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PARIS SCHOOL OF ECONOMICS
ECOLE D'ECONOMIE DE PARIS

WORKING PAPER N° 2010 - 18

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Committing to Transparency to Resist Corruption *

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June 21, 2010

Abstract

This paper examines firms' incentives to commit to a transparent behavior (that precludes bribery) in a competitive procedure modeled as an asymmetric information beauty contest managed by a corrupt agent. In his evaluation of firms' offers for a public contract the agent has some discretion to favor a firm in exchange of a bribe. It is shown that a *conditional* commitment mechanism can eliminate corruption when it is pure extortion. Otherwise, when corruption can affect allocation and the market's profitability is small, a low quality firm may prefer not to commit. In that situation, the existence of a separating equilibrium in which only the high quality firms commit is guaranteed when commitment decisions are kept secret, but requires some conditions on firms' beliefs when commitment decisions are publicly announced. Generally, a *unilateral* commitment mechanism that rewards commitment with a *bonus* performs less well. A mechanism combining both conditional commitment and a bonus has the potential to fully eliminate corruption.

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1 Introduction

Corruption in competitive procedures for public contracts is an issue in both developed and developing countries. The stakes involved in many public contracts (e.g., in the construction of infrastructure or in the extractive industry) can be huge, and the highly specific character of these large markets leaves significant room for discretion to the agents who administer the procedures. This discretion can be abused in corruption at large costs for the national economy (see, for instance, Mauro, 1995, Bardhan, 1997, and Robinson and Torvick, 2005). The consequences are most serious in developing countries where government accountability is low. Great efforts have been exerted by international organization (e.g., the World Bank or the European Community) to improve the legislation in developing countries. Many countries adopted a new procurement legislation (satisfying international standards), started deep going reforms of the public administration, introduced conflict of interests laws, etc. Yet, it has been recognized that good laws alone are not sufficient to combat corruption. There is now a consensus that the active engagement of the "civil society" (citizens, firms, NGOs) is necessary.

*We would like to thank Laurent Lamy for useful comments and suggestions.

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In this paper we are interested in the properties of simple voluntary mechanisms aimed at combating corruption in competitive procedures. The anti-corruption community and in particular Transparency International has been prolific in developing various forms of commitment and transparency enhancing mechanisms to complement the legal system.[1] The United Nation Convention Against Corruption also calls for the private sector to adopt standards of transparency that precludes bribery.[2] These mechanisms have been used and are currently being used in a variety of countries and industrial contexts. Our objective is to characterize mechanisms that allow firms to commit not to bribe, in terms of social economic efficiency and corruption reduction in different contexts. More precisely we are asking the following questions: When is refraining from bribery in firms' collective interest? Should commitment decisions be rewarded? Should they be publicly announced? Among different commitment mechanisms which one performs best and under which circumstances?

We model competition for a public project as an asymmetric information beauty contest with two firms. An example would be in the extractive industry when the government of the Republic of Congo wants to allocate extraction rights and the government values the contribution of the firm to the development of the industry's infrastructure a lot. More generally a beauty contest is an allocation procedure where the price is either fixed or plays a minor role in competition. Instead, firms compete in "quality". This procedure can be motivated when firms' private value is viewed as a poor proxy of the social economic value of the allocation. Another case is when there are fears that the cost of price competition reduces the winning firm's capacity to undertake social economic efficient investments. The allocation of 3G cell phone licenses in Europe offers a recent well-documented case where beauty contests were used. Some countries, like France and Sweden, opted for a beauty contest (see, e.g., Andersson et al., 2005) and others, like England and Germany, for auction. A main critic against the beauty contest is that the evaluation of offers is less transparent than in a first price auction (see, e.g., Binmore and Klemperer, 2002). Therefore it opens the way for favoritism and corruption. We view this vulnerability as special reason for investigating the potential of commitment to transparency to reduce corruption in beauty contests.

The competitive procedure is managed by an agent who may be corruptible. Corruption is modeled as an auction game where the firms compete in the bribes they offer to the agent in exchange for a selection advantage in the evaluation of submitted projects. In equilibrium, bribery is either pure extortion, i.e., it does not affect the allocation of the contract, or it is accompanied by social economic inefficiency: the bad project wins.

We introduce a commitment mechanism which allows firms to credibly commit not to bribe. The

[1] For example, Integrity Pact (http://transparency.org), Extractive Industry Transparency Initiative (http://eitransparency.org).

[2] Chapter 2, article 12: "(f) Ensuring that private enterprises, taking into account their structure and size, have sufficient internal auditing controls to assist in preventing and detecting acts of corruption and that the accounts and required financial statements of such private enterprises are subject to appropriate auditing and certification procedures."

starting point for the analysis is that no firm has any incentive to commit unilaterally. Therefore, we first consider a mechanism where commitment is *conditional*: the commitment of one firm is valid only if the other firm also commits. We find that this conditional commitment mechanism can eliminate corruption when the corrupt agent's discretion is weak, i.e., too small to secure the gain of a low quality type against a high quality type,[3] or when discretion is large but the high quality firm type has low costs. Otherwise when the high quality firm has high costs, the low quality type may prefer not to commit, in which case corruption obtains in equilibrium. This happens when the market is not so profitable and/or the probability that the contestant is of the low quality type is not sufficiently large. The low quality firm has then better prospects to win with corruption against a high quality type.

When conditional commitment by all firms' types is not possible in equilibrium there still exists a separating equilibrium in which only firms of the high quality type commit, provided the commitment decisions are not observable by the other firm. In such a case the conditional commitment mechanism allows to eliminate corruption when two high quality firms meet. Quite surprisingly, publicly announcing the firms' commitment decision either has no impact on behavior or is detrimental, i.e., it induces more corruption than if commitment decisions were kept secret.

Next, we consider a mechanism of unilateral commitment rewarded with a *bonus*, i.e., an official selection advantage. We find that it generally performs less well than conditional commitment. Under weak discretion, it only eliminates corruption in the trivial case when the bonus is larger than the selection advantage available through corruption. Under all other cases, only firms of the high quality type have an incentive to commit provided that the probability that it faces another high quality type is sufficiently small.

Finally, we devise a new mechanism of *conditional commitment with bonus* that performs better than the two earlier investigated mechanisms. A main result is that corruption can be fully eliminated for a bonus that is smaller than the selection advantage in corruption provided *only* that the bonus is large enough to secure win for the committing firm of the high quality type against a corrupt firm of the low quality type.

Related Literature. Corruption in competitive procedures has been studied in a few recent papers including, e.g., Burguet and Che (2004), Celentani and Ganunza (2002), Compte et al. (2005). These papers focus on incentives to bribe a corruptible agent in an auction context and study the impact of corruption on social economic efficiency. Typically, the impact depends on the type of discretion that the agent can abuse. In this paper we are interested in the agent's discretion to favor a firm in the evaluation of offers. Favoritism as been addressed in Burget and Che (2004) and more recently in Kosenok and Lambert-Mogiliansky (2009). While Burget and Che's main result is to demonstrate that corruption can result in allocation inefficiency, Kosenok and Lambert-Mogiliansky show how favoritism and collusion between firms can complement each other. In

[3] Corruption determines allocation in case of tie only.

this literature corruption deterrence (if considered at all) is most often captured by an expected punishment cost. Simple comparative statics results on the magnitude of the punishment costs are derived. In contrast, we focus on corruption deterrence appealing to a simple voluntary commitment mechanism. For that reason we depart a from the earlier mentioned literature and model the competitive procedure that allocates the project as a beauty contest (rather than an auction), while the bribing game is modeled as an auction in bribes.

