},$$
$$\pi_i(b^k) = [F_j(b^k + \lambda P) + F_j(b^k - \lambda P) - \omega_j(b^k - \lambda P)]\frac{\bar{p} - b^k}{2}.$$

Yet because $F_j(\tilde{b} + \lambda P) = F_j(b^k + \lambda P)$, $F_j(\tilde{b} - \lambda P) = F_j(b^k - \lambda P)$, and $\omega_j(b^k - \lambda P) = 0$, the profit of firm i when offering b^k is strictly higher than when offering $\tilde{b}$, contradicting the assumption of an equilibrium.

Step 4. *There can be a mass point in the bribe distribution of a firm only at $b = \bar{p} - 3\lambda P$.*

Suppose firm j has a mass point at $b^* \in [\bar{p} - 4\lambda P, \bar{p} - 3\lambda P)$ equal to ω.

We can write

$$\pi_i(b^* + \lambda P + \varepsilon) = [F_j(b^* + 2\lambda P + \varepsilon) + F_j(b^* + \varepsilon) - \omega_j(b^* + \varepsilon)] \cdot \frac{\bar{p} - (b^* + \lambda P + \varepsilon)}{2},$$
$$\pi_i(b^* + \lambda P - \varepsilon) = [F_j(b^* + 2\lambda P - \varepsilon) + F_j(b^* - \varepsilon) - \omega_j(b^* - \varepsilon)] \cdot \frac{\bar{p} - (b^* + \lambda P - \varepsilon)}{2}.$$

Subtracting the second equation from the first, we get

$$\begin{aligned}
&\pi_i(b^* + \lambda P + \varepsilon) - \pi_i(b^* + \lambda P - \varepsilon) \\
&= \frac{\bar{p} - (b^* + \lambda P)}{2}[F_j(b^* + 2\lambda P + \varepsilon) - F_j(b^* + 2\lambda P - \varepsilon) + F_j(b^* + \varepsilon) \\
&\qquad - F_j(b^* - \varepsilon) - \omega_j(b^* + \varepsilon) + \omega_j(b^* - \varepsilon)] \\
&\quad - \frac{\varepsilon}{2}[F_j(b^* + 2\lambda P + \varepsilon) + F_j(b^* + \varepsilon) - \omega_j(b^* + \varepsilon) \\
&\qquad + F_j(b^* + 2\lambda P - \varepsilon) + F_j(b^* - \varepsilon) - \omega_j(b^* - \varepsilon)].
\end{aligned}$$

For small enough $\varepsilon > 0$

$$\pi_i(b^* + \lambda P + \varepsilon) - \pi_i(b^* + \lambda P - \varepsilon) > 0,$$

and firm i, by shifting some density from the bottom to the top of $b^* + \lambda P$, can be strictly better off. So a mass point cannot exist at $b^* \in [\bar{p} - 4\lambda P, \bar{p} - 3\lambda P)$.

Now, suppose firm j has a mass point at $b^* \in (\bar{p} - 3\lambda P, \bar{p} - 2\lambda P]$.

As before, we get

$$\pi_i(b^* - \lambda P + \varepsilon) - \pi_i(b^* - \lambda P - \varepsilon) > 0,$$

for small enough ε. Therefore, a mass point cannot exist in this range either.

From above, it is clear that firm j (and by the same argument firm i also) can have a mass point only at $b^* = \bar{p} - 3\lambda P$.

Step 5. *Equilibrium profits for both firms are* $(3\lambda P)/2$.

Firm i is playing a mixed strategy, so it must be indifferent between offering any bribe in its support, including $b_i = \bar{p} - 3\lambda P$. Profit for firm i can be written using Equation (1) as

$$\begin{aligned}
&\pi_i(\bar{p} - 3\lambda P) \\
&= [F_j(\bar{p} - 2\lambda P) + F_j(\bar{p} - 4\lambda P) - \omega_j(\bar{p} - 4\lambda P)]\frac{\bar{p} - (\bar{p} - 3\lambda P)}{2},
\end{aligned}$$

which simplifies to $\pi_i = (3\lambda P)/2$. The proof for firm j is similar.

Step 6. *Both firms have mass points at $b = \bar{p} - 3\lambda P$.*

Suppose $\omega_j(\bar{p} - 3\lambda P) = 0$. Using Equation (1), we can write

$$\begin{aligned}
&\pi_i(\bar{p} - 2\lambda P) \\
&= [F_j(\bar{p} - \lambda P) + F_j(\bar{p} - 3\lambda P) - \omega_j(\bar{p} - 3\lambda P)]\frac{\bar{p} - (\bar{p} - 2\lambda P)}{2} \\
&= [1 + F_j(\bar{p} - 3\lambda P)]\lambda P.
\end{aligned}$$

From Step 5, $\pi_i = (3\lambda P)/2$. Therefore, $F_j(\bar{p} - 3\lambda P) = \frac{1}{2}$.

Now, again using Equation (1), we write

$$\begin{aligned}
&\pi_i(\bar{p} - 4\lambda P) \\
&= [F_j(\bar{p} - 2\lambda P) + F_j(\bar{p} - 5\lambda P) - \omega_j(\bar{p} - 5\lambda P)]\frac{\bar{p} - (\bar{p} - 4\lambda P)}{2} \\
&= F_j(\bar{p} - 3\lambda P)2\lambda P.
\end{aligned}$$

Substituting $F_j(\bar{p} - 3\lambda P)$, we get $\pi_i = \lambda P$. We get a contradiction. The proof for firm i is identical.

