# Cartels and Bribes[*]

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**Abstract**

We study the relationship between collusion and corruption in a stylized model of repeated procurement where the cost of reporting corrupt bureaucrats gives rise to a free riding problem. As in Dixit (2015, 2016), cooperation among honest suppliers alleviates free-riding in reporting. However, it also facilitates collusion in bidding by increasing the value of the collusive rent. In turn, bidding collusion facilitates cooperation in reporting by increasing the value of having honest bureaucrats, generating a trade-off. When the likelihood of corruption is high and competition is weak, collusion may be a price worth paying to curb corruption.

**Keywords**: Bribes, cartels, collusion, corruption, free-riding.
**JEL Classification**: D44, D73, H57, L41.

# 1 Introduction

Cartels and corruption are widespread problems but the relationship between the two is not yet fully understood, nor taken into account by policymakers.[1] The phenomena often coexist in public procurement markets.[2] Corrupt public servants may collaborate with ring members against non-members or new entrants, helping to enforce collusive

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[1]See Burguet et al. (2018) and Luz and Spagnolo (2017).
[2]For a general discussion on how bid rigging in procurement works, see Harrington et al. (2006) and Marshall and Marx (2009, 2012).

strategies. A first strand of important economic analyses has therefore focused on the micro-mechanisms behind this complementarity between bid rigging and corruption.[3]

In this paper, we dig further into the relations between the two phenomena, taking an orthogonal perspective. We focus on the free-riding problem that suppliers may face when fighting corrupt bureaucracies. Our starting point is the recent work by Dixit (2015, 2016), stressing that self-enforcing coalitions of private actors, like business associations, may help to overcome this problem.[4] We note, however, that once firms start meeting to coordinate on reporting corruption, it is likely that they will also start discussing strategies to soften competition.[5] We thus investigate the interaction between suppliers' incentives to coordinate in the fight against corruption and those to collude in bidding.

We propose a model where a buyer must repeatedly procure a good, delegating the purchase to a potentially corrupt agent. If corrupt, this agent can overstate the quality offered by a 'hit-and-run' rogue supplier in exchange for a bribe. High-quality, long-run suppliers can observe and report this corruption, thereby causing the agent to be replaced. Reporting, however, is costly, for example because it takes resources to document and litigate corruption, or since it attracts retaliation by the reported agent before being replaced. A replaced agent, initially honest, may turn corrupt with time.

In this setting, long-run suppliers indeed face a free riding problem, which depresses incentives to report corrupt bureaucrats. We first show that, as suggested by Dixit, cooperative agreements between suppliers to coordinate in reporting and share its cost alleviate the free-riding problem and limit corruption. Cooperation in reporting may however spark talks about raising prices. We show that in fact coordinated reporting does more: it also facilitates the *enforcement* of bidding collusion, by increasing the expected collusive rent. In turn, we find that bidding collusion facilitates cooperation in reporting by increasing the profits lost when corrupt deals occur. In contrast with previous work, these effects highlight a complementarity between collusion and the fight

[3] The seminal papers on the relationship between corruption and collusion are Lambert-Mogiliansky and Sonin (2006), Lambert-Mogiliansky (2011), and Compte et al. (2015). See also Celentani and Ganuza (2002) and Burguet and Che (2004), who study the relation between corruption and competition.

[4] The cooperative agreements among firms that Dixit envisage resemble that of Maghribi traders in the work of Greif (1993), but also more standard business associations or labor unions. It also reminds of the *Addiopizzo* movement in Sicily, where hundreds of businesses created a coalition that, together and simultaneously, resisted and reported the predatory behavior of criminal organizations, while businesses that did not participate in the 'resistance' were also ostracized (Superti, 2009).

[5] As Adam Smith famously put it: "People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices."There are uncountable examples where trade association initiated, facilitated or run legal and illegal cartels, the most notable being perhaps that of the Dutch association of construction firm running a cartel involving the whole industry, more than one thousand firms, for almost two decades. Levine et al. (2021) recently studied whether one can spot any real difference between cartels and trade associations.

*against* corruption. As a result, when corruption is a major problem and competition is relatively weak, a bidding cartel that facilitates coordination in reporting increases the buyer's welfare.

Finally, we highlight a subtle relationship between the intensity of the corruption threat and the firms' ability to collude. On the one hand, when corruption is present, the threat of losing gains from coordinating in reporting may discipline deviations from collusive agreements. On the other hand, corruption acts as a tax that reduces rents from collusion, making it harder to sustain. Either of the two effects may dominate, depending on the intensity of competition and the seriousness of the corruption problem.

The paper unfolds as follows. In Section 2, we present the model. Section 3 studies the case of competition: after some preliminaries (Subsection 3.1) it discusses incentives to report corruption when there is no coordination in reporting (Subsection 3.2) and when there is (Subsection 3.3). Section 4 investigates the interaction between the incentives to cooperate in bidding and in fighting corruption (Subsection 4.1), as well as the implications for buyer's surplus (Subsection 4.2). Section 5 further investigates the relationship between corruption and collusion, showing that the existence of a corruption threat may facilitate collusion (Subsection 5.1), and studying the dynamics of beliefs on the honesty of the bureaucrat (Subsection 5.2). Section 6 describes a puzzling correlation between corruption perception and cartels in Europe, consistent with our results. Section 7 briefly concludes.

## 2 Model

**Preliminaries.** We consider an infinite horizon problem where a buyer delegates contract procurement to a potentially corrupt agent. High-quality, non-bribing long-run suppliers compete for a contract each period, anticipating that short-run suppliers may bribe dishonest bureaucrats to overstate their quality. Suppliers can observe and report this corruption, thereby causing the agent to be replaced, but reporting is costly. A replaced agent, initially honest, may turn corrupt with time. All agents discount the future at a common factor $\delta$.

**The firms.** There are two long-run firms, $L_1$ and $L_2$. Each firm $L_i$ is able to deliver the good with quality $q_i^t \in \{0, q\}$, $i = 1, 2$ in period $t$, and these random variables are independent across $i$ and $t$. The probability of $q_i^t = q$ (high quality) is $\mu$; thus, $1 - \mu$ is the probability of $q_i^t = 0$ (low quality). Firms $L_1$ and $L_2$ learn both $q_1^t$ and $q_2^t$ at the beginning of period $t$ and before any contracting in that period.

In each period, there is a probability $\nu$ that a short-run supplier, $S^t$, is also available –only at period $t$– . A short-run supplier can only deliver low quality $q_s^t = 0$. Nothing of interest depends on whether the long-run firms observe the presence of this supplier before or after contracting, so we will assume that they observe it after, to simplify the analysis. We also assume that all costs of production are zero.

**The buyer.** The buyer (e.g., a public administration) is interested in his net surplus, given by $\bar{q} - \bar{p}$, where $\bar{q}$ is the quality of the good received and $\bar{p}$ is the price paid. The buyer uses an agent, the bureaucrat, to conduct the procurement process, namely select the price-quality offer that results in the highest net surplus, pay the selected supplier the price $\bar{p}$ equal to its price bid, and verify (perfectly and at no cost) that the quality of the good delivered corresponds to the quality offered.

**The agent.** Bureaucrats are honest when first hired. However, in every period of their tenure, they have a probability $\beta$ of turning dishonest. Whether that has happened or not is not observed and thus can only be inferred from behavior.