This approach allows to focus on the impact of commitment and brings us to a recent literature in game theory including Kalai et al. (2010) who characterize equilibrium payoffs that can be achieved in a game when allowing for conditional strategies. Bade et al. (2009) and Renou (2009) study the impact on equilibrium outcomes when players can commit unilaterally to some subspace of strategies. These papers address games with complete information while our application involves asymmetrically informed players. Recently, Kalai and Kalai (2010) provide a cooperative and non-cooperative approach to conditional commitment in games with incomplete information. Contrary to our setting, they allow players to sign more general binding agreements, including payoff transfers and information sharing. They also allow players to pre-commit on a decision even when the conditional commitment stage fails. In contrast we let players choose freely in case commitment fails and this allows for interesting signaling problems that are precludes in Kalai and Kalai's setting.

Organization of the paper. In the next section we present the model and the benchmark equilibria are characterized with and without corruption. In section 3 we introduce commitment. First, we consider the impact of a conditional commitment mechanism and characterize the conditions under which corruption is deterred. We next turn to a unilateral commitment mechanism that rewards commitment with a bonus and describe the conditions under which it reduces corruption. Finally, we investigate a conditional mechanism with bonus and characterize an equilibrium that fully eliminates corruption. The last section discusses the assumptions, results and possible extensions of the model.

2 The Model

2.1 Benchmark: No Corruption

Consider a situation where the state looks for a firm to exploit its oil resources. Firms are differentiated with respect to their technology: firms make more or less valuable investments in the public infrastructure. The winning firm will be paid a fixed amount P (e.g., the right to sell a given amount of the oil) in exchange for the proposed development of the infrastructure.

We model this situation as a beauty contest with two firms. Each firm $i \in \{1, 2\}$ submits a version of the project $q_i \in \{\underline{q}, \bar{q}\}$ with $\bar{q} > \underline{q}$. With probability ρ the technology of firm i allows for a realization of the high quality version of the project ($q_i = \bar{q}$) and with probability $1 - \rho$ it only allows for the low quality version ($q_i = \underline{q}$).[4] The qualities of the firms are drawn independently. To realize its project a firm incurs some cost $\bar{c}$ when its quality type is high ($\bar{q}$), and $\underline{c}$ when its quality type is low ($\underline{q}$). Notice that we may have $\underline{c} < \bar{c}$ or $\underline{c} > \bar{c}$, but we always assume that $P > \max\{\underline{c}, \bar{c}\}$, i.e., the government always wants to realize the project. For simplicity we let q_i correspond to a given technology so that we do not consider firms' choice in this respect. In particular, the high quality firm cannot produce the lower valued version of the project. In Remark 2.2 at the end of the section we briefly address the case in which the high quality type can also offer and deliver the low quality project.

Each firm privately observes its own type. As a benchmark, assume that the government can directly observe the quality of the firms' project offer. Equivalently, a government official (his agent) can evaluate the projects and his incentives are perfectly aligned with the interests of the government. The government's objective is simply to maximize the quality of the accepted project, so the selection rule is $\max\{q_1, q_2\}$, and the government selects either firm with equal probability in case of tie. Note that the beauty contest procedure is a rather crude allocation mechanism that generally does not maximize social economic efficiency. But for $\overline{q} - \overline{c} > \underline{q} - \underline{c}$, which we shall assume, the beauty contest does select the socially efficient project.

If a firm can deliver the highly valuable project $\bar{q}$, its expected profit is given by

$$\Pi^N(\bar{q}) = \left(\frac{1}{2}\rho + (1-\rho)\right)(P - \bar{c}). \tag{1}$$

It wins the contest when the other firm's type is low or with probability 1/2 when the contestant's type is also high. The gain is simply the fixed price minus the cost for delivering the high quality project. On the other hand if the firm is of the low quality type $\underline{q}$, its expected profit is

$$\Pi^N(\underline{q}) = \frac{1}{2}(1-\rho)(P - \underline{c}). \tag{2}$$

It only wins with probability 1/2 when the contestant's type is low as well.

2.2 Equilibrium with Corruption

Suppose now that the government cannot observe the qualities of the firms' project and must rely on an agent whose incentives are not aligned with the interests of the government. The evaluation process is pretty involved and therefore not fully transparent to the government. This means that the agent has some discretion in evaluating the quality of the projects q_1 and q_2. More precisely, we assume as in Burguet and Che (2004) that the agent can upscale the quality of a firm's project with a magnitude of $m > 0$.[5] If $m < \bar{q} - \underline{q}$ he cannot strictly affect the selection, he can only favor a firm in case of tie (weak discretion). But if $m > \bar{q} - \underline{q}$ he has full discretion to choose the winner. The corrupt agent will try to money his discretion, accepting bribes in exchange of adding m to the submitted quality.

[4] Firms are ex-ante symmetric, which is useful for deriving the auction results.

[5] We assume that he cannot downscale the quality presumably because the firm would then complain.

Firms are willing to offer bribes $(b_1, b_2) \in \mathbb{R}^2_+$ in exchange of the favor. The bribe is only paid if the firm wins the contest. The agent has a simple utility function: he maximizes his bribe revenue, so he favors firm i when $b_i > b_{-i}$. More precisely, the rules of the game with corruption is as follows:

1. Each firm $i \in \{1, 2\}$ privately learns its type $q_i \in \{\underline{q}, \bar{q}\}$;
2. Each firm $i \in \{1, 2\}$ submits an offer (q_i, b_i), where $b_i \geq 0$;
3. The agent selects firm i if either
   - $b_i > b_{-i}$ and $q_i + m > q_{-i}$, or
   - $b_i < b_{-i}$ and $q_i > q_{-i} + m$.

   To ensure existence of an equilibrium, the selecting rule is endogenous when $b_1 = b_2$.[6]
4. The submitted bribe is paid by the winner (whether corruption was actually needed or not).

There are two cases of interest that we shall consider in turn. The two cases are characterized by which type of firm has the lowest cost for the project, i.e., $\bar{c} > \underline{c}$ or $\bar{c} < \underline{c}$. We first analyze the situation where the government official has full discretion to choose the winner, i.e., $m > \bar{q} - \underline{q}$.

Large discretion ($m > \bar{q} - \underline{q}$)

Case 1: $\bar{c} > \underline{c}$. When $P - \underline{c} > P - \bar{c}$ the value of the contract is larger for a low quality type. There exists a unique equilibrium where a high cost (and quality) type submits $b_i^* (\bar{q}) = P - \bar{c}$, earning an expected profit of $\Pi^C(\bar{q}) = 0$, and a low quality type plays a mixed strategy according to a distribution $F(b)$ with support $[P - \bar{c}, \hat{b}]$. The boundaries are calculated in the standard way by setting the expected profit equal to a constant:

$$\Pi^C(\underline{q}) = (P - \underline{c} - b) (\rho + (1 - \rho) F (b)),$$

for every $b \in [P - \bar{c}, \hat{b}]$. When $b = P - \bar{c}$ we have $F(b) = 0$ so

$$\Pi^C(\underline{q}) = (\bar{c} - \underline{c})\rho. \tag{3}$$

At $\hat{b}$, $F(\hat{b}) = 1$ so $(P - \underline{c} - \hat{b}) = (\bar{c} - \underline{c})\rho$, which implies $\hat{b} = P - \underline{c} - (\bar{c} - \underline{c}) \rho$. Notice that $\hat{b}$ is decreasing with ρ down to $P - \bar{c}$ when $\rho \to 1$ and that $\Pi^C(\underline{q})$ is increasing with ρ.

In this situation the high quality firm type always strictly prefers the no corruption regime since it earns zero with corruption and some positive expected profit without corruption. For the low quality firm type, we have

$$\Pi^N(\underline{q}) > \Pi^C(\underline{q}) \iff \frac{1}{2} (1 - \rho) (P - \underline{c}) > (\bar{c} - \underline{c}) \rho, \tag{4}$$

[6] See Simon and Zame (1990). Alternatively, one may consider a discrete, fine enough, bribing strategy space.

so the low quality firm type prefers the no-corruption regime whenever

$$\rho < \frac{(P - \underline{c})}{(P - \underline{c}) + 2\,(\bar{c} - \underline{c})}. \tag{5}$$

Under the no corruption regime the low quality firm wins only if it meets another low quality firm, so the probability that the contestant is of low the quality type should not be too small, i.e., ρ should not be too large to secure the dominance of the no-corruption regime. The right hand side of Equation (5) is increasing in the value $P - \underline{c}$ of the corruption free contest. Under the corruption regime what matters is the difference between the costs of the two firms; the larger the difference, the less intense competition in bribes and the more attractive corruption.

