Cartels and Bribes (VERY PRELIMINARY)

Roberto Burguet* Elisabetta Iossa† Giancarlo Spagnolo‡

January 15, 2019

Abstract

We study the relationhip between collusion and corruption in a model where a buyer must repeatedly procure a good through a potentially corrupt agent that can overstate quality by a poor producer in exchange for a bribe. High quality suppliers can observe and report the corruption, causing the agent to be replaced, but reporting is costly, and the agent may turn corrupt again in time. Competing suppliers are stuck in a free-riding problem. As trade associations in Dixit (2015a,b), a cartel between high quality suppliers facilitates reporting by allowing to share its cost (coordination effect). The higher cartel profits further increase the incentives to report corruption (rents effect). Gains from fighting corruption may however make cartels viable even when they would not be otherwise (corruption-driven cartels). The results offer a novel perspective on the relation between collusion and corruption, appear consistent with the low level of corruption observed in countries with a tradition of extensive legal cartelization, and add another reason why governments should fight corruption.

1 Introduction

Cartels and corruption are widspread problems in many countries, but the relationship between the two is not yet fully understood, nor is taken into account by policy makers.[1] The phenomenons co-exist often in public procurement markets, where a frequently observed case is that of a corrupt public servant collaborating with a bidding ring among suppliers, e.g. favoring in various ways ring members against non-members or new entrants, or helping members to enforce the agreed collusive strategies, etc. A first strand of important economic analyses has therefore focussed on understanding the micro-mechanisms behind these complementarities between collusion and corruption.[2]

*Uniersity of Central Florida

†University of Rome, Tor Vergata

‡University of Rome Tor Vergata and SITE - Stockholm School of Economics

[1] See Burguet et al. (2018) for a recent survey, and Luz and Spagnolo (2017) for an in depth discussion how policy sistematically fails to take their interaction into account.

[2] See in particular the work of Lambert-Mogiliansky and co-authors.

In this paper we dig further on the relations between the two phenomenons by taking a completely orthogonal perspective, one focussing on the free rider problems competing private agents may face when fighting corrupt bureaucracies, and on how suppliers' cartels may affect this problem. Our starting point are a couple of recent papers by Avinash Dixit (2015a,b) stressing that self-enforcing coalitions of private sector actors, like more or less formal trade/business associations, may play a crucial role in the fight of corrupt bureaucracies/states (and organized crime), because they are in the position to overcome problems of coordination and free-riding typical of these situations. Resisting and reporting extortionary requests from corrupt bureaucracies (or organized crime) can be extremely costly for an individual business, as the reported corrupt actor may be able to retaliate imposing large costs on the reporting firm. If corruption is widespread in the bureaucracy, even if the reported bureaucrat is replaced, it can try to exclude the reporting firms from future purchases replacing it with competitors; the mafia can set an example for everyone at low cost by punishing that single resisting firm very heavily. This generates a free rider problem in resisting and reporting, as each firm prefers to save retaliation costs and enjoy a competitive advantage having its competitors reporting. However, when hundreds of businesses create a coalition that, together and simultaneously, resists and denounces the predatory behavior of corrupt bureaucrats or criminal organizations, as it happened for some time with the *Addiopizzo* movement in Sicily, where businessess that did not participate to the 'resistance' were also ostracised, the cost of resisting and reporting can be shared and for the individual firm may fall dramaticaly.[3]

Dixit suggests that trade associations could take the lead in generating and maintaining/enforcing this kind of coordinated behavior.[4] But much like trade associations and other more innocent forms of firms coalitions, cartels have the ability and – in fact – as main objective that of coordinating their members' choices on a number of competitive dimensions and to reduce internal free-riding. This ability is normally utilized by cartels to curb competition. Indeed, trade associations are very often found to be directly involved in forming and maintaining non-competitive cartel agreements between their members on prices, quotas and other competitive variables, and have been fined heavily for that.[5] But the same coordination and enforcement power is also available to

[3] The ability of the predatory agent to retaliate may be severely limited: the mafia cannot react destroying all businesses in the area, as it would undermine its own ability to extract income from society in the future and risk a general political and popular backlash; the corrupt bureaucracy cannot exclude all the firms in the market, because it does need the supply in the first place.

[4] The cooperative agreements among firms that Dixit envisage resembles that of Maghribi traders in the work of Greif, but also more standard business associations or labor unions. Business associations are indeed there to solve the collective action problems of the firms involved in the industry. It is entirely possible that a strong association of firms might be able to overcome collective action problems and coordinate a joint effort to limit appropriation by predatory corrupt bureaucracies. However, it is also possible that a strong business associations starts coordinating other forms of collective action problems, for example competitive pricing.