Honest bureaucrats implement the buyer's instructions. Dishonest bureaucrats accept bribes when offered. We assume that only the short-run supplier $S^t$ may bribe. The corrupt deal is modeled very mechanically. A bribe buys misrepresentation of quality by the bureaucrat, who manipulates the bids to make $S^t$'s bid (and only that one) a high-quality bid, thus ensuring that $S^t$ is selected as the winner and paid a price $q$.

**Reporting corruption.** A corrupt deal can be reported to the buyer by either firms $L_1$ or $L_2$ at cost $c$ (retaliation, documentation, etc., which we treat in reduced form). When reported, the corrupt deal is detected and documented –we assume that with probability 1–, the bureaucrat is removed and a new bureaucrat is assigned the task. No other consequences for either $S^t$ or the bureaucrat are considered here. Also, contracts are not reassigned. The only consequences of reporting are the removal of the bureaucrat and the cost for the reporting firm.

**Timing.** The timing of the game in each period $t$ is as follows. First, firms submit bids (and $S^t$ submits a bribe, in case it is present). The bureaucrat announces the winner. If the bureaucrat is honest or $S^t$ is not present, (one of) the highest-score bid is accepted, the good is delivered and the winner obtains his bid as payment. If $S^t$ is present and the bureaucrat is dishonest, then a bribe is paid and $S^t$ is selected as the winner. If so, $L_1$ and $L_2$ simultaneously decide whether to report or not. If at least one of them reports, then the bureaucrat is replaced. Each reporting firm incurs a cost $c$.

# 3 Competition

In this section, we study $L_i's$ incentives to unilaterally report a corrupt agent, and how these change when firms manage to coordinate in reporting, under the assumption that they behave competitively at the bidding stage.

## 3.1 Preliminaries

Suppose that $\beta = 0$ and firms "compete," in the sense that they play the short-run equilibrium in each period. Then, firm $L_i$ makes profits $q$ in period $t$ with probability $\mu(1-\mu)$, the probability that it has high quality and the other long-run firm has low quality, in which case it bids $(q, q)$ and wins.[6] Both the other long-run firm and $S^t$, if present , bid $(0, 0)$.

Let $\pi = \mu(1-\mu)q$ denote the per-period, expected profits in the absence of bribery. The present value of this stream of profits is therefore:

$$V_0 \equiv \frac{\pi}{1-\delta}.$$

Now, suppose that $\beta > 0$. We look for subgame perfect equilibria in Markov strategies that represent competition. First, we check whether there exists an equilibrium in pure strategies where one of the long-run firms always reports and the other never does. Then, we consider equilibria where long-run firms coordinate and take turns in reporting corruption, thereby sharing its cost.

## 3.2 Uncoordinated reporting

In line with the meaning of competition defined above, we define uncoordinated reporting as any (Markov) strategy that does not depend on past play or any "correlation device", when it comes to reporting. To investigate equilibria with these characteristics, let us begin by assuming that firm $L_1$ conjectures that firm $L_2$ will never report bribery. Suppose that firm $L_1$ decides not to report either. Let $V_u^H$ and $V_u^D$ be the supplier's (expected, discounted) payoff when the current bureaucrat is respectively honest and dishonest. Then, $V_u^H$ and $V_u^D$ are the solutions to:

$$V_u^H = \pi + \delta(\beta V_u^D + (1-\beta)V_u^H), \quad (1)$$

$$V_u^D = \pi \frac{1-\nu}{1-\delta} \quad (2)$$

[6] Of course, we use the tie-breaking rule that assigns a high quality firm the contract in the period when two firms tie.

Under the conjecture that firm $L_2$ will never report, firm $L_1$ has no incentive to report (once) if:

$$c > \delta(V_u^H - V_u^D), \tag{3}$$

Solving for $V_u^H$ and $V_u^D$ in (1) and (2), we obtain the next proposition.

**Proposition 1.** *If:*

$$c > \frac{\delta\nu\pi}{1-\delta(1-\beta)} \equiv c_u. \tag{4}$$

*there is no uncoordinated equilibrium in which long-run suppliers report corruption when they compete in bidding.*

The left-hand side of the inequality in (4) measures the cost of reporting. The right-hand side is the benefit: (beginning next period) there is a gain of $\pi$ whenever there is a short-run supplier (probability $\nu$) and the bureaucrat stays honest. If the bureaucrat turns dishonest again, the gain is wiped out (unless a new cost $c$ is incurred). Thus, the probability of future gains is discounted at a rate $\delta(1-\beta)$.

If (4) is satisfied, there is no uncoordinated equilibrium where one long-run supplier reports corruption, conjecturing that the other does not. Note that these conjectures maximize the incentives to report. Indeed, if there was any probability that the other long-run supplier reported, then (in any Markov equilibrium) $L_1$'s gain from reporting (the right-hand side of (4)) would be multiplied by one minus that probability, but the cost would still be the same. Thus, under (4), there is no uncoordinated equilibrium with reporting.

## 3.3 Coordination in reporting: the Dixit effect

Let us now consider Dixit's proposal. Suppose that firms $L_1$ and $L_2$ coordinate their reporting strategy. For simplicity, we focus on equilibria sustained by grim strategies, and such that whenever bribery takes place, firms decide who reports by flipping a coin.[7] In case the firm designated to report fails to do so, they switch to never reporting forever after. We characterize the conditions under which this is an equilibrium when, absent cooperation, unilateral reporting is not an equilibrium, so we will assume that (4) is satisfied: $c > c_u$.

Let $V_r^H$ and $V_r^D$ represent the discounted payoffs expected by each $L_i$ when they adhere to this cooperating behavior and the bureaucrat is respectively honest and dishonest. We

[7] Alternatively, we could model this coordination as firms taking turns. We have chosen the modeling that makes the analysis simple, by doing away with the need to introduce states related to whose turn it is to report. The qualitative conclusions do not depend on this modeling choice.

have:

$$
\begin{aligned}
V_r^H &= \pi + \delta(\beta V_r^D + (1-\beta)V_r^H), & (5)\\
V_r^D &= \nu(-\frac{c}{2} + \delta V_r^H) + (1-\nu)(\pi + \delta V_r^D). & (6)
\end{aligned}
$$

When the bureaucrat is honest, the one-period payoff is $\pi$. When the bureaucrat is dishonest, the one-period payoff is $-c$ with probability $\frac{\nu}{2}$ (the probability that a short-run supplier $S$ is present and the long-run supplier is selected to report), 0 with probability $\frac{\nu}{2}$ (the probability that $S$ is present but $L_i$ is not selected to report) and $\pi$ with probability $1-\nu$. In the first two cases, the bureaucrat is removed (and so an honest bureaucrat will be present in the next period), and in the third case the (dishonest) bureaucrat will stay put.

In this context, if the designated supplier deviates and does not report, there will be no reporting anymore. As the bureaucrat revealed himself to be dishonest, the expected payoff from the next period onward will then be $V_u^D$, as obtained in Subsection 3.2. Thus, coordinated reporting in equilibrium requires:

$$
c \leq \delta \left( V_r^H - V_u^D \right). \tag{7}
$$

which yields the next proposition.