Case 2: $\bar{c} < \underline{c}$. When the high quality firm type is also the cost efficient firm, the low quality type submits $b_i(\underline{q}) = P - \underline{c}$ and earns zero profit with corruption. With a similar reasoning as above, the high quality firm type plays a mixed strategy and earns an expected profit of $\Pi^C(\bar{q}) = (\underline{c} - \bar{c})(1-\rho)$. In this situation the low quality firm type always strictly prefers the no corruption regime, and the high quality firm type prefers the no corruption regime iff

$$\Pi^N(\bar{q}) > \Pi^C(\bar{q}) \iff \left(\frac{1}{2}\rho + (1-\rho)\right)(P - \bar{c}) > (\underline{c} - \bar{c})(1-\rho),$$

i.e., $\rho(P - \bar{c}) + 2(1-\rho)(P - \underline{c}) > 0$, which is always satisfied.

Weak Discretion ($0 < m < \bar{q} - \underline{q}$)

This situation is simpler because here firms compete in bribes only when they are of the same quality type. Whether $\bar{c}$ is lower or higher than $\underline{c}$ there exists a unique symmetric equilibrium where a low quality type submits $b_i^*\left(\underline{q}\right) = P - \underline{c}$, earning an expected profit of $\Pi^C(\underline{q}) = 0$, and a high quality type plays a mixed strategy according to a distribution $F(b)$ with support $[\hat{b}_1, \hat{b}_2]$. We have $\Pi^C(\bar{q}) = (P - \bar{c} - b)\left((1-\rho) + \rho F(b)\right)$ for every $b \in [\hat{b}_1, \hat{b}_2]$. When $b = \hat{b}_1$ we have $F(b) = 0$ so $\Pi^C(\bar{q}) = (P - \bar{c} - \hat{b}_1)(1-\rho)$. By bribing 0 the firm gets at least $(P - \bar{c})(1-\rho)$, so $\hat{b}_1 = 0$ and $\Pi^C(\bar{q}) = (P - \bar{c})(1-\rho)$. At $\hat{b}_2$, $F(\hat{b}_2) = 1$ so $(P - \bar{c} - \hat{b}_2) = (P - \bar{c})(1-\rho)$, which implies $\hat{b}_2 = \rho(P - \bar{c})$. Comparing with the no corruption payoffs in (1) and (2), we clearly see that whatever $\underline{c}$ and $\bar{c}$, the corruption regime is worse for both types of players.

The above characterization of equilibria of the game with corruption in the different configurations directly give the following propositions:

Proposition 1

- *With weak discretion the winner of the contest is a firm of the high quality type (when it exists) whatever its cost.*
- *With large discretion the winner of the contest is a low cost firm whatever its quality.*

- *In equilibrium both firm types offer strictly positive bribes.*

Proposition 1 tells us that allocation is efficient with respect to the beauty contest whenever there is no corruption or the agent's discretion is weak. Corruption is then only a distribution issue, i.e., the agent appropriates some of the winner's rents. In contrast, when the agent has large discretion, the covert competition in bribes is the effective selection rule instead of the official beauty contest. Corruption also has an impact on the allocation of the contract: the bad quality firm wins whenever its cost is lower. Finally, we note that in the presence of a corruptible agent, no firm type can refrain from bribery in equilibrium. This holds true even if both firm types would prefer the no corruption regime as the next proposition shows.

Proposition 2 *The no-corruption equilibrium payoffs dominate for both firm types the equilibrium payoffs in the game with corruption in the following situations:*

(i) Weak discretion ($0 < m < \bar{q} - \underline{q}$);

(ii) Large discretion ($m > \bar{q} - \underline{q}$) and the high quality firm type has a lower cost ($\bar{c} < \underline{c}$);

(iii) Large discretion ($m > \bar{q} - \underline{q}$), the low quality firm type has a lower cost ($\bar{c} > \underline{c}$) and

$$\rho \leq \frac{P - \underline{c}}{P - \underline{c} + 2(\bar{c} - \underline{c})}.$$

Under conditions (i) and (ii) equilibrium corruption has no impact on the allocation of the contract, i.e., corruption boils down to pure extortion. This means that no firm type benefits from it, so they both prefer the no corruption regime. Under condition (iii), corruption has the potential to affect selection but competition in bribes for the project is very costly. Consider the case where competition eliminates all the rents, i.e., $\bar{c} = \underline{c}$ (so profits are null). Then any $\rho \leq 1$ satisfies the condition and the no corruption regime always dominates. On the other hand when the low quality type's profit-if-win from corruption is equal to his profit-if-win from the contest without corruption, i.e., $P - \underline{c} = \bar{c} - \underline{c}$, the probability that the other firm is a high type (i.e., that the corruption gain can be realized) must be $\rho \geq 1/3$ to secure the dominance of the no-corruption regime.

We assumed that firms do not choose the quality of the project they offer. If instead the high quality type could mimic the low quality type and offer the low quality project at low cost, then corruption never benefits the firms. To see this we recall from Proposition 2 above that the only case when the corruption payoff may dominate the no corruption payoff is for the low quality type when it also has low costs and ρ is large. The low quality type can then win with positive profit in the corruption regime. With corruption, bribe competition is the effective selection mechanism and from Proposition 1 we know that all that matters for selection is the costs of the firm. Clearly, if the high quality type can choose between $\bar{q}$ and $\underline{q}$ with the associated costs, it will choose $\underline{q}$ at cost $\underline{c}$. This means that in the presence of a corruptible agent, both firm types offer $\underline{q}$, they have the same costs $\underline{c}$ and they compete in bribes until full rent extraction so profit are null. Condition (iii) from Proposition 2 is always fulfilled ($\rho = 0$) and both firm types always prefer the no corruption regime.

The fact that firms can be trapped into unwanted competition in bribes can be exploited to combat corruption. We shall see that the more interesting situations arise when at least one firm type may benefit from corruption, i.e., under the maintained assumption that firms do not choose the quality.

3 Committing to Transparency

In this section we assume that there exists a voluntary commitment mechanism that precludes bribery and we study its properties.[7] The idea is that firms can commit to reveal all their transactions with the agent to an independent audit who verifies the truthfulness and completeness of the declarations.

From Proposition 1 we know that zero bribe is not part of any equilibrium of the beauty contest game with corruption. This implies that, in this context, no firm will ever choose to *unilaterally* commit to transparency. Indeed if one firm commits, the other firm prefers not to commit since it wins for sure provided it only pays a very small bribe. Therefore, our first question is whether a firm may have an incentive to commit if its commitment can be made *conditional* on the other firm's commitment to transparency (Subsection 3.1). In Subsection 3.2 we assume that the government observes firms' commitment decisions and gives committing firms a bonus, i.e., a selection advantage in the beauty contest. We characterize the conditions for unilateral commitment with bonus to be incentive compatible and effectively deter corruption. Finally, in Subsection 3.3, we combine the two mechanisms by allowing both conditional commitment and a bonus for firms willing to commit.

3.1 Conditional Commitment (CC)

In this subsection we study the properties of a commitment to transparency that is conditional on whether the other firm also commits to transparency. We assume that there exists an independent agency that collects firms' commitment decisions. If both firms commit they are informed that their commitment is in force. Otherwise, they are informed that they are not bounded by additional obligations (in excess of legal ones). Whether or not they are informed about the rival's decision (for the case they don't commit) is a choice variable for the mechanism designer which we address below.