Step 7. *Both firms have a point mass of $\frac{1}{4}$ at $b = \bar{p} - 3\lambda P$.*

Using Equation (1), we can write

$$\begin{aligned}
\pi_i(\bar{p} - 2\lambda P) &= [1 + F_j(\bar{p} - 3\lambda P) - \omega_j(\bar{p} - 3\lambda P)]\frac{\bar{p} - (\bar{p} - 2\lambda P)}{2} \\
&= [1 + F_j(\bar{p} - 3\lambda P) - \omega_j(\bar{p} - 3\lambda P)]\lambda P.
\end{aligned}$$

Similarly

$$\pi_i(\bar{p} - 4\lambda P) = F_j(\bar{p} - 3\lambda P)2\lambda P.$$

Using the result from Step 5, we solve two equations to get $F_j(\bar{p} - 3\lambda P) = \frac{3}{4}$ and $\omega_j(\bar{p} - 3\lambda P) = \frac{1}{4}$. The proof for firm i is identical.

Step 8. *The equilibrium bribing strategy for firm j is given by*

$$F_j(b_j) = \begin{cases} \dfrac{3\lambda P}{\bar{p} - b_j - \lambda P} - 1 & \text{if } \bar{p} - 4\lambda P \le b_j < \bar{p} - 3\lambda P, \\[2ex] \dfrac{3\lambda P}{\bar{p} - b_j + \lambda P} & \text{if } \bar{p} - 2\lambda P \ge b_j \ge \bar{p} - 3\lambda P. \end{cases}$$

Using Equation (1) and Step 5, we can write

$$[F_j(b_i - \lambda P) + F_j(b_i + \lambda P) - \omega_j(b_i - \lambda P)]\frac{\bar{p} - b_i}{3\lambda P} = 1.$$

Using the above equation and the results from Steps 2 and 7, we can write

$$F_j(b_i+\lambda P) = \frac{3\lambda P}{\bar{p}-b_i} \quad \text{if } b_i \le \bar{p}-3\lambda P,$$
$$F_j(b_i-\lambda P) = \frac{3\lambda P}{\bar{p}-b_i}-1 \quad \text{if } \bar{p}-2\lambda P > b_i \ge \bar{p}-3\lambda P,$$
$$F_j(b_i-\lambda P) = \frac{3}{4} \quad \text{if } b_i = \bar{p}-2\lambda P.$$

Applying appropriate transformations to the above three equations proves Step 8.

Proof of Proposition 3

Because the proof of Proposition 3 is similar to that of Proposition 2, we only provide the steps here.

Step 1. If a firm makes a bribe offer of $\bar{p}/2-\lambda P$, the other firm will be indifferent between offering a bribe higher by λP and offering no bribe. It prefers to overbid on smaller offers. This holds given $\lambda \ge \bar{p}/(4P)$.

Step 2. If a firm makes a bribe offer $b \ge \lambda P$, the other firm prefers to offer $b-\lambda P$. This also holds given $\lambda \ge \bar{p}/(4P)$.

Step 3. $f(b)=0$ for $b > \bar{p}/2$ and for $b \in (\bar{p}/2-\lambda P, \lambda P)$.

Step 4. There are no holes in the interval $[0, \bar{p}/2-\lambda P]$ and in the interval $[\lambda P, \bar{p}/2]$.

Step 5. No density exists at $b=\lambda P$ for either firm because if it did, firms could strictly benefit by moving density from $b=\lambda P$ to $b=\bar{p}/2-\lambda P$.

Step 6. Both firms make profits of $(\bar{p}+2\lambda P)/4$. This is obtained by evaluating Equation (1) at $b=\bar{p}/2-\lambda P$.

Step 7. A mass point of $(4\lambda P-\bar{p})/(2(\bar{p}-\lambda P))$ exists at $b=0$, and a mass point of $(\bar{p}-2\lambda P)/(2\bar{p})$ exists at $b=\bar{p}/2-\lambda P$ for both firms.

Step 8. Using Equation (1) and Step 6, we can write

$$[F_j(b_i-\lambda P)+F_j(b_i+\lambda P)-\omega_j(b_i-\lambda P)]\frac{2(\bar{p}-b_i)}{\bar{p}+2\lambda P}=1.$$

Using Steps 2, 7, and the above equation, and applying appropriate transformations, we get the *cdf* given in Proposition 3.

Proof of Proposition 4

(a) $0<\lambda \le \bar{p}/(4P)$ case

Using Equation (3), we can write Pr as

$$\begin{aligned} Pr &= \frac{1}{2}\int_{\bar{p}-4\lambda P}^{\bar{p}-3\lambda P}[1-F_j(b_i+\lambda P)]f_i(b_i)\,db_i \\ &\quad + \frac{1}{2}\int_{\bar{p}-3\lambda P}^{\bar{p}-2\lambda P}[F_j(b_i-\lambda P)]f_i(b_i)\,db_i \\ &= \frac{1}{2}\int_{\bar{p}-4\lambda P}^{\bar{p}-3\lambda P}\left(1-\frac{3\lambda P}{\bar{p}-b_i}\right)\frac{3\lambda P}{(\bar{p}-b_i-\lambda P)^2}\,db_i \\ &\quad + \frac{1}{2}\int_{\bar{p}-3\lambda P}^{\bar{p}-2\lambda P}\left(\frac{3\lambda P}{\bar{p}-b_i}-1\right)\frac{3\lambda P}{(\bar{p}-b_i+\lambda P)^2}\,db_i, \end{aligned}$$

where $f_i(b_i)$ is the probability density function (*pdf*) of the bribe offer and is obtained by differentiating the *cdf* described in Proposition 2. Simplifying the above equation, we get $Pr = 9\ln(9/8)-1$.