**Proposition 2.** *Suppose long-run firms compete in bidding. If $c \in (c_u, c_r]$, where:*

$$
c_r \equiv \pi\nu \frac{\delta}{1-\delta(1-\beta) - \frac{\nu\delta^2}{1-\delta(1-\nu)}\frac{\beta}{2}} > c_u, \tag{8}
$$

*there exist equilibria where long-run firms report corruption only if they coordinate on reporting.*

Proposition 2 may be viewed as giving formal content to Dixit's claim in the framework of our model. The threshold for the cost of reporting below which reporting is part of an equilibrium is higher under coordination: $c_r > c_u$. The additional term in the denominator of $c_r$, compared to $c_u$, reflects the new "asset" that reporting buys, when there is coordination. With probability $\nu\beta$ the honest bureaucrat goes rotten and a short-run player enters one period down the road, but one period later honesty is restored at no cost for the firm with probability 1/2, the probability that it is the other long-run supplier who is selected to report. The greater incentives to report steam from cost-sharing: the coordination involving the sharing of reporting costs, reduces the cost of reporting, alleviating free-riding.

# 4 Anti-Corruption Cartels

## 4.1 Equilibrium conditions

In this section, we investigate the incentives for firms to coordinate both in reporting and in bidding. Again, we shall confine ourselves to parameter values such that, in the absence of coordination, reporting cannot be part of an equilibrium, i.e., $c > c_u$. We refer to an agreement between suppliers to collude in bidding and coordinate in reporting corruption as an 'anti-corruption cartel'.

Collusion serves a purpose when both $L_1$ and $L_2$ draw high quality $q$, an event that occurs with probability $\frac{\mu^2}{2}$. We assume that when colluding in such an event, $L_1$ and $L_2$, toss a coin to choose the designed supplier who bids $q$ whereas the other supplier bids 0. The understanding among the long-run suppliers is that, in case any defection is detected, either in bidding or in reporting, they will stop coordinating on both reporting and bidding. We denote by

$$\pi' = \pi + \frac{\mu^2}{2} q,$$

a long-run firm $L_i$'s expected payoff in each period under collusion when the bureaucrat is honest or there is no short-run firm.

Let $V_c^D$ and $V_c^H$ denote $L_i$'s expected collusive equilibrium payoff, respectively when the bureaucrat is dishonest and when she is honest. In the latter case, the firm obtains the collusive profits $\pi'$ in the current period and anticipates that in the next period with probability $\beta$ the bureaucrat will turn dishonest and the firm will obtain $V_c^D$ whilst with probability $(1-\beta)$ the bureaucrat will remain honest and the firm will obtain $V_c^H$. Therefore:

$$V_c^H = \pi' + \delta \left[ \beta V_c^D + (1-\beta) V_c^H \right]. \tag{9}$$

When instead the bureaucrat is dishonest, the firm anticipates that it will have to incur the cost $c$ of reporting corruption with probability $\frac{1}{2}$ if the short-run firm $S$ is present. The bureaucrat will then be replaced and the firm will obtain $V_c^H$ from the next period onward. If there is no short-run firm $S$, the long-run firms will obtain collusive profits $\pi'$ today and $V_c^D$ from the next period onward. Therefore:

$$V_c^D = \nu(-\frac{c}{2} + \delta V_c^H) + (1-\nu)(\pi' + \delta V_c^D). \tag{10}$$

Deviations in reporting will not occur if:

$$c < \delta(V_c^H - V_u^D). \tag{11}$$

Note that the equations defining $V_c^D$ and $V_c^H$ are the same as the equations defining

$V_r^D$ and $V_r^H$ apart from replacing $\pi$ with $\pi'$. Moreover, we are assuming that $c > c_u$, so that the consequences of deviation in reporting are as in the competition case, i.e., reversion to competition without reporting. It follows that sustaining coordination in reporting when long-run suppliers also collude is feasible as long as:

$$c < \pi' \nu \frac{\delta}{1 - \delta(1-\beta) - \frac{\nu\delta^2}{1-\delta(1-\nu)} \frac{\beta}{2}} \equiv c_c. \tag{12}$$

Note that $c_c > c_r$: it is easier to sustain coordinated reporting when firms collude rather than compete. Moreover, when a long-run firm deviates from a collusive agreement (by undercutting the designated supplier), it obtains $q$ regardless of whether they coordinate in reporting or not. However, as one would expect and we show in the proof of the following proposition, $V_c^D > V_u^D$, and $V_c^H > V_u^H$, which implies that the future punishment from deviations in bidding is higher under coordination than under uncoordinated reporting. Thus, we obtain:

**Proposition 3.** *Coordination in reporting facilitates collusion. More importantly, collusion facilitates coordination in reporting, so that under collusion, reporting is an equilibrium outcome when* $c \in (c_u, c_c]$.

*Proof.* See the Appendix.

The mutual reinforcing between bid rigging and coordination in fighting corruption is reminiscent of the mutual reinforcing of collusion across markets with multi-market contact (e.g. Bernheim and Whinston (1990), Spagnolo (1999)). In both cases, punishments of deviations in one dimension are pooled with punishments of deviations in another. The mechanism at work here, however, has important peculiarities that considerably strengthen the effects of the joint agreement. First, the choices in the two dimensions are mutually exclusive: when coordination is required (a short-run supplier has won the contract), collusion is not active, and vice versa. This precludes gains from deviations to be 'summed' across dimensions by a simultaneous deviation. Second, collusion increases the rents from coordination (long-run suppliers obtain $\pi'$ instead of $\pi$ when the dishonest bureaucrat is replaced), and coordination bolsters collusion rents (reducing the probability of corruption by the short-run supplier). Thus, coordinating in both dimensions endogenously increases overall rents from cooperation summed across the two dimensions.

## 4.2 Buyer surplus

From the buyer's point of view, the best-case scenario in the presence of corruption is that long-run suppliers report bribery but do not collude. That would maximize the number of periods in which the buyer pays 0 for a project of value $q$. However, reporting may not be possible in the absence of collusion. As we have seen in the previous section, if $c \in (c_r, c_c]$, long-run suppliers cannot sustain coordination in reporting unless they collude. Then, a relevant question is whether collusion is a price the buyer might be willing to pay to avoid corruption. That is, which of the two "bads" is less so, corruption or collusion.

Let us begin with an honest bureaucrat (as in time 0). If firms do not collude and corruption goes unchecked, that is, under no reporting, the buyer's surplus, $W_u^H$, may be written as:

$$W_u^H = q\mu^2 + \delta\left(\beta W_u^D + (1-\beta)W_u^H\right), \tag{13}$$

where $W_u^D$ is the expected, discounted buyer's surplus when the bureaucrat is dishonest (and remains so forever), given by:

$$W_u^D = \frac{\nu(-q) + (1-\nu)\mu^2 q}{1-\delta}. \tag{14}$$

With probability $\nu$ the short-run supplier is present and if the bureaucrat is dishonest she is assigned the contract. In that case, the buyer pays $q$ for a project of value 0. When the short-run supplier is not present, then the buyer pays for what it gets except when both long-run firms have high quality $q$, in which case they drive the price to 0 for a project worth $q$.