[5] There are uncountable examples where trade association initiated, facilitated or run legal

defend the cartel profits from the predatory behavior of corrupt bureaucracies and organized crime.

To analyze the relationhip between collusion and corruption from this novel perspective, we study 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 producer in exchange for a bribe. High-quality, long-term 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, and the corrupt bureaucracy can retaliate. We also assume that a replacement agent, initially honest, may turn corrupt with time. We show that competing suppliers face indeed a free riding problem, and that the higher future rents expected by joining a cartel increase the incentives to report the corrupt bureaucrat (rents effect). We further show that – as trade associations in Dixit (2015a,b) – a cartel between long-term, high-quality suppliers may further facilitate reporting by enforcing cooperative reporting and allowing to share its cost among suppliers (coordination effect). Our third main result is that these gains from fighting corruption may make cartels viable even when they would not have been sustainable in the absence of corruption (corruption-driven cartels). This final result suggests another important reason why governments, if able to, should invest resources in fighting corruption rather than delegating to the private sector: preventing cartelization.

It is worth noting that cartels have been common, legal, and registered in many countries until a few decades ago, when US-style antitrust laws became more widspread and started to be enforced. This happened in particular in northern European countries, and the reason is that they were considered effective instruments of industrial governance, in particular after the great depression, generally regarded as a consequence of unreliable 'wildly' free markets. Trade associations were then often hard to distinguish from the registered cartel active in the specific industry. Therefore, legal or illegal, it is plausible that cartels may have played the same role as trade associations in terms of governing the industry, coordinating individual firms' behavior and enforcing common rules, whether to curb competition or to fight corruption. Conjecturing that collusive behavior tends to be persistent in terms of norms and habits, it is suggestive to note that for a sample of European countries for which we could find data, the most often used measures of effecttive or percived corruption are strongly and negatively correlated with the presence and extent of legal cartelization in the country's recent past (see Tables 1 and 2).

The paper unfolds as follows. In the next section, we present the model. Section 3 studies the incentives to report corruption in the absence of collusion. Section 4 presents the effect of higher rents accruing from collusion on the incentives to report, and also the effect on these incentives of the pure coordi-

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 thousends firms, for almost two decades. Levine et al. (2018) to ask whether one can spot any real difference between cartels and trade associations.

nation in reporting. Section 5 investigates the opposite causality, that is, how the threat of bribery may provide the incentives that firms may otherwise lack for collusion. The paper closes with a section on conclusions.

2 Model

2.1 Preliminaries

We consider a procurement problem where a buyer needs to contract a (different) service or acquire a (different) good in each period with an infinite horizon. Two long run firms, L_1 and L_2, may deliver the good or service in each period. The specifications vary. As a consequence, firm L_i is able to deliver quality $q_i^t \in \{0, q\}$, $i = 1, 2$ in period t. The probability that $q_i^t = q$ is μ, and these random variables are independent across i and t.[6] This is common knowledge. In addition, 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. All agents discount the future at a common rate δ.

In each period, there is a probability ν that a short term supplier, S^t is also available –only at period t– who could also deliver with quality $q_s^t = 0$. (This needs not being observed by firms L_1 and L_2 before contracting.) We also assume that all costs of production are zero.

The buyer (e.g., a public administration) uses an agent, the bureaucrat, to select the supplier and instructs her to do so by asking for bids in each period and using the scoring rule $\bar{q} - \bar{p}$. That is, by selecting the offer that results in the highest net surplus.

2.2 Honest agency

When the bureaucrat is honest, she asks for bids (p, q) by firms L_1, L_2, and S^t, if present, and selects the one with highest score. The supplier selected delivers the good or service, the bureaucrat inspects the quality of the delivered good (at no cost and perfectly), and approves the payment p included in the supplier's bid. We assume that delivering lower quality means no payment and perhaps a large penalty, so that this is never an option when the bureaucrat is honest.