(b) $\bar{p}/(4P) \le \lambda \le \bar{p}/(2P)$

Using Equation (3), we can write Pr as

$$\begin{aligned} Pr &= \frac{1}{2}\Bigg[\omega_i(0)[1-F_j(\lambda P)] + \int_0^{\bar{p}/2-\lambda P}[1-F_j(b_i+\lambda P)]f_i(b_i)\,db_i \\ &\quad + \int_{\lambda P}^{\bar{p}/2}[F_j(b_i-\lambda P)]f_i(b_i)\,db_i\Bigg] \\ &= \frac{1}{2}\Bigg[\frac{4\lambda P-\bar{p}}{2(\bar{p}-\lambda P)}\left(1-\frac{\bar{p}+2\lambda P}{2\bar{p}}\right) \\ &\quad + \int_0^{\bar{p}/2-\lambda P}\left(1-\frac{\bar{p}+2\lambda P}{2(\bar{p}-b_i)}\right)\frac{\bar{p}+2\lambda P}{2(\bar{p}-b_i-\lambda P)^2}\,db_i \\ &\quad + \int_{\lambda P}^{\bar{p}/2}\left(\frac{\bar{p}+2\lambda P}{2(\bar{p}-b_i)}-1\right)\frac{\bar{p}+2\lambda P}{2(\bar{p}-b_i+\lambda P)^2}\,db_i\Bigg], \end{aligned}$$

where *pdf* is obtained by differentiating the *cdf* described in Proposition 3. Simplifying the above expression gives

$$Pr = -\frac{(\bar{p}-2\lambda P)(\bar{p}+4\lambda P)}{4\bar{p}\lambda P}+\frac{(\bar{p}+2\lambda P)^2}{4\lambda^2P^2}\ln\frac{(\bar{p}+2\lambda P)(\bar{p}-\lambda P)}{\bar{p}^2}. \tag{A.1}$$

It is straightforward to show that Pr first increases from $9\ln(9/8)-1$ at $\lambda=\bar{p}/(4P)$, attains a maximum at about $\lambda \simeq \bar{p}/(3P)$ (numerically calculated), and then decreases to zero at $\lambda=\bar{p}/(2P)$.

(c) $\lambda \ge \bar{p}/(2P)$ case

Firms do not offer bribes if monitoring is sufficiently large ($\lambda \ge \bar{p}/(2P)$). The agent, therefore, does not select a nondeserving firm. The probability Pr is zero in this range.

Proof of Proposition 5

From Equation (5), Δ is zero for $0<\lambda\le\bar{p}/(4P)$. If $\bar{p}/(4P)\le\lambda\le\bar{p}/(2P)$, substituting the expressions of $\pi_G|_{c(\lambda)=0}$ and $\pi_G(\lambda=2k/(3P))|_{c(\lambda)=0}$ from Equation (5) to Equation (6), we get

$$\begin{aligned}\Delta = \Bigg[&\frac{[\bar{p}^2-8\lambda^2P^2+2\bar{p}\lambda P(18\ln(9/8)-1)]}{4\bar{p}\lambda P} \\ &-\frac{(\bar{p}+2\lambda P)^2}{4\lambda^2P^2}\ln\left(\frac{(p-\lambda P)(\bar{p}+2\lambda P)}{\bar{p}^2}\right)\Bigg](2\rho-1)v.\end{aligned}$$

The difference Δ is negative for all $\lambda\in(\bar{p}/(4P),\tilde{\lambda})$. It is zero at $\lambda=\tilde{\lambda}$ and increases to $(9\ln(9/8)-1)(2\rho-1)v$ at $\lambda=\bar{p}/(2P)$.

In the range $\lambda\ge\bar{p}/(2P)$, it can be shown using Equation (5) that Δ stays at $(9\ln(9/8)-1)(2\rho-1)v$. The buyer would therefore set a λ only from the set $\{2k/(3P),(\tilde{\lambda},\bar{p}/(2P)]\}$. Because Δ is the extra benefit of limiting corruption by setting some monitoring λ instead of ignoring corruption, a cost of monitoring higher than Δ would discourage the buyer from setting that λ. If it is the case for all $\lambda\in(\tilde{\lambda},\bar{p}/(2P)]$, the buyer sets the monitoring at $2k/(3P)$. If $c(\lambda)-c(2k/(3P))<\Delta$ for some $\lambda\in(\tilde{\lambda},\bar{p}/(2P)]$, the buyer limits corruption by setting a λ that maximizes her payoff.

Proof of Proposition 6

If firm i is not under unilateral control, the difference between the buyer's payoff (for costless monitoring) when setting $\lambda=\bar{p}/(2P)$ and setting $\lambda=2k/(3P)$ is given by $(9\ln(9/8)-1)\cdot(2\rho-1)v$. However, if firm i is controlled, the buyer sets monitoring either at zero or at $\bar{p}/(2P)$. In this case, the increase in the buyer's payoff if she limits corruption instead of being ignorant is $\frac{1}{2}(2\rho-1)v$. We now look at the three cases.

(a) $c(\bar{p}/(2P)) \leq (9\ln(9/8)-1)(2\rho-1)v + c(2k/(3P))$ case

The profits of firm i under unilateral control is $\bar{p}/2$. In the absence of unilateral control, firm i's profit is $(\bar{p}+2\lambda^* P)/4$, where $\lambda^* \in (\tilde{\lambda}, \bar{p}/(2P)]$. The maximum profit of firm i in the absence of unilateral control could be $\bar{p}/2$ if $\lambda^* = \bar{p}/(2P)$. Therefore, in this range of cost curves, the profit for firm i as a result of unilateral control on bribes will either not change or increase. It cannot decrease.

(b) $(9\ln(9/8)-1)(2\rho-1)v + c(2k/(3P)) < c(\bar{p}/(2P)) < \frac{1}{2} \cdot (2\rho-1)v$ case

Firm i still makes $\bar{p}/2$ under unilateral control, because the buyer eliminates corruption. However, if there is no unilateral control in this range of cost curves, the buyer does not find it optimal to completely eliminate corruption, resulting in profits strictly lower than $\bar{p}/2$. Here, the controlled firm strictly benefits as a result of unilateral control.

(c) $c(\bar{p}/(2P)) \geq \frac{1}{2}(2\rho-1)v$ case

Firm i makes zero profits under unilateral control. In the absence of unilateral control, the buyer does not find it optimal to completely eliminate corruption. However, for the cost curve that become very steep as they approach $\lambda = \bar{p}/(2P)$, the buyer might find it optimal to set a $\lambda \in (\tilde{\lambda}, \bar{p}/(2P))$. Therefore, in this case, the controlled firm will either make the same or lower but not higher profits, compared to if it were not controlled.