The timing of the beauty contest game with interim[8] conditional commitment is as follows:

[7] We assume that the proposed mechanism has the potential to fully eliminate corruption. That is not crucial to the qualitative results.

[8] See Remark 1 for ex-ante conditional commitment, in which case stages 1 and 2 are reversed.

1. Each firm $i \in \{1,2\}$ privately learns its type $q_i \in \{\underline{q}, \bar{q}\}$;

2. Each firm $i \in \{1,2\}$ decides whether to make a conditional commitment to transparency.

3. The commitment decisions are publicly announced or

3'. The commitment decisions are private (but a firm that committed learns whether its commitment is in force).

4. Each firm $i \in \{1,2\}$ submits an offer (q_i, b_i), under the constraint that $b_1 = b_2 = 0$ if both firms committed to transparency

5. The agent selects firm i if $b_i = b_{-i} = 0$ and $q_i > q_{-i}$ or if $b_i > b_{-i}$ and $q_i + m > q_{-i}$, or $b_i < b_{-i}$ and $q_i > q_{-i} + m$.

3.1.1 Full Commitment

We are first interested in equilibria where both firm types commit, i.e., full commitment. In the next subsection we will consider partial commitment in separating equilibria, i.e., where only one firm type commits.

Clearly, if the no-corruption payoff dominates for both firms' types (i.e., condition (i), (ii) or (iii) of Proposition 2 is satisfied), then they have an incentive to commit jointly to transparency (whether *3* or *3'* applies). Such an equilibrium is easily sustained, e.g., with passive beliefs off the equilibrium path: in case one of the firm deviates and does not commit, the other firm's keeps his prior belief about the deviant's type. It is also easy to verify that a *necessary* condition for full commitment is that the no-corruption payoff dominates for both firms' types, even if we allow arbitrary beliefs off the equilibrium path. To see this, assume on the contrary that the corruption payoff dominates for the low quality and low cost type, i.e., assume that none of the conditions of Proposition 2 holds, which we shall refer to as condition (iv):

(iv) $m > \bar{q} - \underline{q}$, $\bar{c} > \underline{c}$ and

$$\rho > \frac{P - \underline{c}}{P - \underline{c} + 2(\bar{c} - \underline{c})} \Longleftrightarrow \rho(\bar{c} - \underline{c}) > \frac{1}{2}\left(1 - \rho\right)\left(P - \underline{c}\right).$$

Whatever the other firm's belief, a firm of type $\underline{q}$ who does not commit gets a profit at least equal to $\rho(\bar{c} - \underline{c})$ which is larger than the commitment payoff $\frac{1}{2}\left(1 - \rho\right)\left(P - \underline{c}\right)$. But that contradicts the initial hypothesis that commitment is an equilibrium strategy for all firm types. Note that the reasoning above does not depend on whether the commitment decision is publicly observable or not.

Proposition 3 *There exists an equilibrium of the beauty contest game with conditional commitment in which firms commit to transparency whatever their types if and only if conditions (i), (ii) or (iii) of Proposition 2 are satisfied (whether commitments are publicly observable or not).*

The intuition is straightforward. The conditional commitment mechanism provides firms with a means to cooperate to achieve the higher no corruption payoffs. An interesting analogy can be made with collusion in a price cartel. In our context, the commitment mechanism provides the firms with an instrument to collude against the agent so as to avoid costly competition in bribes.

What determines the power of the CC mechanism to deter corruption is revealed by Equation (5). The more profitable the market (large P) and/or the more fierce competition between high and low cost types ($\bar{c} - \underline{c}$ small), the more likely CC eliminates corruption. Another important parameter is ρ, the probability that the low quality type's contestant is a high quality type. This probability should not be too small. The intuition is simple. Under the no corruption regime the low quality type only wins against another low quality type, so the expected gain decreases in ρ. On the other hand, since the low quality firm always wins in bribes against a high quality type, the corruption payoff increases in ρ. This means that if the market is characterized by a large share of low quality firms, conditional commitment is likely to be an effective tool to combat corruption.

Conversely, the conditional commitment mechanism will not work well if the market is not sufficiently profitable, if firms' cost types are far apart, and if the low quality type believes there is very little chance that the other is of low quality type. In particular we see immediately that the mechanism does not prevent corruption under complete information when the firms are of different quality type. The firm of the low quality (and low cost) type wins for sure with corruption.

3.1.2 Partial Commitment

We next show that when none of the conditions of Proposition 2 are satisfied (i.e., under condition (iv), so full commitment does not obtain in equilibrium), there may exist a separating equilibrium in which only the high quality firms' types choose to commit. We also investigate the impact of the observability of the commitment decisions. More precisely two cases are possible. In the first case the commitment decisions are publicly observable. In the second case the decisions are not publicly observable but since commitment is conditional, a firm that made a commitment always learns the commitment decision of the other. Indeed it must know whether its own commitment is in force before making the subsequent decisions. In contrast, when a firm does not commit, it never learns the commitment decision of the other. We denote that case as private conditional commitment.

First notice that whether commitment is observable or not, type $\bar{q}$ never has a strict incentive to deviate and refrain from committing since it gets a zero payoff in the beauty contest with corruption. But as we shall see next, the condition for not committing to be part of an equilibrium strategy for type $\underline{q}$ depends on the extent of observability of the firms' commitment decisions.

Publicly observable conditional commitments When firms' commitment decision are publicly observable, the profit of a firm type $\underline{q}$ when it does not commit is

$$\begin{cases} \bar{c} - \underline{c} & \text{if the other firm's type is } \bar{q}, \\ 0 & \text{if the other firm's type is } \underline{q}. \end{cases}$$

If a firm of type $\underline{q}$ deviates and commit (recall we are considering a separating equilibrium), its profit is

$$\begin{cases} 0 & \text{if the other firm's type is } \bar{q}, \\ \bar{c} - \underline{c} & \text{if the other firm's type is } \underline{q}, \end{cases}$$

because when the low quality type observes that the firm commits, it believes that it is of the high quality type and therefore bribes $b^* \left(\underline{q}\right) = P - \bar{c}$. The incentive constraint for type $\underline{q}$ in the separating equilibrium thus writes

$$\rho \left(\bar{c} - \underline{c}\right) \geq (1 - \rho) \left(\bar{c} - \underline{c}\right),$$

i.e., $\rho \geq 1/2$. If the probability to meet a high quality firm is lower, it becomes attractive to fool the contestant hoping that he is of low quality and compete him out in bribes. Under condition (iv) when $\rho \leq 1/2$, there exists no equilibrium with full commitment and no separating equilibrium, in which case we simply have the corruption regime.

Private conditional commitments Here the commitment of the rival is observed only when the firm commits itself. The expected profit of type $\underline{q}$ when it does not commit (and thus observes nothing) is $\rho(\bar{c} - \underline{c})$ as in the corruption equilibrium. If type $\underline{q}$ deviates and commits its profit is

$$\begin{cases} 0 & \text{if the other firm's type is } \bar{q} \\ X & \text{if the other firm's type is } \underline{q}, \end{cases}$$

where

$$X = \max_b (P - \underline{c} - b) F(b).$$

We know from the analysis of the corruption equilibrium that $(P - \underline{c} - b) \left(\rho + (1 - \rho) F(b)\right) = \rho(\bar{c} - \underline{c})$ so

$$X = \max_{P - \bar{c} \leq b \leq \hat{b}} \frac{\rho}{1 - \rho} (b - (P - \underline{c})) = \rho(\bar{c} - \underline{c}).$$

Hence, the separating equilibrium condition is $\rho(\bar{c} - \underline{c}) \geq (1 - \rho)\rho(\bar{c} - \underline{c})$, which is always satisfied.

The equilibrium conditions are summarized by the following proposition.