2.3 Dishonest agency

If the bureaucrat is dishonest, then she accepts bribes, when offered. For the time being we assume that only the short term supplier S^t may consider –and in fact will try to– paying a bribe. A bribe (of fixed size, b, irrelevant for the time being) buys misrepresentation of quality by the bureaucrat, and so the declaration of S^t as the winner for period t, at some price larger than b. The corrupt deal can be detected and documented –with probability ρ which we

[6] Alternatively, q is the size of a opportunity cost reduction (due, for instance, to low portfolio of clients in the period) that a firm may experience in every given period.

assume equal to 1– and reported by both firms L_1 and L_2. Reporting bribery is costly (retaliation, documentation, etc., which for the time being we treat in reduced form) for the reporting firm. Thus, we assume that the cost of doing so is c. When reported, the bureaucrat is removed and a new bureaucrat is put in charge of selecting winners in the future. No other consequences for either S^t or the bureaucrat are considered here.

2.4 Bureaucrat population

Bureaucrats are honest when first hired. However, in every period of their tenure, they will have a probability β of turning dishonest.[7] Whether that has happened or not is not observed, and so could only be inferred from behavior. Honest bureaucrats implement the instructions whether they are offered bribes or not. Dishonest bureaucrats will always take a bribe, if offered.

2.5 Timing

The timing of the game in each period t is as follows. First, firms submit bids (and bribes, in case S^t is present). The bureaucrat determines the winner. That is, if the bureaucrat is honest or S^t is not present, (one of) the highest-score bids is accepted. The good is delivered and the winner obtains the payment. If S^t is present and the bureaucrat is dishonest, then S^t is selected as the winner. (Bribes are paid, and S^t receives the payment p. For the time being, we assume that firm L_i, $i = 1, 2$, cannot bribe.) If so, (with probability $\rho = 1$ bribery could be documented and) each firm L_1 and L_2 simultaneously decides whether to report or not. If one of them reports, then the bureaucrat is removed and replaced. Each reporting firm incurs a cost c, but the contract is not reassigned in the period.

3 Competition

Suppose $\beta = 0$ and firms "compete." Here, as usual, this means that they play an (subgame-perfect) equilibrium that simply reproduces the short-run equilibrium in each period. Then firm L_i will make profits q in period t with probability $\mu(1-\mu)$. That is, the probability that it has high quality and the other long term firm has low quality, in which case it bids (q, q) and wins.[8] (In that equilibrium, both the other long term firm and S^t, if present , bid $(0, 0)$.) Let $\pi = \mu(1-\mu)q$, i.e., the per-period, expected profits when no bribery exists.

[7] We should interpret this as an exogenous probability of stepping down and being replaced by a dishonest bureaucrat. The two models, with possibility of exogenous replacement and with the possibility of honesty turning dishonesty, are homomorphic except that the latter does not allow for dishonest bureaucrats to be exogenously removed. The implications of the two models are the same.

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

The present value of this stream of profits is therefore

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

Now, suppose that $\beta > 0$. We look for subgame perfect equilibria in Markov strategies that, in particular, represent competition. That is, strategies that reproduce the strategy discussed before whenever no short term (or no bribery) is present.

First, we check whether an equilibrium where one of the long term firms always reports exists. That is, an equilibrium in pure strategies were one of the long term firms reports and the other does not.

3.1 Best case for reporting

Let us investigate the existence of an equilibrium where firm L_1 always reports the occurrence of bribes (when detected), and firm L_2 never does. We will show that no (pure strategy, Markov) equilibrium with reporting exists if this equilibrium does not exist. First let us compute the payoffs for firm L_1 if it never reports and conjectures that firm L_2 will never report either. For this case, let us denote by V^H the (expected, discounted) payoff for firm L_1 computed from a period when the bureaucrat is honest and by V^D these payoffs when the bureaucrat is dishonest. Then, V^H and V^D are the solutions to

$$\begin{aligned} V^H &= \pi + \delta(\beta V^D + (1-\beta)V^H), \qquad (1) \\ V^D &= \pi\frac{1-\nu}{1-\delta}. \end{aligned}$$

Solving for V^H we get

$$V^H = \frac{\pi}{1-\delta}[1 - \delta\frac{\nu(1-\beta)}{1-\delta\beta}]$$

Under these conjectures, firm L_1 has no incentive to report (once) if

$$c > \delta(V^H - V^D),$$

which substituting from above results in

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

Thus, if this inequality is satisfied, a firm does not have incentives to play a strategy that requires reporting, given that the other player plays the strategy of not reporting. The following proposition shows that no pure strategy equilibrium with reporting then exists.