Now suppose that long-run firms collude but report corruption. In that case, the buyer pays for what it gets except when the short-run supplier is present and the bureaucrat is dishonest. Once again, beginning with an honest bureaucrat, the buyer's surplus, $W_c^H$, may be written as:

$$W_c^H = \delta\left(\beta W_c^D + (1-\beta)W_c^H\right), \tag{15}$$

where $W_c^D$ is the expected discounted surplus when the bureaucrat is dishonest:

$$W_c^D = (1-\nu)\delta W_c^D + \nu\left(-q + \delta W_c^H\right). \tag{16}$$

Indeed, if the short-run supplier is not present, then the buyer pays for what it gets whether the bureaucrat is honest or dishonest. When the short-run supplier is present, the buyer pays a price of $q$ for a project worth 0 if the bureaucrat is dishonest, but the bureaucrat is removed and replaced by an honest bureaucrat in the following period. Substituting for $W_c^D$ in the previous equation, we obtain:

$$W_c^H = \frac{q}{1-\delta}\frac{-\delta\nu\beta}{1-\delta(1-\beta-\nu)}.$$

Comparing the buyer's surplus under collusion and reporting with the one under competition with unchecked corruption, we conclude:

**Proposition 4.** *An anti-corruption cartel, in which suppliers coordinate in reporting and collude in prices, increases buyer's surplus compared to a setting with no reporting and no collusion in bidding, when* $c \in (c_r, c_c]$*, and:*[8]

$$\frac{-\delta\nu\beta}{1-\delta(1-\beta-\nu)} \geq \mu^2 - \frac{\delta\nu\beta\left[1+\mu^2\right]}{1-\delta(1-\beta)}. \tag{17}$$

*Proof.* See the Appendix.

An anti-corruption cartel involves a trade-off. On the one hand, it increases buyer's surplus by inducing long-run suppliers to report corruption whenever it takes place. This ensures higher quality, as it enhances the probability that long-run suppliers win future tenders after the removal of the dishonest bureaucrats, and also lower prices, as it reduces the probability that a high price is paid for low quality. On the other hand, an anti-corruption cartel lowers buyer's surplus by permitting long-run suppliers to charge high prices for quality even in the presence of competition by other providers.

We may study some comparative statics on (17). For simplicity, let us consider the case of sufficiently large $\delta$, that is, a sufficiently patient buyer. In that case, (17) can be written as:

$$\frac{\beta+\nu-1}{\beta+\nu} \geq \mu^2 \frac{1-\nu}{\nu}.$$

As we should expect, whenever $\beta$ and $\nu$, the supply and demand sources of corruption, are low so that $\beta+\nu<1$, deterring corruption does not justify paying the cost of collusion. The larger $\beta+\nu$, the more likely the deterrence of corruption does justify paying that price. Also, for larger values of $\beta+\nu$, whenever competition is weak, that is, $\mu^2$ is small, corruption is a more serious concern than collusion, so that paying the price of collusion is justified, so long it keeps corruption in check. Finally, for a fixed value of $\beta+\nu$, the larger $\nu$ the more likely collusion is a price worth paying to fight corruption. In other words, although both are needed for corruption, corruption demand is a more serious issue than corruption supply. The intuition is simple: whatever the value of $\beta$, eventually (with a probability close to 1) the bureaucrat will turn out dishonest. For a sufficiently patient buyer, this scenario is then the one that matters. In that scenario, the loss from corruption depends exclusively on the demand side: the probability that a short-run supplier shows up. To summarize:

[8] The conditions are compatible. As an example, for $\delta$ sufficiently close to 1, they are satisfied when $\beta = 1/2$, $\nu = 3/4$, $\mu = 1/2$ and $\frac{c}{q} \in \left(\frac{6}{8}, \frac{9}{8}\right)$.

**Corollary 1.** *The scope for paying the price of collusion in order to fight corruption is greater the larger is the likelihood of corruption ($\beta$ large, $\nu$ large) and the smaller are gains from competition ($\mu$ small).*

# 5 Corruption and the sustainability of collusion

## 5.1 Corruption may facilitate collusion

Corruption by officials has long been recognized as an instrument that conspirators may use to sustain collusion, for instance by allowing bid rotation, or discipline deviating conspirators. We now study whether *the existence* of a corruption threat may render possible collusion by firms that are not engaged in bribery, but on the opposite, may be interested in protecting the market from bribery.

One might suspect that the erosion in (future, not present) rents that both bribery and fighting it represents for those conspirators may hinder, not help, collusion. In this section, we show that the truth is subtler. Although the erosion of future rents makes it harder to discipline colluding suppliers, the gains from coordinating in the fight against corruption may be leveraged by conspirators to reinforce that discipline. Moreover, the trade-off between these two opposing effects of the threat of corruption on the incentives to abide by coordination and collusion could resolve in both directions.

When dishonest deals are not a possibility, the condition for collusion to be sustainable is:

$$q \leq (\pi' - \pi)\frac{\delta}{1-\delta}. \tag{18}$$

This condition may be more or less restrictive than what is necessary for collusion to be sustained under the threat of corruption. Indeed,

**Proposition 5.** *The threat of corruption, and the gains from coordinating to fight that threat, make (perfect) collusion easier to sustain if and only if:*

$$\frac{\delta\nu\pi}{1-\delta(1-\beta)} - \frac{c}{2} = c_u - \frac{c}{2} > \pi' - \pi. \tag{19}$$

*Proof.* See Appendix.

The existence of a corruption threat facilitates collusion when the net gains from reporting corruption (once) are larger than the (per period) collusive rent. Otherwise, corruption hinders collusion. The rationale behind the proposition is, in fact, simple. The gain from deviating with or without the threat of corruption (conditional on the deviation being detected, i.e., on no short-run supplier being present), is the same and given by $q$.

When corruption is not a possibility, the per-period loss (beginning the following period) is $\pi' - \pi$. When corruption is a possibility, the per-period loss is the same, $\pi' - \pi$, whenever the bureaucrat is honest or no short-run supplier shows up. However, when the bureaucrat is dishonest and a short-run supplier shows up, then the loss is $\frac{\delta \pi \nu}{1-\delta(1-\beta)} - \frac{c}{2}$. The first term is the benefit from removing the dishonest bureaucrat (once), and the second term is the expected cost of that removal, when reporting is coordinated. That is, gains and losses are common with and without corruption, except when the bureaucrat is dishonest and a short-run supplier shows up. In that case, the loss incurred from a (previous) deviation is the left hand side of (19), whereas if corruption is not an issue the loss is always the right hand side of (19).

## 5.2 The dynamics of beliefs and "imperfect" collusion

The reader will have noticed the word "perfect" in the text of Proposition 5. To explain the meaning of that word we should notice that the model we have been discussing is not perfectly stationary. In particular, long-run suppliers' beliefs about the bureaucrat's honesty are not. They depend on the number of periods that the current bureaucrat has kept office with no short-run supplier showing up. Indeed, conditional on $t$ periods of a bureaucrat's tenure without any short-run supplier showing up, long-run suppliers' posterior assigns probability $(1-\beta)^t$ to the bureaucrat being honest.[9] In its turn, the beliefs about the honesty of the current bureaucrat affect a long-run supplier's assessment of gains and losses from a deviation in bidding.

We have been investigating conditions that support collusion (and reporting) in any node of the game tree: what we refer to when we talk about perfect collusion. However, the observation in the first paragraph points to two interesting, different but related points. First, for perfect collusion, the incentive constraints that need to be satisfied at different nodes of the tree may depend on the probability that long-run suppliers assign to the current bureaucrat being honest (their beliefs).