Proposition 4 *Under condition (iv) we have:*

- *If conditional commitment decisions are publicly observable, there exists a separating equilibrium in which only the high types commit provided $\rho \geq 1/2$.*
- *If conditional commitment decision are kept secrete, there always exists a separating equilibrium in which only the high types commit.*

Proposition 4 establishes that observability of conditional commitment decisions induces more corruption than when commitment decisions are not observed. Indeed under public observability deviating from separation and committing allows to fool the other firm which maybe profitable. It allows to reduce the cost of competition in bribes with a low quality contestant because the latter is fooled to believe it faces a high quality type. When that is profitable (i.e., for $\rho < 1/2$) no separating equilibrium exists.[9] When commitment decisions are not observed, there exists no such opportunity because the non committing low quality contestant does not observe the other firm's decision. A separating equilibrium always exists (under condition (iv)) thus securing that when two high quality types meet, commitment is in force and there is no corruption in equilibrium.

While observability plays no role for our results in Proposition 2, a detrimental effect arises under the conditions of Proposition 4 because of the conjunction of asymmetric information between firms which creates an opportunity to fool and the conditionality of the commitment which secures that the commitment is not effective against another (non committing) low quality firm.

The existence of a separating equilibrium established in Proposition 4 suggests that the government may have an interest in encouraging single types to commit. This will be the object of the next section where we investigate a scheme where commitment is binding independently of the other firm's decision but the government rewards firms that commit to transparency with a selection advantage.

Remark 1 We assumed that commitment choices are made after firms have been privately informed of their type, as it would be the case when firms commit in connection with a specific project. Alternatively, they may commit to transparency for a period of time within their field of activity. An example of the latter would be the Extractive Industry Transparency Initiative (EITI). Clearly, if the no-corruption regime dominates the corruption regime for both types of the firm, then they also have an incentive to commit ex-ante, but the reverse is not true.[10]

3.2 Unilateral Commitment with Bonus (UCB)

In this section we consider a modified beauty contest game. As in the preceding section the government commits to a procedure, managed by an agent, to select a firm. The agent but not the government can "read" the offers which gives him discretion m. In contrast to the previous subsection, commitment is not conditional on the other firm's commitment, but the selection rule favors firms that commit. The selection rule is altered by a bonus $a_i \in \{0, h\}$ for some $h \geq 0$, where $a_i = h$ when firm i commits and $a_i = 0$ otherwise, $i = 1, 2$. The agent selects firm i if $b_1 = b_2 = 0$ and $q_i + a_i > q_{-i} + a_{-i}$, $b_i > b_{-i}$ and $q_i + m + a_i > q_{-i} + a_{-i}$, or $b_i < b_{-i}$ and

[9] It can also be checked that there is no equilibrium in which only the low quality firm type commits. The high quality type gets zero if it does not commit, while it earns a strictly positive profit if it commits.

[10] With large discretion ($m > \bar{q} - \underline{q}$) and when the low quality firm type is the cost efficient firm type ($\bar{c} > \underline{c}$), it can be shown that the condition on the parameters for the no-corruption regime to dominate ex-ante is strictly weaker than the interim condition (Condition (iii) in Proposition 2).

$q_i + a_i > q_{-i} + m + a_{-i}$. For some trivial values of the bonus, the beauty contest with UCB is easy to characterize:

Proposition 5

- *If $h > m$ both firm types unilaterally commit.*
- *If $h + \overline{q} < m + \underline{q}$ no firm type commits.*

The proof of the statements in Proposition 5 is immediate. In the case when $h > m$, committing is always better than bribing. It secures the largest selection advantage at no cost. Committing is a dominant strategy for both types under all circumstances (weak or large discretion, $\overline{c} < \underline{c}$ or $\overline{c} > \underline{c}$).

When $h + \overline{q} < m + \underline{q}$, even a high type who commits cannot win against a low type that does not commit, he can only win against a high type that also commits, i.e., with 1/2 probability. But if the high type contestant commits, it is worthwhile deviating and paying an infinitesimal bribe to win for sure against a high type contestant. A fortiori this is true for the low type who can win with corruption for sure against a committing contestant. If the contestant does not commit, he loses for sure if he commits while it can win with probability 1/2 against another low type. So we are back in the corruption equilibrium described earlier.

In the remaining of this subsection we consider the more interesting intermediary cases characterized by $h < m$ and $\overline{q} + h > \underline{q} + m$, i.e., the official selection advantage is smaller than the one available through corruption but it is sufficient to secure that a high quality type who commits wins against a low quality type who bribes.

Weak discretion ($m < \overline{q} - \underline{q}$) We know that with weak discretion conditional commitment precludes corruption. However, it is easy to show that unilateral commitment does not (for $h < m$). Consider first the high quality type. He always wins against a low quality type (because of weak discretion). If he commits but the contestant does not, he loses for sure against a high quality contestant. And if the contestant commits, it is better not to commit and win for sure by paying an infinitesimal bribe. The same reasoning applies to the low quality type which loses for sure if he commits and the contestant does not. But if the contestant commits he can win with an infinitesimal bribe if the other firm is of the low quality type. So there exists no equilibrium where any of the type commits.

Large discretion ($m > \overline{q} - \underline{q}$) We know from Proposition 3 that conditional commitment can preclude corruption in this case (when Condition (ii) or (iii) applies). Yet, we also know that in the absence of commitment mechanism, firms are trapped in corruption and that unilateral commitment can never arise in the absence of bonus (Proposition 1). The question is whether the opportunity to gain the bonus can make firms commit unilaterally.

It is easy to show that there can be no equilibrium where both types commit, even with a bonus ($h < m$). The low type can only win against another low type. Assume that the other low type commits; if our low type also commits he wins with probability 1/2, but by deviating and offering an infinitesimal bribe, our low type secures win against a low type contestant.

Next, consider an hypothetical equilibrium where the high quality type commits but not the low quality type, in which case competition in bribes between the low types drives up the bribes to $P - \underline{c}$ and they get a zero profit. Clearly, firms of the low quality type have no strict incentive to deviate and commit because they would lose for sure. So it is indeed optimal for the low quality firms not to commit. When considering firms of the high quality type, we have to distinguish between different cases.

When $\overline{c} > \underline{c}$, the condition for committing to be part of an equilibrium for the high quality type is:

$$\rho\frac{1}{2}\left(P - \overline{c}\right) + \left(1 - \rho\right)\left(P - \overline{c}\right) \geq \rho\left(P - \overline{c}\right), \tag{6}$$

where the right hand side is computed knowing that the high quality type can only win in bribe (with an infinitesimal bribe) against a high quality type, and the low quality type bids $P - \underline{c} > P - \overline{c}$. Hence, there exists an equilibrium where the high quality type commits and the low quality does not for $\rho \leq \frac{2}{3}$.

When $\overline{c} < \underline{c}$ and firms do not observe the other firm's commitment decision, a high type who deviates from commitment either bribes just above zero to win only against a high type, or bribes just above $P - \underline{c}$ to win against both contestant's types. Hence, the equilibrium condition is given by:

$$\rho\frac{1}{2}\left(P - \overline{c}\right) + \left(1 - \rho\right)\left(P - \overline{c}\right) \geq \max\{\rho\left(P - \overline{c}\right), \underline{c} - \overline{c}\}. \tag{7}$$

Instead, when commitment decisions are publicly observed, the deviant type can bribe depending on the commitment choice, and the equilibrium condition becomes

$$\rho\frac{1}{2}\left(P - \overline{c}\right) + \left(1 - \rho\right)\left(P - \overline{c}\right) \geq \rho(P - \overline{c}) + (1 - \rho)(\underline{c} - \overline{c})\}. \tag{8}$$

Notice that (7) is stronger than (8), so as in the conditional commitment case commitment is easier to sustain when commitment decisions are not observable. The equilibrium conditions above immediately give the following proposition:

Proposition 6 *When $h < m$ and $h + \overline{q} > m + \underline{q}$ there is no equilibrium in which low firms' types commit. In addition, we have:*

- *With weak discretion the unique equilibrium yields firms of both types choosing not to commit.*
- *With large discretion and $\overline{c} > \underline{c}$ there exists a separating equilibrium in which only the high types commit if and only if $\rho \leq \frac{2}{3}$.*

- *With large discretion and $\overline{c} < \underline{c}$ there exists a separating equilibrium in which only the high types commit if and only if*
  - *Commitment decisions are publicly observable and* $\rho \leq \frac{P-\underline{c}}{P-\underline{c}+\frac{1}{2}(P-\overline{c})}$, *or*
  - *Commitment decisions are not observable and* $\rho \leq \max\left\{\frac{2}{3}, \frac{P-\underline{c}}{\frac{1}{2}(P-\overline{c})}\right\}$.