Endogenous Reserve Price

The buyer sets a reserve price $\bar{p}$ to maximize her profit given in Equation (5) subject to the firms' participation. Firm i's expected profits given monitoring λ and reserve price $\bar{p}$ can be written as (see proofs of Propositions 2 and 3)

$$\pi_i = \begin{cases} \dfrac{\bar{p}}{2} & \text{if } \lambda > \dfrac{\bar{p}}{2P}, \\ \dfrac{\bar{p}+2\lambda P}{4} & \text{if } \dfrac{\bar{p}}{4P} \leq \lambda \leq \dfrac{\bar{p}}{2P}, \\ \dfrac{3\lambda P}{2} & \text{if } \lambda < \dfrac{\bar{p}}{4P}. \end{cases}$$

The buyer must set a $\bar{p}$ such that firms' expected profits are at least infinitesimally higher than k. Therefore, $\bar{p}$ must be higher than $2k$ if monitoring λ is sufficiently large ($\lambda > k/P$), and it must be higher than $4k - 2\lambda P$ if λ is in the intermediate range ($2k/(3P) \leq \lambda \leq k/P$). If the buyer is ignorant about corruption ($\lambda < 2k/(3P)$), firms do not participate in the bidding process, because their expected profits are lower than k in this case.

We first consider $v \leq (8\lambda P)/(3(2\rho-1)(1-8\ln(9/8)))$. In this range, the buyer's payoff (as given in Equation (5)) is monotonically decreasing in $\bar{p}$. Therefore, the buyer sets the $\bar{p}$ at $2k$ if $\lambda > k/P$, and at $4k - 2\lambda P$ if $2k/(3P) \leq \lambda \leq k/(P)$. For any $\lambda < 2k/(3P)$, firms do not participate. Now, we examine the buyer's monitoring decision. Since firms do not participate in bidding for any $\lambda < 2k/(3P)$, the lowest monitoring that the buyer sets is $2k/(3P)$. At $\lambda = 2k/(3P)$, both firms offer bribes with probability one. Also, because firms do not offer bribes for $\lambda > k/P$, any monitoring higher than k/P is wasteful. Similar to the basic model, the buyer either chooses to be ignorant about corruption by setting λ at $2k/(3P)$ or limits corruption by setting a $\lambda \in (\tilde{\lambda}, k/P]$, where $\tilde{\lambda} \in (2k/(3P), k/P)$ is the monitoring beyond which the buyer's payoff (for costless monitoring) becomes higher compared to when she is ignorant about corruption. Note $\tilde{\lambda} > 2k/(3P)\ \forall\, v > 0$.

Next, we consider $v > (8\lambda P)/(3(2\rho-1)(1-8\ln(9/8)))$. In this case, the buyer's payoff (as given in Equation (5)) is nonmonotonic in $\bar{p}$. The buyer sets $\bar{p}$ at $2k$ if $\lambda > k/P$, and for any $\lambda < 2k/(3P)$, firms do not participate in bidding. A local maxima in the buyer's payoff exists at $\bar{p} = 4\lambda P$. Therefore, the buyer sets $\bar{p}$ at $4\lambda P$ for $2k/(3P) \leq \lambda \leq \hat{\lambda}$ and at $4k - 2\lambda P$ for $\hat{\lambda} < \lambda \leq k/(P)$, where $\hat{\lambda}$ is the monitoring corresponding to the reserve price $\hat{p} \in (2\lambda P, 4\lambda P)$ at which the buyer is indifferent between setting the reserve price at $\hat{p}$ and at $4\lambda P$. Therefore, the buyer's payoff with monitoring (for costless monitoring) is constant for $2k/(3P) \leq \lambda \leq \hat{\lambda}$. The implication is that the buyer either ignores corruption by setting small monitoring at $2k/(3P)$ or limits corruption by setting a $\lambda \in [\tilde{\lambda}, k/(P)]$, where $\tilde{\lambda} > 2k/(3P)$ is as defined in the previous paragraph.

Therefore, the buyer either ignores corruption by setting a small monitoring at $2k/(3P)$ or limits corruption by setting a large enough monitoring in the range $(\tilde{\lambda}, k/P]$.

As in the case of the basic model, a unilateral control on firm i may lead the buyer to set a higher monitoring if $c(\bar{p}/(2P)) \leq (9\ln(9/8)-1)(2\rho-1)v + c(2k/3P)$, definitely leads the buyer to set a higher monitoring if $(9\ln(9/8)-1)(2\rho-1) \cdot v + c(2k/(3P)) < c(\bar{p}/(2P)) < \frac{1}{2}(2\rho-1)v$, and may lead the buyer to set a lower monitoring probability if $c(\bar{p}/(2P)) \geq \frac{1}{2}(2\rho-1)v$. However, because the buyer sets a reserve price that extracts all of the surplus from firms, the profits of the controlled firm remain unchanged as a result of unilateral control.

Informed Firm

Here, we assume firms also have the fit information that was available only to the agent in the basic model. Because the expected penalty imposed on the agent for a dishonest behavior (selecting a nondeserving firm) is λP, the agent does not select a nondeserving firm unless that firm's bribe offer exceeds the deserving firm's offer by λP. Therefore, in equilibrium, the deserving firm ensures its selection by offering a large enough bribe $\bar{p} - \lambda P$ such that even if the nondeserving firm offers the entire $\bar{p}$ in bribes, the agent prefers to select the deserving firm. The firm's expected profits are $\frac{1}{2}[\bar{p} - (\bar{p} - \lambda P)] = \lambda P/2$. However, if $\lambda \geq \bar{p}/P$, both firms do not offer bribes and make expected profits of $\bar{p}/2$. Note that the agent always selects the deserving firm regardless of what monitoring the buyer sets. Therefore, the buyer prefers to set the lowest monitoring. The buyer sets the monitoring probability at $2k/P$, which ensures participation of both firms and maximizes the buyer's payoff. The buyer's expected equilibrium payoff (for costless monitoring) is $\rho v - \bar{p}$.