Indeed, when the bureaucrat is considered honest with probability 1 and the non-designated winner does not deviate, a supplier expects $V_c^H$ in the next period with the probability that the bureaucrat remains honest, $(1-\beta)$, and $V_c^D$ otherwise. Deviation by the non-designated winner (when both long-run suppliers have quality $q$) involves a short-term gain of $q$, but also a reversion to competition (and no reporting, if $c > c_u$) in

[9] If a short-run supplier shows up and one of the long-run suppliers wins the competition, long-run suppliers assign the bureaucrat a posterior probability of 1 of being honest. So, to all effects, the clock is set back to zero as if the bureaucrat had been replaced.

the next period. Therefore, perfect collusion requires

$$\delta\left[\beta V_c^D + (1-\beta)\, V_c^H\right] \geq q + \delta\left[\beta V_u^D + (1-\beta)\, V_u^H\right]. \tag{20}$$

Instead, when the bureaucrat is thought dishonest with probability (very close to) 1, no deviation requires:

$$\delta V_c^D \geq q + \delta V_u^D. \tag{21}$$

Indeed, not deviating means a zero profit today but an expected payoff of $V_c^D$ from next period on. Deviating means a profit $q$ today, but reverting to competition with no reporting (again, if $c > c_u$), and so an expected payoff $V_u^D$ from next period on. Of course, both gains and losses materialize with probability $(1-\nu)$, the probability that a short-run supplier does not show up.[10] Deviations (go undetected and) have no consequences in case a short-run supplier is present: the winner is the short-run player, and long-run suppliers will (flip a coin to decide who reports and) remove the dishonest bureaucrat. In that case, the agreement continues to hold whether a long-run supplier tried to steal the market or not.

Solving for $q$ in the two inequalities (20) and (21), we conclude that the latter is more restrictive than the former (i.e., sustainability under the most pessimistic beliefs about the bureaucrat's honesty implies sustainability under the most optimistic beliefs) if:

$$V_c^H - V_c^D \geq V_u^H - V_u^D,$$

and vice versa. The following Lemma states when this inequality holds.

**Lemma 1.** *When $c < c_c$, the largest incentives to deviate in bidding from an agreement, to both collude and coordinate in reporting, occur when the belief in the bureaucrat's honesty is maximum if and only if 19 holds.*

*Proof.* See the Appendix.

Thus, collusion is more difficult to sustain when the beliefs about the bureaucrat are the most pessimistic if and only if the threat of corruption does help collusion! The intuition for this result, and the coincidence between this trade-off and the one in Proposition 5, is in fact simple. Here as there, defection has consequences only if the bureaucrat is honest or if he is dishonest and there is no short-run player. Conditional on having consequences, here as there, the gain is the same, $q$, whether the bureaucrat is honest or

[10] Note that, whether the long-run suppliers observe the presence of the short-run supplier or not before their decision to bid (and so to deviate) is inmaterial: a deviation has effects, both in the award of the contract and on the future interaction between long-run suppliers, only if the short-run supplier is not present.

not. The cost is also the same in many cases: whenever the (today) honest bureaucrat turns dishonest, for instance, or when no short-run supplier shows up. Indeed, in all those cases, the loss from having deviated in the past is the loss of current collusion rents: $\pi' - \pi$. However, there is a probability that the cost of having defected is different in the two scenarios. That happens when the honest bureaucrat has stayed honest until the period, and a short-run supplier shows up. In that case, the loss (in the period) when the bureaucrat was (and still is) honest is again $\pi' - \pi$. However if the bureaucrat was (and still is, of course) dishonest, the cost is not having the benefits of reporting, computed in (4) as $\frac{\delta\nu\pi}{1-\delta(1-\beta)}$, for an expected cost of $c/2$. When (19) holds, that means that the (discounted, future, expected) loss from deviating today when the bureaucrat is dishonest is lower than when the bureaucrat is honest. Consequently, collusion is more difficult to sustain in the former case.

The second interesting point that our model raises is the possibility of "imperfect" collusion, in particular when (19) does not hold. In that case, as time elapses without a short-run supplier showing up, the incentives to deviate from collusion grow stronger. As such, it is possible that long-run suppliers would be willing to sustain collusion as long as their beliefs about the bureaucrat's honesty are not too pessimistic, but would default if these beliefs reach a low point.

Note that this opens the door to equilibria where long-run suppliers coordinate and collude for long periods, but abandon collusion with some probability: after a long series of periods in which no short-run player shows up. That is, after a long series of periods where corruption does not materialize! Needless to say, the expected, discounted equilibrium payoffs would be different from the ones we have computed for "perfect" collusion.

# 6 A puzzling correlation

Previous work has stressed complementarities between collusion and corruption in procurement (see references in footnote 3). These complementarities would generate a positive association between the two phenomena. The novel forces we highlight suggest that there may also be complementarities between collusion and the fight of 'predatory' government corruption. In situations where these forces play a dominant role, they might induce a negative relation between corruption and collusion.

In this section, we present suggestive evidence of a negative correlation across European countries between corruption and legal and illegal collusion. Such a negative relationship would be consistent with the hypothesis that the higher levels of industry cartelization present in northern European countries might have helped them in disciplining government corruption by limiting free-riding.

Cartels have been common, legal, and registered in several European countries until a few decades ago, when antitrust laws became more widespread and the EU antitrust law started to be implemented at national levels. The first modern European cartels emerged in the second half of the 19th century, most likely as a reaction to the 1870s economic downturn (Fear, 2006). They were legal entities performing a large number of functions typical of self-regulating industry associations and were particularly common in northern Europe.

Schröter (1996) argues that Germany's first-mover advantage in forming cartels in the second half of the 19th century provided a crucial learning experience for the building of international cartels. If 'cartel knowledge' is persistent and transferable, then it is natural to conjecture that countries with a history of legal cartelization are also likely to have a higher rate of illegal cartelization after Antitrust laws have been introduced in Europe.

Figure 1 shows that for a sample of European countries for which we could find information on legal cartels, a history of cartelization is significantly negatively correlated with corruption, as measured by the Corruption Perception Index (CPI) of Transparency International.[11]

Regarding current illegal cartels, we can proxy them with cartels and firms convicted by supranational enforcers, like the European Commission (EC) or the US Department of Justice (DoJ).[12] We had access to two databases on convicted cartels. The first one is on cartels convicted by the EC, from Marvão (2015). It starts from the first leniency reduction, granted in 1998, up to June 2020, and includes 161 cartels. The second is John Connor's "Private International Cartel" (2020) which includes all cartels convicted by the DoJ between 1990 and 2014, covering 146 cartels.

Figure 2 shows that, again, there is a significant negative correlation between corruption, as measured by the CPI, and the amount of fines paid by firms from each European country in recent cartel convictions (by the EC in the left panels, by the EC and the DoJ in the right ones). Fines are weighted by countries' average GDP (upper panels) or the average population (lower panels) in the period of observation.[13] This second correlation appears to confirm our conjecture on the persistence of 'cartel knowledge' linked to a history of legal cartelization.

These correlations are of course purely suggestive. But if confirmed by more thorough

[11]The CPI is a widely used corruption index based on experts' (e.g. businessmen and risk analysts) corruption perceptions that ranks almost 200 countries since 1995. We used the 2017 CPI but the results don't change using the average CPI of the period considered. The rankings are very stable over time.

[12]We can do this under the plausible assumption that cartels with firms from some combinations of European countries would be convicted with approximately the same probability than cartels composed of firms from other combinations of countries.