Proposition 1 *Under (2), there is no pure strategy equilibrium with competition and reporting.*

Proof. Note that, in any equilibrium, the payoffs of a firm when the bureaucrat is dishonest cannot be smaller than $\pi\frac{1-\nu}{1-\delta}$, as these payoffs can always be guaranteed (if the other firm plays stationary, undominated strategies). On the other hand, using the first line of (1)

$$\begin{aligned} V^H - V^D = \quad & \pi + \delta(\beta V^D + (1-\beta)V^H) - V^D \\ & \pi + \delta(1-\beta)(V^H - V^D) - V^D(1-\delta), \end{aligned}$$

which implies that $V^H - V^D$ is decreasing in V^D. Thus, in any potential equilibrium, the incentives of one firm to report a bribery occurrence are even lower than in our extreme candidate equilibrium with only firm L_1 reporting. ■

4 Collusion, Rents and Coordination

We now begin by analyzing the simplest possible equilibrium with reporting when the two L firms collude. It follows closely the potential equilibrium discussed above, in the sense that only one firm is supposed to report. The second simplification (constraint imposed on the set of equilibria that we discuss) is that we will concentrate on collusion only in bidding, and not on reporting. That is, we will assume that L firms will resort back to competition only if one deviates by winning when it is its turn not to do so. However, deviations in reporting/not reporting corruption will not affect bidding collusion. As should be apparent, this time we are not studying the collusive agreement most conducive to reporting. Thus, the conditions obtained here for existence of equilibrium with collusion and reporting are stronger than necessary. That is, they are sufficient but not necessary. We analyze this case first for simplicity.

Also, collusion here means that each firm acts as without collusion, except that in every period that both L_1 and L_2 draw high quality q they flip a coin that decides who bids q and who bids 0, so that the winner still makes q profits (thus, with probability $\frac{\mu^2}{2}$).

Consider first the decision to report by firm L_1 once bribery has taken place and been detected, under the assumption that collusion will survive both under dishonest and honest bureaucrats. Let

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

This is the (expected, before drawing quality and flipping the coin) payoff per period under collusion (when the agent is honest). Note that other than substituting π' for π in (2), the condition for firm L_1 to (not) have incentives to report is the same as in that equation. Indeed, the expressions for the expected, discounted payoffs under honest and dishonest bureaucrat are as in (1) with only this change.

However, collusion (and reporting) is sustainable if, conditional on (in this case) L_1 reporting when a bribe is detected, no L firm has incentive to deviate

in bidding. The incentives to deviate in bidding are highest for firm L_1 (as it has less long run, collusive profits due to reporting costs) and when the coin has selected L_2 as the winner and both firms have high quality. (Whether S^t is present or not is immaterial, since bidding deviations are only detected if S^t is not present or the bureaucrat is honest.

There is an additional point, however, having to do with some lack of –belief– stationarity in this game. As time evolves with no short run players arriving, the belief on the honesty of the bureaucrat changes.

Indeed, after t' periods of no short run player appearance, the posterior belief that the bureaucrat is honest in the next period is $(1-\beta)^{t'}$. That converges to 0 as t' grows, which diminish the continuation value of sticking to the collusive aggreament in the period. Thus, the highest incentives for deviation occur when $t' \to \infty$. Although this event has lower and lower probability ($(1-\nu)^{t'}$), if we are interested in perfect collusion, we need to guarantee no incentive to deviation even when the players' posterio s that the bureaucrat is dishonest with probability 1.

Of course, this is the worst case scenario for collusion sustained with corruption. Yet, as we will see, collusion is also possible in this scenario.

Indeed, the following proposition gives sufficient (again, not nearly necessary) conditions for this.

Proposition 2 *(Rents effect) When (2) is satisfied, collusion and reporting (by firm L_1 with probability 1) are equilibrium outcomes, even in the absence of coordination in reporting, if $c \leq \pi' \nu \frac{\delta}{1-\delta\beta}$ ($> \pi\nu\frac{\delta}{1-\delta\beta}$) and*

$$\delta > \frac{1}{1+\mu^2(1-\nu)/2}. \tag{3}$$

Proof. As t', the number of periods without a short lived firm appearing, grows large, the continuation value for firm L_1 of not defecting (conditional on a short run firm not being present in this period either) is larger than

$$\delta\pi' \frac{1-\nu}{1-\delta}.$$

Indeed, firm L_1 may always stop reporting, in which case, that is the payoff. When both firm L_1 and L_2 have high quality and firm L_1 is not chosen to be the winner, deviating (and bidding just below q) conditional on the short run firm not being present this period is