Now, suppose one of the firms (say firm i) is restricted from bribing under a unilateral anticorruption control. In this case, if $\lambda < \bar{p}/P$, the firm that is not controlled offers a bribe of λP if it is not deserving and does not offer bribes if it is deserving, and the agent selects it with probability one. Because firm j is fit only with probability $\frac{1}{2}$, the buyer's payoff (for costless monitoring) is $\frac{1}{2}v - \bar{p}$. If $\lambda \geq \bar{p}/P$, even the firm that is not restricted from bribing does not offer bribes. The agent selects the deserving firm, and the buyer's payoff for costless monitoring is $\rho v - \bar{p}$. The buyer can potentially be worse off if one of the firms is restricted from bribing. As in the basic model, a strategic buyer may respond by increasing the monitoring, which leads to higher profits for the controlled firm.

Monitoring Before Purchase

The proof is similar to the proof of Propositions 1–6. Here, we list the results and present a sketch of the proof.

If $\lambda \geq \bar{p}/(\bar{p}+2P)$, both firms offer no bribes and make profits of $\bar{p}/2$; otherwise, no Nash equilibrium exists in pure strategies.

If $0<\lambda \leq \bar{p}/(\bar{p}+4P)$, both firms offer bribes with probability one. They make profits of $(\lambda(3P+\bar{p}))/2$ and the equilibrium bribe-offer distribution for firm j is given by

$$F_j(b_j)=\begin{cases}\dfrac{3\lambda P}{\bar{p}-b_j-\lambda P-\lambda\bar{p}}-1 \\ \quad \text{if } \bar{p}(1-\lambda)-4\lambda P \leq b_j < \bar{p}(1-\lambda)-3\lambda P, \\ \dfrac{3\lambda P+\lambda\bar{p}}{\bar{p}-b_j+\lambda P} \\ \quad \text{if } \bar{p}(1-\lambda)-2\lambda P \geq b_j \geq \bar{p}(1-\lambda)-3\lambda P.\end{cases}$$

The probability with which the agent selects a nondeserving firm is given by

$$Pr=-\frac{P}{\bar{p}+P}+\frac{3P(\bar{p}+3P)}{(\bar{p}+P)^2}\ln\frac{3(\bar{p}+3P)}{2(\bar{p}+4P)},$$

which is independent of λ.

If $\bar{p}/(\bar{p}+2P)>\lambda>\bar{p}/(\bar{p}+4P)$, both firms offer bribes but with probability smaller than one. They make profits of $(\bar{p}+2\lambda P+\lambda\bar{p})/4$. The equilibrium bribe offer distribution for firm j is given by

$$F_j(b_j)=\begin{cases}\dfrac{\bar{p}+2\lambda P+\lambda\bar{p}}{2(\bar{p}-b_j+\lambda P)} \quad \text{if } b_j\in\left[\lambda P,\dfrac{\bar{p}(1-\lambda)}{2}\right], \\ \dfrac{2\lambda P}{\bar{p}(1-\lambda)}+\dfrac{1-\lambda}{1+\lambda}\left[1-\dfrac{\bar{p}+2P+\lambda\bar{p}}{2\bar{p}}\right] \\ \quad \text{if } b_j\in\left[\dfrac{\bar{p}}{2}-\lambda P-\dfrac{\lambda\bar{p}}{2},\lambda P\right], \\ \dfrac{\bar{p}+2\lambda P-\lambda\bar{p}}{2(\bar{p}-b_j-\lambda P-\lambda\bar{p})}-1 \quad \text{if } b_j\in\left[0,\dfrac{\bar{p}}{2}-\lambda P-\dfrac{\lambda\bar{p}}{2}\right).\end{cases}$$

The probability with which the agent selects a nondeserving firm is given by

$$\begin{aligned}Pr=&-\frac{(\bar{p}-\lambda\bar{p}-2\lambda P)(\bar{p}+\lambda\bar{p}+4\lambda P)}{4\bar{p}(\bar{p}+P)\lambda} \\ &+\frac{(\bar{p}-\lambda\bar{p}+2\lambda P)(\bar{p}+\lambda\bar{p}+2\lambda P)}{4(\bar{p}+P)^2\lambda^2} \\ &\cdot\ln\left(\frac{(\bar{p}-\lambda\bar{p}-\lambda P)(\bar{p}+\lambda\bar{p}+2\lambda P)}{\bar{p}^2(1-\lambda)}\right).\end{aligned}$$

The buyer's payoff is given by

$$\pi_G=(1-\lambda)[(1-\rho)v-\bar{p}]Pr+(\rho v-\bar{p})(1-Pr)-c(\lambda).$$

In the range of monitoring $0<\lambda\leq\bar{p}/(\bar{p}+4P)$, the slope of $\pi_G|_{c(\lambda)=0}$ is positive if $v\leq\bar{p}/(1-\rho)$ and is negative otherwise. In the $\bar{p}/(\bar{p}+2P)\geq\lambda\geq\bar{p}/(\bar{p}+4P)$ range, the slope is negative close to $\bar{p}/(\bar{p}+2P)$ and is positive close to $\bar{p}/(\bar{p}+4P)$. The slope is zero for $\lambda>\bar{p}/(\bar{p}+2P)$. Therefore, in the equilibrium, the monitoring is either low or high but not in the intermediate range.