[13]We used the amount of cartel fines paid because they also capture the severity of cartels' infringements; Figure 3 in the Appendix shows that the results are qualitatively unchanged if we use instead the number of firms convicted for cartel participation.

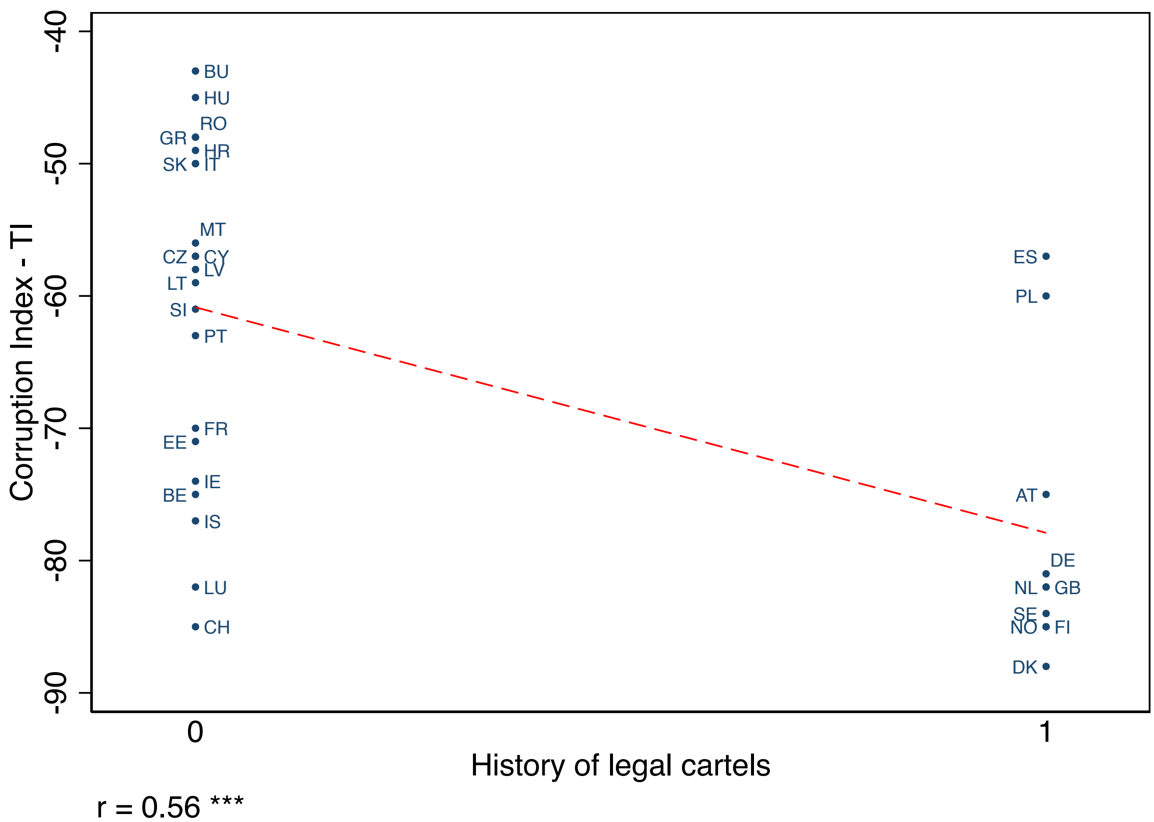


Figure 1: Correlation between corruption perception (TI) and history of legal cartels.
*Notes:* r stands for Pearson's correlation coefficient. The vertical axis shows the corruption perception index (CPI) and the variable in the horizontal axis is a dummy for a history of legal cartels. The red dashed line is the linear regression of the corruption index on history of legal cartels. *** p-value $< 0.001$, ** p-value $< 0.05$, * p-value $< 0.1$

empirical analysis, they would be puzzling in terms of previous knowledge, but consistent with the novel forces uncovered by our model.

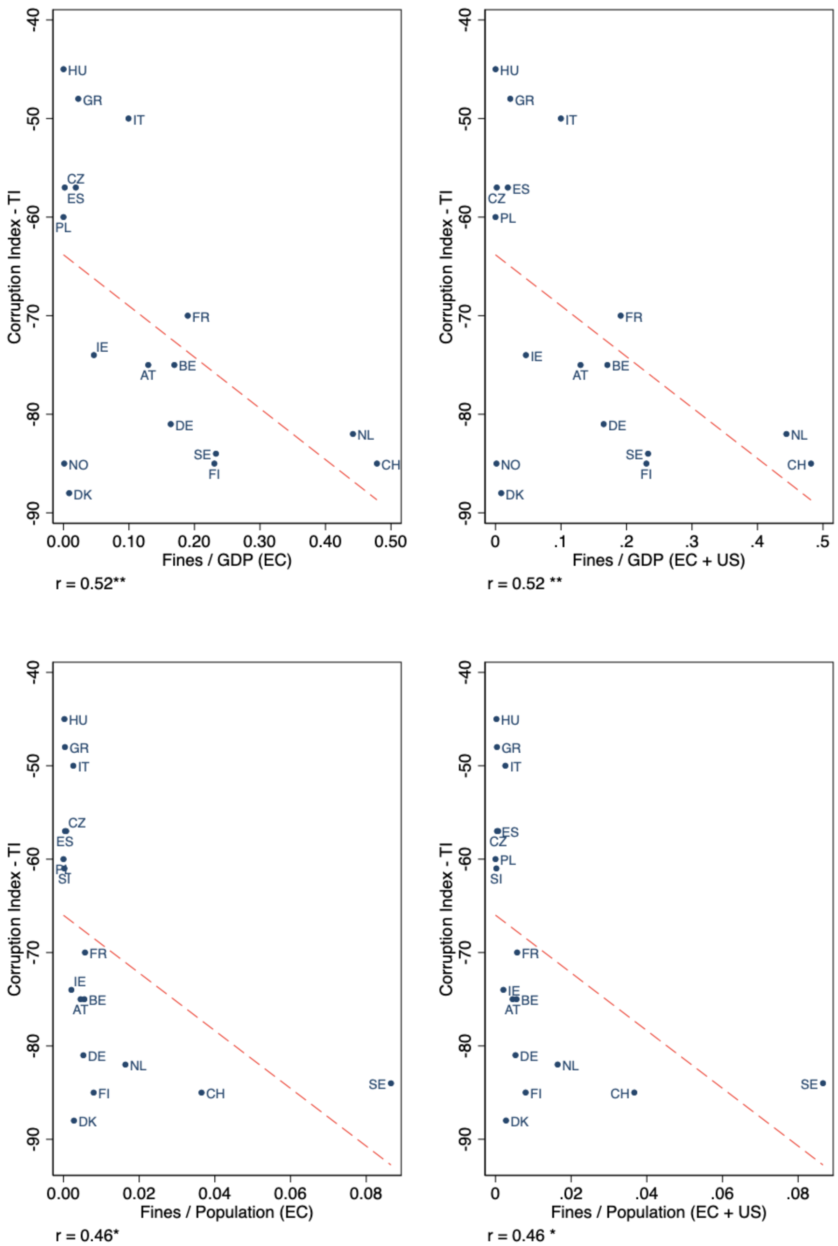


Figure 2: Correlation between corruption perception and cartel fines on firms of different nationality. *Notes:* r stands for Pearson's correlation coefficient. The vertical axis shows the corruption perception index (TI). The horizontal axes of the left panels show the amount of fines received in EU normalized for GDP (top panel) and population (bottom panel). The horizontal axis of the right panels shows the amount of fines received in EU and US normalized for GDP (top panel) and population (bottom panel). The red dashed line is the linear regression of the corruption index on the amount of fines. *** p-value $< 0.001$, ** p-value $< 0.05$, * p-value $< 0.1$

# 7 Conclusions

In a stylized model where a buyer repeatedly procures a good through a potentially corrupt agent who can overstate the quality offered by a 'hit-and-run' rogue supplier, we study the incentives of high quality long-run suppliers to report dishonest bureaucrats. As reporting is costly, suppliers face a free-riding problem. Cooperation among long-run suppliers taking turns to report alleviates this problem and results in increased reporting. Cooperation in reporting, however, facilitates enforcement of collusion in bidding, causing the latter to arise when it would not otherwise. In turn, the additional rents from bidding collusion increase long-run firms' losses from corrupt deals, facilitating cooperation on reporting corrupt bureaucrats.