$$q + \delta\pi \frac{1-\nu}{1-\delta}.$$

$$
\begin{aligned}
\delta\pi'\frac{1-\nu}{1-\delta} &> q+\delta\pi\frac{1-\nu}{1-\delta},\\
\delta\left(\pi+\frac{q}{2}\mu^2\right)\frac{(1-\nu)}{(1-\delta)} &> q+\delta\pi\frac{1-\nu}{1-\delta},\\
\delta\left(\pi+\frac{q}{2}\mu^2\right)(1-\nu) &> q(1-\delta)+\delta\pi(1-\nu),\\
\delta\frac{q}{2}\mu^2(1-\nu) &> q(1-\delta),\\
\frac{\delta\mu^2}{2}(1-\nu)+\delta &> 1,\\
\delta &> \frac{1}{1+\mu^2(1-\nu)/2}.
\end{aligned}
$$

Indeed, the deviation will trigger competition, and in that case reporting will not be in the interest of firm L_1, since (2) is satisfied. To ensure that this is a non empty set of parameters we can re-write (2) as

$$
\begin{aligned}
c &> \pi\nu\frac{\delta}{1-\delta\beta}\\
c &> \delta\beta+\pi\nu\delta\\
\delta &< \frac{c}{\pi\nu+\beta}
\end{aligned}
$$

and verify that

$$
\begin{aligned}
\frac{1}{1+\mu^2(1-\nu)/2} &< \delta < \frac{c}{\pi\nu+\beta}\\
&\text{or}\\
\frac{c}{\mu(1-\mu)q\nu+\beta} &> \frac{1}{1+\mu^2(1-\nu)/2}
\end{aligned}
$$

can be satisfied. This proofs the result. ■

This result assumed no coordination in reporting, and it is therefore entirely driven by the higher rents the cartel produces, making it worthwhile to unilaterally invest/incur the cost of reporting when it was not worthwhile with competition. Therefore we named it 'rents effect', and it is a completely different channel than make collusion potentially a tool to fight corrupton than the one highlighted by Dixit.

Dixit's point was instead about coordination. He argued that trade associations could coordinate the cost of fighting corruption (or mafia) across honest businesses, enforcing reporting behavior through exclusion, thereby reducing/sharing the burden and avoid free riding. We may investigate these, more conducive to reporting equilibria that require coordination in reporting. As mentioned, cartels have many features in common with trade associations, and may enforce reporting rules with the threat of price wars or exclusion. In that case, with collusion firms would be able to enforce coordinated behavior

in reporting corrupt bureaucrats, making it a feature of the equilibrium even if $c > \pi\nu\frac{\delta}{1-\delta\beta}$. Indeed, we can state the following proposition, the proof of which is a simple corollary of the proof of Proposition 2.

Proposition 3 *(Coordination effect). Even when (2) is satisfied, and provided that (3) is also satisfied, there are parameter values (in particular, low values of β and sufficiently low ratio of c to q) such that collusion and coordination in reporting are equilibrium outcomes.*

Proof. The strategies supporting this collude and report equilibrium would prescribe incumbents to always collude, to report the buyer if she accepts a bribe (she is dishonest and an entrant appears), and to revert to competition and no reporting forever if an incumbent fails to apply this rule.

As before, when both firm L_1 and L_2 have high quality and firm L_1 is not chosen to be the winner, deviating (and bidding just below q) conditional on the short run firm not being present this period is dominated if (3) is satisfied. Indeed, the deviation will trigger competition, and in that case reporting will not be in the interest of firm L_1, since (2) is satisfied.

Consider now the incentive to deviate by not reporting when the buyer is dishonest, the entrant showed up and the bribe is observed. Note that $c > \pi\nu\frac{\delta}{1-\delta\beta}$ can be written as $\frac{c}{q} > (1-\mu)\,\mu\nu\frac{\delta}{1-\delta\beta}$ which for small values of β approaches $\frac{c}{q} > (1-\mu)\,\mu\nu\delta$. Thus, there are alues of the parameters for which (2) is satisfied yet $c < q$. For these values, deviating and not reporting when the firm is selected to report a bribe is not profitable if

$$c < \delta\left(V^H - \pi\frac{1-\nu}{1-\delta}\right),$$

where V^H is the discounted, expected payoffs when the bureaucrat is honest and cooperation and collusion is played by both L firms. Note that, as discussed in the proof of Proposition 2, $V^H > \delta\pi'\frac{1-\nu}{1-\delta}$, and so, the right hand side of the inequality above is larger than q, and so if $q > c$ and (3) is satisfied, that inequality is also satisfied. ■

5 Fighting corruption may induce collusion

Thus, we have established that collusion may give incentives for L firms to report on corrupt officials, and so to keep corruption to a minimum. We show now that the direction of the causality may be reversed. That is, it may be that the threat of corruption allows L firms to sustain collusion when otherwise collusion could not be sustained.