Proposition 6 shows that unless the bonus is larger than the selection advantage available in corruption (Proposition 5), the beauty contest with UCB is characterized by more corruption than the beauty contest with CC (Propositions 3 and 4). In particular, it does not succeed in having firms to cooperate under weak discretion to avoid extortion. And it only partially allows the high quality type to avoid extortion under large discretion, even when commitment decisions are not observable and the high quality type is cost efficient.

3.3 Conditional Commitment with Bonus (CCB)

In this section we investigate the properties of a mechanism that combines the two mechanisms studied above. More precisely we consider a mechanism of commitment such that commitment is binding only if both firms commit as in the CC mechanism, but also such that the decision to commit is rewarded with a bonus as in the UCB mechanism. Compared with the conditional commitment scheme, the firm that commits enjoys a bonus for committing whether commitment is actually in force or not (i.e., whether the other firm did commit or not). Compared with the unilateral commitment with bonus scheme, the difference is that if the other firm does not commit, the firm who committed is free to give bribes while keeping the bonus. So the conditional commitment with bonus mechanism (CCB) gives more incentives to commit than either the conditional or the unilateral commitment mechanism.

The timing of the game is as in Section 3.1 but the selection rule is as follows: The agent selects firm i if $b_i = b_{-i} = 0$ and $q_i + a_i > q_{-i} + a_{-i}$, or $b_i > b_{-i}$ and $q_i + m + a_i > q_{-i} + a_{-i}$, or $b_i < b_{-i}$ and $q_i + a_i > q_{-i} + m + a_{-i}$. As before $a_i \in \{0, h\}$, for some $h \geq 0$, $a_i = h$ when firm i commits and $a_i = 0$ otherwise. Given our results in Proposition 5, we focus on the case where $h < m$ and $h + \overline{q} > m + \underline{q}$.

It is immediate that if conditional commitment can eliminate corruption (in situations (i), (ii) and (iii)), the CCB mechanism does as well; incentives to commit are only reinforced by the bonus. Hence, we focus on the "difficult" case defined by condition (iv), where the agent's discretion is large, the high quality type has high cost, and the probability for the contestant of the low quality type to be of the high quality is large. In this case, we know that corruption allocates the contract to a low quality type even when there is a high quality type around (see Proposition 1). From Proposition 3 we also know that there exists no equilibrium of the beauty contest with CC and full commitment (but sometimes a separating one, see Proposition 4). We now ask when is full commitment possible with CCB. It turns out that adding the bonus to the conditional commitment mechanism induces asymmetries between firms off the equilibrium path, when a firm is conditionally committed and the other is not. For this reason and in order to get some understanding of what happens, we shall first characterize two simple equilibria with degenerated beliefs off the equilibrium path, and only thereafter present the general solution for arbitrary beliefs.

When both firm types commit there is no bribery, both firms get their bonus (which does not affect allocation) and the payoffs for the high and low types are respectively given by

$$\left(\frac{1}{2}\rho + (1-\rho)\right)(P-\overline{c}) \text{ and } \frac{1}{2}(1-\rho)(P-\underline{c}).$$

Let us denote by μ the belief off the equilibrium path that firm 2 assigns to the event that firm 1 is of the high quality type when firm 2 observes that firm 1 did not commit. We first consider equilibrium conditions with the extreme beliefs $\mu = 0$ and $\mu = 1$.

If firm 1 deviates two things happen. First, the commitment of firm 2 is not binding. Second, it introduces an asymmetry between the firms because firm 2's quality is $q_2 + h$ while firm 1's is q_1. Since we have $h + \overline{q} > m + \underline{q}$, it means that firm 2 of the high quality type can win without bribing. From firm 1's perspective it also means that it can only win against a firm 2 of the low quality type. Moreover the bribing game becomes asymmetric compared to the one we studied in Section 2.2 since μ may be different from ρ. In the bribing game off the equilibrium path we claim that the following strategies are part of an equilibrium:

$$\begin{aligned} b_2^*(\overline{q}) &= 0,\ b_1^*(\overline{q}) = 0, && (9) \\ b_2^*(\underline{q}) &= b_1^*(\underline{q}) = P - \underline{c}_1 && (10) \end{aligned}$$

These strategies are supported by $\mu = 0$, i.e., the complying firm believes that if the other firm did not commit it must for sure be of the low quality type. On the other hand the deviating firm's beliefs about the type of the complying firm are as before: it assigns probability ρ to the event that it is of the high quality type. To see that the bribes in (9) and (10) are part of an equilibrium, we note that the high quality type of firm 2 is sure to win without bribing since $h + \overline{q} > m + \underline{q}$ so it is optimal to bribe zero. When $b_1 = b_2$ and $q_1 = q_2$, the agent selects firm 1.

The second line (10) reminds us of the strong bribe competition occurring between low quality types under weak discretion. This follows from the fact that firm 2 is sure to meet a low quality type ($\mu = 0$) and since $h < m$ it can only win with the corruption advantage (m). Firm 1 of the low type knows it can never win against a committed high type. So it only cares about the low type and competition dissipates the rents.

Firm 1's incentive constraints write

$$\frac{1}{2}(1-\rho)(P-\underline{c}) \geq 0$$
$$\left(\frac{1}{2}\rho + (1-\rho)\right)(P-\overline{c}) \geq \rho(P-\overline{c})$$

This yields $\rho \leq \frac{2}{3}$. Similarly we can show that there exists an equilibrium with full commitment when $P \geq 2\overline{c} - \underline{c}$. This equilibrium is supported by firm 2's beliefs that the deviating firm is of the high quality type ($\mu = 1$). It is characterized by the following bribes off the equilibrium path:[11]

$$b_2^* (\overline{q}) = b_1^* (\overline{q}) = P - \overline{c}, \tag{11}$$

$$b_2^* (\underline{q}) = P - \overline{c} + \varepsilon, \; b_1^* (\underline{q}) = P - \overline{c} + 2\varepsilon \tag{12}$$

Equation (11) reflects the fact that since firm 2 of the high quality type is sure to meet a high quality type, it must offer the largest bribe it can. The high quality type of firm 1 responds by competing in bribe to the full dissipation of the rents. We recall that by convention, when the two firms are of the same type and they offer the same bribe, firm 1 is selected. Equation (12) is explained as follows. Firm 2 of the low quality and low cost type is sure to meet a high quality high cost type. Since it has the bonus it can win provided it overbribes him by an arbitrary small amount $\varepsilon > 0$. Firm 1 of the low quality type can never win against a high quality type. But it only needs to slightly overbribe firm 2 to win for sure against a low quality type. The incentive constraints for firm 1 in this case are:

$$\frac{1}{2} (1 - \rho) (P - \underline{c}) \geq (1 - \rho) (\overline{c} - \underline{c}),$$
$$\left(\frac{1}{2}\rho + (1 - \rho) \right) (P - \overline{c}) \geq 0,$$

which yields $P \geq 2\overline{c} - \underline{c}$.