From the buyer's point of view, this complementarity between bidding collusion and reporting corruption leads to a trade-off between the gains from fighting corruption and the cost of bid rigging. The scope for the buyer for paying the price of collusion to fight corruption is greater the larger is the likelihood of corruption and the smaller are gains from competition.

A number of issues have been left out of the analysis and could be addressed by future research. To keep the model simple, we have assumed that there are only two long-run suppliers competing for the contract. Generalizing the model in this dimension could help study the impact of increased competition. On the one hand, an increase in the number of long-run suppliers would allow reporting costs to be shared among more firms, raising the benefit of coordination. On the other hand, it would lower both the competitive and the collusive rents that firms enjoy absent corruption, thus reducing their gains from reporting it.

Similarly, we have also assumed that only the short-run firms are willing to corrupt, thus leaving out the question as to why a long-run firm does not try to bribe the official itself so as to obtain a monopoly rent. It could be interesting to relax this assumption and study the conditions under which in equilibrium the long-run firms could, but choose not to corrupt. Our model could also be used as a workhorse to study the effects of debarment, leniency, and other law enforcement policies when the risks of corruption and collusion are both taken into account. Finally, in future work it would be interesting to study how firms' incentives to produce high quality are affected by collusion and corruption.

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# 8 Appendix

## 8.1 Proof of Proposition 2

From (1) and (2) we obtain:

$$V_r^H = \frac{-\delta\beta\nu\frac{c}{2} + \pi\left[1-\delta(1-\nu)(1-\beta)\right]}{(1-\delta)(1-\delta(1-\beta-\nu))}, \tag{22}$$

$$V_r^D = \frac{-\nu\frac{c}{2} + (1-\nu)\pi}{1-\delta(1-\nu)} + \frac{\delta\nu}{1-\delta(1-\nu)}V_r^H. \tag{23}$$

Substituting for $V_u^H$ and $V_u^D$ in (3), we obtain condition (4).

## 8.2 Proof of Proposition 3

Recall that $V_c^H$ and $V_c^D$ are as $V_r^H$ and $V_r^D$ with only substituting $\pi'$ for $\pi$. Thus, using (22) and (23) , we have:

$$V_c^H = \frac{-\delta\beta\nu\frac{c}{2} + \pi'\left[1-\delta(1-\nu)(1-\beta)\right]}{(1-\delta)(1-\delta(1-\beta-\nu))}, \tag{24}$$

$$V_c^D = \frac{-\nu\frac{c}{2} + (1-\nu)\pi'}{1-\delta(1-\nu)} + \frac{\delta\nu}{1-\delta(1-\nu)}V_c^H. \tag{25}$$

Also, solving (2) and (1) for $V_u^H$, we obtain

$$V_u^H = \pi \frac{1-\delta(1-(1-\nu)\beta)}{(1-\delta)\left(1-\delta(1-\beta)\right)}.$$

Note that we can write

$$\begin{aligned}
& \pi' \frac{1-\delta(1-\nu)(1-\beta)}{(1-\delta(1-\beta-\nu))} - \pi \frac{1-\delta(1-(1-\nu)\beta)}{(1-\delta(1-\beta))} \\
= \;& (\pi'-\pi)\frac{1-\delta(1-(1-\nu)\beta)}{1-\delta(1-\beta)} + \pi' \left( \frac{1-\delta(1-\nu)(1-\beta)}{1-\delta(1-\beta-\nu)} - \frac{1-\delta(1-(1-\nu)\beta)}{1-\delta(1-\beta)} \right).
\end{aligned}$$

The first term is positive. The second is

$$\begin{aligned}
& \pi' \left( \frac{1-\delta(1-\nu)(1-\beta)}{1-\delta(1-\beta-\nu)} - \frac{1-\delta(1-(1-\nu)\beta)}{1-\delta(1-\beta)} \right) \\
= \;& \pi' \left( \frac{-\delta\nu\beta}{1-\delta(1-\beta-\nu)} + \frac{\delta\nu\beta}{1-\delta(1-\beta)} \right) \\
= \;& \delta\nu\beta\pi' \frac{-\left(1-\delta(1-\beta)\right)+1-\delta(1-\beta-\nu)}{\left(1-\delta(1-\beta-\nu)\right)\left(1-\delta(1-\beta)\right)} \\
= \;& \delta\nu\beta\pi' \frac{\delta\nu}{\left(1-\delta(1-\beta-\nu)\right)\left(1-\delta(1-\beta)\right)}.
\end{aligned}$$

Thus, $V_c^H > V_u^H$ if this is larger than the first (negative) term in $V_c^H$ multiplied by $(1-\delta)$,

$$\frac{\delta\beta\nu\frac{c}{2}}{1-\delta(1-\beta-\nu)}$$

when $c < c_c$. That is, when:

$$\pi' \frac{\delta\nu}{1-\delta(1-\beta)} > \frac{c}{2}. \tag{26}$$

A sufficient condition is that:

$$\pi' \frac{\delta\nu}{1-\delta(1-\beta)} > \frac{c_c}{2}$$

that is,

$$\frac{1}{2} < \frac{1-\delta(1-\beta) - \frac{\nu\delta^2}{1-\delta(1-\nu)}\frac{\beta}{2}}{1-\delta(1-\beta)} = 1 - \frac{\frac{\nu\delta^2}{1-\delta(1-\nu)}\frac{\beta}{2}}{1-\delta(1-\beta)}.$$

That is,

$$\frac{1}{2} > \frac{\frac{\nu\delta^2}{1-\delta(1-\nu)}\frac{\beta}{2}}{1-\delta(1-\beta)},$$

or

$$\begin{aligned} & (1-\delta(1-\beta))\,(1-\delta(1-\nu)) - \nu\delta^2\beta \\ = \; & 1-\delta(1-\beta)-\delta(1-\nu)+\delta^2(1-\beta-\nu) \\ = \; & 1-\delta(1-\nu)-\delta(1-\beta(1-\delta)) > 0. \end{aligned}$$