Under the unilateral anticorruption control, corruption is eradicated if $\lambda\geq\bar{p}/(\bar{p}+2P)$. Both firms make profits of $\bar{p}/2$. However, if $\lambda<\bar{p}/(\bar{p}+2P)$, the firm that is not controlled offers a bribe λP that the agent accepts. The controlled firm makes zero profits, and the one that is not controlled makes $\bar{p}-\lambda P-(\lambda\bar{p})/2$. The expected payoff of the buyer is given by

$$\begin{aligned}\pi_G|_{c(\lambda)=0}&=\tfrac{1}{2}(1-\lambda)[(1-\rho)v-\bar{p}]+\tfrac{1}{2}(\rho v-\bar{p}) \\ &=\tfrac{1}{2}v-\bar{p}-\frac{\lambda}{2}[(1-\rho)v-\bar{p}].\end{aligned}$$

If bribery is prevalent, the payoff of the buyer reduces drastically under the unilateral anticorruption control. However, it remains at the same level if corruption is eradicated. This reduction in payoff induces the buyer to set higher monitoring if a unilateral anticorruption control is imposed on one of the firms. It is straightforward to write conditions on the cost curve for which the buyer finds it optimal to set higher monitoring as a result of unilateral anticorruption control on one of the firms. An increase in the monitoring results in higher profits for the controlled firm.

Bribes Observable On Monitoring

A penalty P_b is imposed on the agent if monitoring discovers that the agent accepted bribes, and an additional penalty P is imposed if the agent is found to have selected a nondeserving firm. Therefore, the minimum bribe the agent ever accepts is λP_b, and the minimum bribe a firm must offer to ensure its selection is $\lambda(P+P_b)$.

If $\lambda\geq\bar{p}/(2(P+P_b))$, both firms offer no bribes in the equilibrium and make expected profits of $\bar{p}/2$. If a firm deviates and makes a bribe offer of $\lambda(P+P_b)$, it gets selected with probability one but makes profits lower than $\bar{p}/2$.

Next, we consider the parameter space $0<\lambda\leq\bar{p}/(4P+2P_b)$, in which both firms offer bribes with probability one. In this case, the equilibrium bribe offers are exactly the same as those described in Proposition 2. The proof is the same as the proof of Proposition 2.

Now, suppose $\bar{p}/(4P+2P_b)<\lambda<\bar{p}/(2P+2P_b)$. In this region, the agent's reluctance to accept any bribes smaller than λP_b affects firms' bribing strategies. Because the proof is similar to that of Proposition 3, we only provide a sketch of the proof here. If a firm offers a bribe that is larger than $\bar{p}/2-\lambda P$ but smaller than $\lambda(P+P_b)$, the other firm prefers to offer no bribes.

If $\bar{p}/(4P+2P_b)<\lambda<\bar{p}/(4P+P_b)$, the support of the bribe offer distribution is $[\bar{p}-4\lambda P,\bar{p}/2-\lambda P]\cup[\lambda(P+P_b),\bar{p}/2]\cup[\lambda(2P+P_b),\bar{p}-2\lambda P]$. The holes in the support of the bribe offer distribution appear because of the agent's unwillingness to accept any bribes smaller than λP_b. Both firms offer bribes with probability one and make expected profits of $(3\lambda P)/2$. The equilibrium bribe offer distribution for firm j is given by

$$F_j(b_j)=\begin{cases}\dfrac{3\lambda P}{\bar{p}-b_j-\lambda P}-1 \\ \quad \text{if } b_j\in\left[\bar{p}-4\lambda P,\dfrac{\bar{p}}{2}-\lambda P\right)\cup(\lambda(P+P_b),\bar{p}-3\lambda P), \\ \dfrac{3\lambda P}{\bar{p}-\lambda P_b-2\lambda P}-1 \quad \text{if } b_j\in\left[\dfrac{\bar{p}}{2}-\lambda P,\lambda(P+P_b)\right], \\ \dfrac{3\lambda P}{\bar{p}-b_j+\lambda P} \quad \text{if } b_j\in\left[\bar{p}-3\lambda P,\dfrac{\bar{p}}{2}\right]\cup[2\lambda P+P_b,\bar{p}-2\lambda P],\end{cases}$$

and the probability Pr with which the agent selects a nondeserving firm is given by

$$Pr = \frac{-\bar{p}^2 + \bar{p}(-9P + P_b)\lambda + 20P(2P + P_b)\lambda^2}{(\bar{p} + 2\lambda P)(\bar{p} - 2\lambda P - \lambda P_b)} + 9\ln\left(\frac{9(\bar{p} - \lambda P_b - 2\lambda P)(\bar{p} + 2\lambda P)}{8\bar{p}(\bar{p} - \lambda P_b - \lambda P)}\right).$$

It is straightforward to show that the probability Pr simplifies to $-1 + 9\ln(9/8)$ at $P_b = 0$, which corresponds to the basic model. Also, it is continuous and increasing at $\lambda = \bar{p}/(4P + 2P_b)$.

If $\bar{p}/(4P + P_b) < \lambda < \bar{p}/(2(P + P_b))$, the support of firms' bribe offer distribution is $\{0\} \cup [\lambda P_b, \bar{p}/2 - \lambda P] \cup [\lambda(P + P_b), \bar{p}/2]$. In this region, firms offer bribes with probability smaller than one and make expected profits of $(\bar{p} + 2\lambda P)/4$ (similar to the region $\bar{p}/(4P) < \lambda < \bar{p}/(2P)$ in the basic model). The equilibrium bribe offer distribution for firm j can be written as

$$F_j(b_j) = \begin{cases} \dfrac{4\lambda P - \bar{p} + 2\lambda P_b}{2(\bar{p} - \lambda P_b - \lambda P)} & \text{if } b_j = 0, \\[2ex] \dfrac{\bar{p} + 2\lambda P}{2(\bar{p} - b_j - \lambda P)} - 1 & \text{if } b_j \in \left[\lambda P_b, \dfrac{\bar{p}}{2} - \lambda P\right), \\[2ex] \dfrac{\bar{p} + 2\lambda P}{2(\bar{p} - \lambda P_b)} & \text{if } b_j \in \left[\dfrac{\bar{p}}{2} - \lambda P, \lambda(P + P_b)\right], \\[2ex] \dfrac{\bar{p} + 2\lambda P}{2(\bar{p} - b_j + \lambda P)} & \text{if } b_j \in \left[\lambda(P + P_b), \dfrac{\bar{p}}{2}\right], \end{cases}$$

and Pr is given by

$$Pr = \frac{-(\bar{p} + 4\lambda P)(\bar{p} - 2\lambda P - 2\lambda P_b)}{4\lambda P(\bar{p} - \lambda P_b)} + \frac{(\bar{p} + 2\lambda P)^2}{4\lambda^2 P^2} \cdot \ln\frac{(\bar{p} - \lambda P_b - \lambda P)(\bar{p} + 2\lambda P)}{\bar{p}(\bar{p} - \lambda P_b)}.$$