To summarize, under condition (iv) and when $h < m$ and $h + \overline{q} > m + \underline{q}$ we have shown that there exists an equilibrium of the beauty contest game with conditional commitment in which firms commit to transparency whatever their types if $\rho \leq \frac{2}{3}$ or $P \geq 2\overline{c} - \underline{c}$. This is an improvement on the simple conditional commitment equilibrium. For instance, take $P = \overline{c}$, with the simple conditional mechanism the no corruption equilibrium requires $\rho \leq 1/3$ (CCB only requires $\rho \leq \frac{2}{3}$). It is an improvement over the unilateral commitment mechanism because with $\rho \leq \frac{2}{3}$ we obtained that only firms of the high quality type commit implying that the equilibrium is characterized by corruption whenever one of the firm is of the low quality type. With CCB both types commit so there is an equilibrium with no corruption at all.

The equilibria characterized above are rather simple. First, they involve extreme beliefs which implies that off the equilibrium path we have incomplete information on one side only. In particular $\mu = 0$ has an intuitive appeal. Second, and as a consequence of one sided information asymmetry the equilibria are characterized by pure bribing strategies. We address below the general case with two-sided asymmetry in the bribing game.

Again, let $\mu \in (0, 1)$ be firm 2's beliefs about firm 1's type after the deviation. We considered above two extreme beliefs that generated incentives constraints from which we derived two conditions for full commitment to be an equilibrium of the beauty contest with CCB. Intuitively, as we

[11] This is not an exact equilibrium but the equilibrium characterized in the Appendix for $\mu \in (0, 1)$ converges to this one when $\mu \to 1$.

move away from $\mu = 0$ ($\mu = 1$, respectively) the incentive constraint of low (high, respectively) quality type becomes less binding. For appropriate intermediate beliefs the other firm may put sufficient weight on *both* types which forces them to bribe consequently and reduces the attractiveness of the deviation. In the next proposition we actually show that there exists an equilibrium of the beauty contest with CCB with full corruption deterrence provided only that $h + \overline{q} > m + \underline{q}$ (the detailed proof is in Appendix A). This equilibrium is supported by beliefs $\mu = 1/2$ off the equilibrium path and has the following form. Firm 1 with the high quality plays a mixed strategy according to a continuous distribution with support $(0, y_1]$, firm 1 with the low quality plays a mixed strategy according to a continuous distribution with support $(y_1, y]$, firm 2 with the high quality plays a mixed strategy according to a discontinuous distribution with support $[0, y_2]$ and a positive mass at the lower end of the interval, and firm 2 with the low quality plays a mixed strategy according to a continuous distribution with support $(y_2, y]$, where $0 < y_2 < y_1 < y$.

Proposition 7 *Assume that $h + \overline{q} > m + \underline{q}$. In the asymmetric information beauty contest game with conditional commitment with bonus, there always exists an equilibrium with full corruption deterrence .*

We already knew that conditional commitment achieves corruption deterrence for the case the no corruption regime is preferred by the firms of both types. It gives them an instrument to cooperate in resisting costly competition in bribe. What the CCB mechanism achieves is to preclude corruption even when some firms strictly prefer the corruption regime. This is made possible because of the conjunction of the conditionality of commitment combined with the bonus for (unilaterally) committing. By rewarding a "good" firm that commits with a selection advantage but leaving it "free to bribe" in case full commitment fails, competition in bribes is made unprofitable for the firm who initially preferred the corruption regime. It may at first appear trivial: making corruption more expensive reduces its attractiveness. What is much less trivial is that this obtains as the result of the interaction between firms that voluntarily commit not to bribe in spite of the fact that some firms originally gain from corruption.

4 Concluding Remarks

In this paper we have investigated mechanisms of corruption deterrence based on firms' voluntary decision to commit to transparency. A first main finding is that a simple conditional commitment mechanism has a powerful potential to deter corruption when no firm benefits from it, i.e., when corruption boils down to pure extortion. In those cases, the firms face a cooperation problem, they prefer not to bribe but do bribe unless they trust the other will not. A conditional commitment mechanism provides them with an instrument to cooperate. When introducing a selection advantage rewarding the decision to commit, the no corruption regime becomes even more attractive. In contrast we find that the wider spread unilateral commitment mechanism has a much less powerful deterrence potential. Basically it has no impact if used without bonus and with a (sufficiently high but not prohibitive) bonus it can at best induce high quality types to refrain from corruption. In the more difficult cases where the low quality type can gain from corruption, we find that a mechanism that rewards the commitment decision but where commitment itself is conditional on the other firm's decision has the potential to fully deter corruption and bribery.

As mentioned in the Introduction there exists a variety of commitment mechanisms aimed at curbing corruption in competitive procedures. Among them of particular interest are the Integrity Pact (which come in several variants) and the Extractive Industries Transparency Initiative. The first is usually compulsory and includes sanctions in case of violation. That sanctions are determined and enforced by an arbitration court. In contrast the EITI is based on free choice and relies on the power of transparency. It should be mentioned that EITI has two components. The first regards the commitment of the central government and the second regards the commitment of the firms. The two key principles of firms' commitment are (i) a commitment to regular publications of information regarding all payments by the company made to the government, and (ii) an independent administrator whose role is to reconcile payments and revenues and publish reports including of possible discrepancies.[12] Our results are most closely related to EITI in the sense that we investigate non-compulsory commitment and we do not consider sanctions.[13] Two recommendations emerge from this analysis. First, it may not always be necessary to make commitment compulsory as in the Integrity Pact of Transparency International to obtain significant or even full corruption deterrence. Next, it may be worthwhile to consider making commitment conditional and explicitly rewarding with a selection advantage firms that choose to commit.[14] These recommendations are made to the attention of the Extractive Industry Transparency Initiative which basically rely on unilateral commitment without bonus, but it may apply more generally in public-private partnership contexts.

The analysis in this paper relies on a number of simplifying assumptions. In particular we assume ex-ante symmetric firms. Both firms are equally likely to be of the high quality type. This symmetry allows to solve for the equilibrium in the basic corruption game. Some readers may feel that this assumption of symmetry is not always warranted. Consider the case when on an extraction rights market a foreign firm compete with a local one. It may be more reasonable to assume that the probability that the contestant of the local firm is of good quality is close to one. This means that a local firm of the low quality type can only win with corruption and therefore has no incentive to commit to transparency; so the simple conditional commitment fails to prevent corruption if the local firm also has lower costs. However, with the conditional bonus scheme the foreign firm of the high type wins without corruption. If the probability that the foreign firm is of

[12] See EITI criteria on www.eiti.org.

[13] This means that the mechanism in itself does not introduce sanctions in addition to the ones that are foreseen in the law.

[14] It can be argued as for instance in EITI reports, that the value of committing for firms, often expressed in terms of good reputation is a (implicit) selection advantage in competitive procedures for extraction rights.

the high quality type is high, there will be very little corruption in equilibrium. This suggests that despite the simplifying assumptions our main results can be useful to the more complex situations of real life.

Another interesting extension would be to study how commitment can deter corruption in beauty contests with more than two firms. This raises practical implementation problems when only a strict subset of firms decide to (conditionally) commit. Should those firms being effectively bound to transparency while the others are not subject to any constraints? How should the official selection advantage (the bonus) be shared? More generally, voluntary commitment in incomplete information contests is clearly a fundamental applied and theoretical issue that should deserve much more attention in future research.

A Appendix

A.1 Proof of proposition 8

We show that when conditions (i), (ii) and (iii) of Proposition 2 are not satisfied, i.e., $m > \bar{q} - \underline{q}$, $\bar{c} > \underline{c}$ and $\rho > \frac{P-\underline{c}}{P-\underline{c}+2(\bar{c}-\underline{c})}$, there is an equilibrium in which both firms, whatever their types, conditionally commit to transparency for a bonus h such that $h + \bar{q} > m + \underline{q}$. The case $h > m$ has been solved in Proposition 5 so we focus on the case where $h < m$. Consider such an hypothetical equilibrium and consider without loss of generality (firms are ex-ante symmetric) a deviation by firm 1. We have to construct equilibrium bribing strategies as a function of firm 2's belief about firm 1's type after the deviation from commitment. Notice that in this situation, since firm 1 is conditionally committed, it gets the bonus, so $\underline{q}_1$ cannot win against $\bar{q}_2$ but $\underline{q}_2$ can win against $\bar{q}_1$ by bribing more. Let $\mu \in (0, 1)$ be firm 2's belief about firm 1's type after the deviation. There are two asymmetries now compared to the bribing game analyzed in Subsection 2.2 because the selection rule and the priors (ρ and μ) are asymmetric.