Note that the left-hand side is increasing in $\beta$, and so attains the lowest value when $\beta = 0$, at which value it is

$$(1-\delta)(1-\delta(1-\nu)) > 0.$$

On the other hand, from (2) and (1)

$$\begin{aligned} V_u^D &= V_u^H - \frac{\pi\nu}{1-\delta(1-\beta)} \\ &= \frac{\delta\nu}{1-\delta(1-\nu)}V_u^H + V_u^H\left(1-\frac{\delta\nu}{1-\delta(1-\nu)}\right) - \frac{\pi\nu}{1-\delta(1-\beta)} \\ &= \frac{\delta\nu}{1-\delta(1-\nu)}V_u^H + V_u^H\left(\frac{1-\delta}{1-\delta(1-\nu)}\right) - \frac{\pi\nu}{1-\delta(1-\beta)} \end{aligned}$$

whereas, from (2),

$$V_c^D = \frac{-\nu\frac{c}{2}+(1-\nu)\pi'}{1-\delta(1-\nu)} + \frac{\delta\nu}{1-\delta(1-\nu)}V_c^H.$$

Thus, since $V_c^H > V_u^H$, a sufficient condition for $V_c^D > V_u^D$ is that

$$\begin{aligned} \frac{-\nu\frac{c}{2}+(1-\nu)\pi'}{1-\delta(1-\nu)} &> V_u^H\left(\frac{1-\delta}{1-\delta(1-\nu)}\right) - \frac{\pi\nu}{1-\delta(1-\beta)} \\ &= \pi\frac{1-\delta(1-(1-\nu)\beta)}{(1-\delta)\,(1-\delta(1-\beta))}\frac{1-\delta}{1-\delta(1-\nu)} - \pi\frac{\nu}{1-\delta(1-\beta)}. \end{aligned}$$

Note that the right-hand side is increasing in $\pi$, and so it is smaller than

$$\begin{aligned} & \pi'\frac{1-\delta(1-(1-\nu)\beta)}{(1-\delta)\,(1-\delta(1-\beta))}\frac{1-\delta}{1-\delta(1-\nu)} - \pi'\frac{\nu}{1-\delta(1-\beta)} \\ = \; & \frac{\pi'}{1-\delta(1-\nu)}\left(1-\frac{\delta\nu\beta}{(1-\delta(1-\beta))}\right) - \pi'\frac{\nu}{1-\delta(1-\beta)} \\ = \; & \frac{\pi'(1-\nu)}{1-\delta(1-\nu)} - \frac{\pi'}{1-\delta(1-\nu)}\frac{\delta\nu\beta}{(1-\delta(1-\beta))} \end{aligned}$$

Thus, and again since $\pi' > \pi$, a sufficient condition for$V_c^D > V_u^D$ is that

$$-\frac{\pi'}{1-\delta(1-\nu)}\frac{\delta\nu\beta}{(1-\delta(1-\beta))} < \frac{-\nu\frac{c}{2}}{1-\delta(1-\nu)},$$

that is,

$$\frac{\delta\beta\pi'}{1-\delta(1-\beta)} > \frac{c}{2},$$

which is (26), which we have argued is satisfied when $c < c_c$. The result follows.

## 8.3 Proof of Proposition 4

Substituting for $W_u^D$ in the expression for $W_u^H$ (expression 13) and solving for $W_u^H$, we obtain:

$$W_u^H = \frac{q}{1-\delta}\left[\mu^2 - \frac{\delta\beta\nu\left[1+\mu^2\right]}{1-\delta(1-\beta)}\right].$$

Substituting for $W_c^D$ in the expression for $W_c^H$ (expression 15) , we obtain

$$W_c^H = \frac{q}{1-\delta}\frac{-\delta\nu\beta}{1-\delta(1-\beta-\nu)}.$$

Comparing $W_u^H$ with $W_c^H$, we obtain the condition in the proposition.

## 8.4 Proof of Proposition 5

Suppose that (19) holds. Then, for collusion to be (fully) sustainable, $V_c^D - V_u^D > (\pi' - \pi)\frac{1}{1-\delta}$. In the proof of Proposition 3 we have computed

$$\begin{aligned} V_c^H &= \frac{-\delta\beta\nu\frac{c}{2} + \pi'\left[1-\delta(1-\nu)(1-\beta)\right]}{(1-\delta)(1-\delta(1-\beta-\nu))} \\ &= \frac{1}{1-\delta}\left(-\delta\beta\nu\left(\frac{c}{2}+\pi'\right)\frac{1}{1-\delta(1-\beta-\nu)} + \pi'\right), \end{aligned} \tag{27}$$

and substituting in (16), we have

$$V_c^D = \frac{1}{1-\delta}\left(\pi' - \nu\frac{(\delta\beta + (1-\delta))\left(\frac{c}{2}+\pi'\right)}{1-\delta(1-\beta-\nu)}\right).$$

Also, as before $V_u^D$,

$$V_u^D = \pi\frac{1-\nu}{1-\delta}.$$

Therefore,

$$\begin{aligned} V_c^D - V_u^D &= \frac{1}{1-\delta}\left(\pi' - \nu\frac{(\delta\beta + (1-\delta))\left(\frac{c}{2}+\pi'\right)}{1-\delta(1-\beta-\nu)}\right) - \pi\frac{1-\nu}{1-\delta} \\ &= \frac{1}{1-\delta}(\pi'-\pi) - \frac{\nu}{(1-\delta)(1-\delta(1-\beta-\nu))}\left((1-\delta(1-\beta))\left(\frac{c}{2}+\pi'-\pi\right) - \delta\nu\pi\right), \end{aligned} \tag{28}$$

and so

$$\begin{aligned} & V_c^D - V_u^D - (\pi'-\pi)\frac{1}{1-\delta} \\ = \quad & -\frac{\nu}{(1-\delta)(1-\delta(1-\beta-\nu))}\left((1-\delta(1-\beta))\left(\frac{c}{2}+\pi'-\pi\right) - \delta\nu\pi\right). \end{aligned}$$

Thus, $V_c^D - V_c^D > (\pi'-\pi)\frac{1}{1-\delta}$ if and only if

$$\pi\delta\nu - (1-\delta(1-\beta))\left(\frac{c}{2}+\pi'-\pi\right) > 0. \tag{29}$$

Condition (29) is exactly (19), and so is satisfied when (19) is satisfied. Thus whenever (19) is not satisfied, collusion is easier to sustain in the absence of the threat of corruption. When (19) is satisfied, 1 will show that collusion (with coordination) can be sustained for all beliefs about the honesty of the bureaucrat when it can be sustained for the most pessimistic. Thus, when (19) is satisfied, (perfect) collusion is easier to satisfied under the threat fo corruption.

## 8.5 Proof of Lemma 1

From (25) and (24), we obtain

$$V_c^H - V_c^D = \nu\frac{\frac{c}{2}+\pi'}{1-\delta(1-\beta-\nu)}.$$

Therefore, coordination in bidding is more difficult to sustain when the bureaucrat is dishonest with probability one if and only if:

$$V_c^H - V_c^D = \nu\frac{\frac{c}{2}+\pi'}{1-\delta(1-\beta-\nu)} \geq V_u^H - V_u^D = \frac{\pi\nu}{1-\delta(1-\beta)},$$

that is, if and only if

$$\begin{aligned} c &\geq 2\frac{\pi\left(1-\delta(1-\beta-\nu)\right)-\pi'\left(1-\delta(1-\beta)\right)}{(1-\delta(1-\beta))} \\ &= -2\left(\pi'-\pi-\frac{\delta\nu\pi}{1-\delta(1-\beta)}\right)=2(c_u-(\pi'-\pi)), \end{aligned}$$

which holds if and only if (19) is violated.