If we substitute $P_b = 0$ in the above expression for Pr, it simplifies to the one for the basic model. The probability Pr is zero at $\lambda = \bar{p}/(2(P + P_b))$ and is weakly decreasing in λ as λ approaches $\bar{p}/(2(P + P_b))$. Therefore, we get a nonmonotonic effect of monitoring on the probability with which the agent selects a nondeserving firm. The buyer's payoff is given by equation (4).

The buyer's payoff $\pi_G|_{c(\lambda)=0}$ does not depend on λ if λ is small ($0 < \lambda \le \bar{p}/(4P + 2P_b)$). It decreases with an increase in λ if $\bar{p}/(4P + 2P_b) \le \lambda \le \bar{p}/(4P + P_b)$. The buyer's payoff $\pi_G|_{c(\lambda)=0}$ starts increasing at some $\lambda \in [\bar{p}/(4P + P_b), \bar{p}/(2P + 2P_b))$ and remains unchanged at its maximum value for all $\lambda \ge \bar{p}/(2P + 2P_b)$. To induce the firms to participate in bidding, the buyer does not set any monitoring smaller than $2k/(3P)$. Therefore, the buyer either ignores corruption by setting λ at $2k/(3P)$ or limits corruption by setting a $\lambda \in (\bar{p}/(4P + P_b), \bar{p}/(2P + 2P_b)]$. Any monitoring in the intermediate range ($\lambda \in (2k/(3P), \bar{p}/(4P + P_b)]$) is not optimal regardless of what cost function is chosen.

The presence of unilateral anticorruption control can potentially reduce the buyer's payoff from $\rho v - \bar{p}$ to $\frac{1}{2}v - \bar{p}$. This reduction in the buyer's payoff induces the buyer to set higher monitoring if a unilateral control is imposed on one of the firms. Because firms make higher expected profits if the buyer chooses to limit corruption instead of allowing it, a unilateral anticorruption control on a firm can potentially increase (as in the case of the basic model) its profits.

Penalty on the Firm

The proof of this extension is similar to the proof of Propositions 1–6. Here, we present a sketch of the proof.

If $\lambda \ge \bar{p}/(P_f + 2P)$, both firms offer no bribes and make profits of $\bar{p}/2$; otherwise, no Nash equilibrium exists in pure strategies.

If $0 < \lambda \le \bar{p}/(P_f + 4P)$, both firms offer bribes with probability one. They make profits of $\lambda(3P + P_f)/2$, and the equilibrium bribe-offer distribution for firm j is given by

$$F_j(b_j) = \begin{cases} \dfrac{3\lambda P}{\bar{p} - b_j - \lambda P - \lambda P_f} - 1 \\ \quad \text{if } \bar{p} - (3P + P_f)\lambda \le b_j < \bar{p} - (4P + P_f)\lambda, \\[2ex] \dfrac{(3P + P_f)\lambda}{\bar{p} - b_j + \lambda P} \quad \text{if } \bar{p} - (2P + P_f)\lambda \ge b_j \ge \bar{p} - (3P + P_f)\lambda. \end{cases}$$

The probability with which the agent selects a nondeserving firm is given by

$$Pr = -\frac{P}{P_f + P} + \frac{3P(P_f + 3P)}{(P_f + P)^2}\ln\frac{3(P_f + 3P)}{2(P_f + 4P)},$$

which is independent of λ.

If $\bar{p}/(P_f + 2P) > \lambda > \bar{p}/(P_f + 4P)$, both firms offer bribes but with probability smaller than one. They make profits of $(\bar{p} + 2\lambda P + \lambda P_f)/4$. The equilibrium bribe offer distribution for firm j is given by

$$F_j(b_j) = \begin{cases} \dfrac{\bar{p} + 2\lambda P + \lambda P_f}{2(\bar{p} - b_j + \lambda P)} \quad \text{if } b_j \in \left[\lambda P, \dfrac{\bar{p} - \lambda P_f}{2}\right], \\[2ex] \dfrac{2\lambda P}{\bar{p} - \lambda P_f} + \dfrac{\bar{p} - \lambda P_f}{\bar{p} + \lambda P_f}\left[\dfrac{\bar{p} - (2P + P_f)\lambda}{2\bar{p}}\right] \\ \quad \text{if } b_j \in \left[\dfrac{\bar{p}}{2} - \lambda P - \dfrac{\lambda P_f}{2}, \lambda P\right], \\[2ex] \dfrac{\bar{p} + 2\lambda P - \lambda P_f}{2(\bar{p} - b_j - \lambda P - \lambda P_f)} - 1 \quad \text{if } b_j \in \left[0, \dfrac{\bar{p}}{2} - \lambda P - \dfrac{\lambda P_f}{2}\right). \end{cases}$$

The probability with which the agent selects a nondeserving firm is given by

$$Pr = -\frac{(\bar{p} - \lambda P_f - 2\lambda P)(\bar{p} + \lambda P_f + 4\lambda P)}{4\bar{p}(P_f + P)\lambda} + \frac{(\bar{p} - \lambda P_f + 2\lambda P)(\bar{p} + \lambda P_f + 2\lambda P)}{4(P_f + P)^2\lambda^2} \cdot \ln\left(\frac{(\bar{p} - \lambda P_f - \lambda P)(\bar{p} + \lambda P_f + 2\lambda P)}{\bar{p}(\bar{p} - \lambda P_f)}\right).$$

The buyer's payoff is given by given by equation 4.