We show that this asymmetric bribing game induced by firm 1's deviation from conditional commitment has an equilibrium of the following form. Firm 1 with the high quality plays a mixed strategy according to a continuous distribution $\bar{F}_1(b)$ with support $(0, y_1]$, firm 1 with the low quality plays a mixed strategy according to a continuous distribution $\underline{F}_1(b)$ with support $(y_1, y]$, firm 2 with the high quality plays a mixed strategy according to a discontinuous distribution $\bar{F}_2(b)$ with support $[0, y_2]$ and a positive mass $\bar{F}_2(0) > 0$ at the lower end of the interval, and firm 2 with the low quality plays a mixed strategy according to a continuous distribution $\underline{F}_2(b)$ with support $(y_2, y]$, where $0 < y_2 < y_1 < y$.

The boundaries y_1, y_2 and y, the mass $\bar{F}_2(0) > 0$ and the values of $\underline{F}_2(y_1)$ and $\bar{F}_1(y_2)$ are calculated by setting the interim expected profits equal to constants, which lead to the following system of 6 equations with 6 unknowns:

$$
\begin{aligned}
(P-\bar{c})\bar{F}_2(0) &= P-\bar{c}-y_2 && (13)\\
(P-\bar{c}-y_2)\rho &= (P-\bar{c}-y_1)(\rho+(1-\rho)\underline{F}_2(y_1)) && (14)\\
(P-\underline{c}-y_1)\underline{F}_2(y_1) &= P-\underline{c}-y && (15)\\
(P-\bar{c})(1-\mu) &= (P-\bar{c}-y_2)(1-\mu+\mu\bar{F}_1(y_2)) && (16)\\
(P-\underline{c}-y_2)\bar{F}_1(y_2) &= P-\underline{c}-y_1 && (17)\\
(P-\underline{c}-y) &= (P-\underline{c}-y_1)\mu. && (18)
\end{aligned}
$$

The third and sixth equations immediately give $\underline{F}_2(y_1)=\mu$. It can also be checked that under the constraints above, the functions $\underline{F}_i$ and $\bar{F}_i$, $i=1,2$, are proper distributions since there are increasing from 0 to 1.

We now show that there exists a belief off the equilibrium both, namely $\mu=1/2$, that guarantee that both types of firm 1 have no incentive to deviate from the conditional commitment. As remarked in the main text, the incentive constraints may be binding for degenerate beliefs $\mu=0$ and $\mu=1$. Incentive compatible conditions for firm 1 in the commitment stage for the high type and the low type are respectively given by:

$$
\begin{aligned}
(P-\bar{c})\,\rho\bar{F}_2(0) &\leq (P-\bar{c})\left(\frac{1}{2}\rho+(1-\rho)\right), && (19)\\
(P-\underline{c}-y_1)\,(1-\rho)\,\mu &\leq (P-\underline{c})\,\frac{1}{2}\,(1-\rho)\,. && (20)
\end{aligned}
$$

The equilibrium condition (20) for the low type is clearly always satisfied for $\mu=1/2$. The equilibrium condition (19) for the high type can be rewritten as $\bar{F}_2(0)\leq\frac{1}{\rho}-\frac{1}{2}$. From (13) this condition becomes:

$$y_2\geq\left(\frac{3}{2}-\frac{1}{\rho}\right)(P-\bar{c})\,. \tag{21}$$

Using the system of three equations and three unknowns (14), (16) and (17) we get

$$(P-\underline{c}-y_2)\,\frac{y_2}{P-\bar{c}-y_2}=\bar{c}-\underline{c}+2\frac{P-\bar{c}-y_2}{1+\rho}. \tag{22}$$

The solution of this last equation is:

$$
\begin{aligned}
y_2=\frac{1}{2+6\rho}\Big(&2(P-\underline{c})(1+\rho)+(P-\bar{c})(3\rho-1)\\
&+\sqrt{-(1+\rho)(8(P-\bar{c})(P-\underline{c})-4(P-\underline{c})^2(1+\rho)+(P-\bar{c})^2(3\rho-5))}\Big).
\end{aligned}
\tag{23}
$$

Notice that $-(8(P-\bar{c})(P-\underline{c})-4(P-\underline{c})^2(1+\rho)+(P-\bar{c})^2(3\rho-5))$ is positive because it is linear in ρ and positive for $\rho=0$ and $\rho=1$. The incentive constraint (21) of the high type is therefore given by:

$$
\begin{aligned}
&2(P-\bar{c})(1+\rho-3\rho^2)+2(P-\underline{c})\rho(1+\rho)\\
&+\sqrt{-(1+\rho)(8(P-\bar{c})(P-\underline{c})-4(P-\underline{c})^2(1+\rho)+(P-\bar{c})^2(3\rho-5))}\geq 0.
\end{aligned}
\tag{24}
$$

To check this inequality it suffices to check that

$$(P - \bar{c})(1 + \rho - 3\rho^2) + (P - \underline{c})\rho(1 + \rho) \geq 0. \tag{25}$$

This inequality is satisfied for $\rho = 0$ and $\rho = 1$, and the left hand side is either increasing (when $(P - \bar{c}) - 6(P - \underline{c}) \geq 0$) or concave (when $(P - \bar{c}) - 6(P - \underline{c}) \leq 0$), so it is positive for all $\rho \in (0, 1)$. ■

References

[1] Andersson P, S. Hulten and P. Valiente (2005) " Beauty Contest Licensing Lessons from the 3G Process in Sweden" *Telecommunication Policy* 29, 577-593.

[2] Bade, S. and Haeringer, G. and Renou, L. (2009) "Bilateral commitment" *Journal of Economic Theory* p.1817–1831.

[3] Bardhan P., (1997) "Corruption and Development: a Review of issues *Journal of Economic Litterature* 35/3, 1320-1346.

[4] Binmore K. and P. Klemperer (202) " The biggest Auction Ever: The Brittish Sale of 3G licences" *The Economic Journal*, 112/478, C74-C96.

[5] Burguet, R. and Y.-K. Che (2004). "Competitive Procurement with Corruption." *Rand Journal of Economics,* 35: 50-68.

[6] Celentani, M. and J. Ganunza (2002). "Competition and Corruption in Procurement." *European Economic Review,* 43: 1273-1303.

[7] Compte, O., A. Lambert-Mogiliansky and T. Verdier (2005). "Corruption and Competition in Procurement." *Rand Journal of Economics,* 36(1): 1-15.

[8] Kalai, T. A. and Kalai, E. (2010) "Engineering Cooperation in Two-Player Strategic Games", mimeo

[9] Kalai, T. A. and Kalai, E. and Lehrer, E. and Samet, D. (2010) "A commitment folk theorem" forthcoming *Games and Economic Behavior.*

[10] Kosenok G. and A. Lambert-Mogiliansky (2009) "Fine-tailored for the Cartel - Favoritism in Procurement" Review of Industrial Organisation 35, 95-121.

[11] Mauro P. (1995), "Corruption and Growth", *The Quarterly Journal of Economics* 110/3, 681-712.

[12] Renou, L (2009) "Commitment games" *Games and Economic Behavior,* p. 488–505.

[13] Robinson J. A. and R. Torvik, (2005) "White Elephant" *Journal of Public Economics* 89, 197-210.

[14] Simon Leo K. and William R. Zame, "Discontinuous Games and Endogenous Sharing Rules," *Econometrica 58* (1990), 861-872.

[15] United Nations Convention Against Corruption, United Nations New York 2004. http://www.unodc.org/documents/treaties/UNCAC.