If the monitoring probability λ is small ($0 < \lambda \le \bar{p}/(\bar{p} + 4P)$), the buyer's payoff $\pi_G|_{c(\lambda)=0}$ does not depend on λ. In the intermediate range ($\bar{p}/(P_f + 2P) > \lambda > \bar{p}/(P_f + 4P)$), it first decreases and then increases with λ reaching the maximum value at $\lambda = \bar{p}/(P_f + 2P)$. For any $\lambda > \bar{p}/(P_f + 2P)$, the buyer's payoff $\pi_G|_{c(\lambda)=0}$ remains unchanged with an increase in λ. The buyer does not set any monitoring smaller than $2k/(3P+P_f)$ to ensure that firms participate in the bidding.

In the equilibrium, the buyer either ignores corruption by setting monitoring at $2k/(3P+P_f)$ or limits corruption by setting monitoring in the interval $(\tilde{\lambda}, \bar{p}/(P_f+2P)]$. Any monitoring in the intermediate range is not optimal.

Under the unilateral anticorruption control, corruption is eradicated if $\lambda \geq \bar{p}/(P_f+2P)$. Both firms make profits of $\bar{p}/2$. However, if $\lambda < \bar{p}/(P_f+2P)$, the firm that is not controlled offers a bribe λP that the agent accepts. The controlled firm makes zero profits, and the one that is not controlled makes $\bar{p}-\lambda P-(\lambda P_f)/2$. The expected payoff of the buyer $\pi_G|_{c(\lambda)=0}$ is $\frac{1}{2}v-\bar{p}$.

If bribery is prevalent, a unilateral anticorruption control on a firm potentially reduces the buyer's expected payoff from $\rho v-\bar{p}$ to $\frac{1}{2}v-\bar{p}$. This reduction in payoff induces the buyer to set higher monitoring if a unilateral anticorruption control is imposed on one of the firms. The conditions under which the profits of the controlled firm are higher or remain unchanged are similar to those presented in Proposition 6.

Endnotes

[1] www.transparency.org/cpi2014/results (accessed March 10, 2016).

[2] Corruption Perceptions Index 2014 for major developing economies (on a scale of 0–100 with 0 being the most corrupt): Russia, 27; Indonesia, 34; Mexico, 35; China, 36; India, 38; Brazil, 43. For comparison, the index for some developed markets: United States, 74; Japan, 76; United Kingdom, 78; Germany, 79; Singapore, 84.

[3] For example, agents may speed up an intentionally slowed-down selection process, introduce noise in the evaluation test, or even change the selection rules, privately disclose bids of other firms, or simply give an opportunity to revise an already-submitted bid in exchange for bribes.

[4] www.thesundayleader.lk/2014/10/05/corruption-continues-at-cpc/ (accessed July 10, 2015).

[5] http://www.moneycontrol.com/news/current-affairs/kalmadi-arrested-by-cbicwg-scam-case_538069.html (accessed March 10, 2016).

[6] www.telegraph.co.uk/finance/newsbysector/energy/oilandgas/9144236/BP-alerted-to-bribery-at-its-tanker-division.html (accessed July 10, 2015).

[7] For purchase of complex plants or machinery, buyers in some markets may use a two-stage process. Firms are evaluated for the fit with the buyer's requirement in the first stage. Shortlisted firms then compete on prices in the second stage. Our model and analysis can be thought of as capturing corruption in the first stage.

[8] www.justice.gov/sites/default/files/criminal-fraud/legacy/2010/04/11/houseprt-95-640.pdf (accessed March 10, 2016).

[9] See www.justice.gov/criminal-fraud/foreign-corrupt-practices-act (accessed July 10, 2015) for the history and details of the Act.

[10] The sizes of procurement contracts are often publicly announced, and they become a reference for future buyers of the same product. For example, see http://www.globalsecurity.org/military/world/fighter-aircraft.htm (accessed July 10, 2015) for the prices of the fighter aircraft in recent procurements by various governments.

[11] The parameter k also captures any bid-preparation costs, which are often nontrivial in the case of procurement auctions.

[12] In Section 4.3, as an extension of the basic model, we discuss the possibility of monitoring the agent before the good is purchased.

[13] Bribes are typically paid in cash or as nonmonetary benefits. Also, they are often transferred to the agent's foreign bank accounts or are received by relatives of the agent.

[14] Many foreign banks typically do not disclose information about their clients' accounts to governments. According to different estimates, Indians have \$500 billion to \$1.5 trillion of illegal money stashed in foreign banks. According to a Global Financial Integrity report, China tops the list of highest illicit financial flows (2002–2006) from developing countries, accompanied by Russia, India, and Indonesia in the top 10.

[15] We also consider the possibility of a penalty being imposed on the firm as well and present it as an extension of this basic model in Section 4.5.

[16] This assumption ensures that the buyer can make the agent honest with probability one by making λ sufficiently large.

[17] This assumption is consistent with the general observation about the discretionary power of agents in corruptible markets. (See anti-corruption profiles for various countries at www.trust.org/trustlaw for detailed information.)

[18] Uslaner (2008) discusses some studies indicating evidence of stickiness of corruption and its effects.

[19] According to a report published by Shearman and Sterling LLP (2012), the corporate FPCA cases increased from 14 between 2002 and 2006 to 70 between 2007 and 2011.

[20] In most real-world situations, the buyer's agents do have better information about the buyer's requirements than what is made available to the firms. Agents may also gain additional information about the fit between the buyer's requirements and the firms' products during the product evaluation process.

[21] www.wsj.com/articles/SB10001424052970204652904577198063320589398 (accessed July 10, 2015).

[22] news.idg.no/cw/art.cfm?id=84BC6035-E78E-1171-C3F4B6F4CC6B58A2 (accessed July 10, 2015).

[23] There is also a possibility that on discovering a dishonest agent behavior, the buyer could potentially purchase the product from the firm that was not recommended. However, consistent with most of the real-world cases, we assume that if a dishonest agent behavior is discovered, the buyer simply cancels the auction.

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