For collusion to be non sustainable in the absence of corruption, it must be that when $\beta = 0$ firms have incentives to deviate. That is,

$$q + \delta\frac{\pi}{1-\delta} > \delta\frac{\pi'}{1-\delta},$$

(the two sides represent the gain from deviating and sticking to the collusive agreement, respectively, when it is a firm's turn to loose to the other firm and both have high quality). Substituting for π and π', this inequality could be written as

$$1 + \delta \frac{\mu(1-\mu)}{1-\delta} > \delta \frac{\mu(1-\mu) + \mu^2/2}{1-\delta},$$

that is,

$$\delta < \frac{1}{1+\mu^2/2}.$$

5.1 No collusion with only retaliation against bidding deviations: a digression

Note that the above inequality never holds if (3) holds. Indeed, if a firm (L_1, in that case) does not have incentives to deviate in bidding and lose all future rewards even when these future rewards only accrue when S^t is not present, then it does not have incentives to deviate when the future rewards accrue with certainty.

But remember that (3) is far from necessary. Indeed, the condition guarantees that an effort to prevent corruption is profitable when: i) the effort is unilateral; ii) the agent is corrupt with probability 1; and iii) there will be no future effort to remove the agent by the other L firm. i) and iii) are not necessary for equilibrium even if we are interested in collusion that will survive the most pessimistic beliefs with respect to the bureaucrat (ii)). However, even if we consider more conducive arrangements, collusion will be unsustainable if only deviations in bidding prompt retaliation.

Indeed, consider the incentives to collude assuming that firms decide to report corruption by flipping a coin, and that they expect the corruption to be, indeed, reported in the future, *independent of whether they are competing or colluding*. Importantly, we are going to keep assuming that firms will not punish deviations in reporting. That is, reporting must be self-sustained.[9]

Under the conjecture that both firms will abide by the reporting rule, the payoff for a firm that does not deviate in bidding expecting the other to do likewise, and conjecturing that the bureaucrat is dishonest, V^D, is

$$V^D = \nu \left[-\frac{c}{2} + \delta V^H \right] + (1-\nu) \left[\pi' + \delta V^D \right], \tag{4}$$

where V^H is the payoff when the bureaucrat is honest,

$$V^H = \pi' + \delta\beta V^D + \delta(1-\beta) V^H. \tag{5}$$

[9] In the notation that will be introduced below,

$$c < V^H - V^D.$$

Letting $\Delta = V^H - V^D$, (4) may be written as

$$V^D(1-\delta) = \pi' - \nu\left(\frac{c}{2} + \pi'\right) + \delta\nu\Delta, \tag{6}$$

and (5) as

$$V^H(1-\delta) = \pi' - \delta\beta\Delta,$$

and substracting the first from the second, and solving for Δ, we obtain

$$\Delta = \nu\frac{\frac{c}{2} + \pi'}{1-\delta(1-(\nu+\beta))}.$$

Thus, (6) results in

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

and

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

Defection in bidding when it is the firm's turn not to win, (and then conjecturing that reporting will still carry on, but the L firms will resort back to competition) implies a payoff

$$(1-\nu)\left(q + \delta\widetilde{V}^D\right) + \nu\left(-\frac{c}{2} + \delta V^H\right),$$

where $\widetilde{V}^D$ is the same expression as V^D except that π substitutes π'. (Again, we are assuming that deviations may be detected, only when S^t is not present. Also, we are considering only one-shot deviation, so that if deviations are not detected due to the presence of S^t, collusion continues. This is sufficient.)

Not defecting when it is the firm's turn to lose implies a payoff of

$$(1-\nu)\delta V^D + \nu\left(-\frac{c}{2} + \delta V^H\right).$$

Thus, for collusion to be sustainable when reporting is expected with or without collusion, we need

$$q < \delta\left(V^D - \widetilde{V}^D\right).$$

Note that

$$V^D - \widetilde{V}^D = \frac{1}{1-\delta}(\pi' - \pi)(1-\nu)\frac{1-\delta(1-\beta)}{1-\delta(1-(\nu+\beta))} \tag{7}$$

Therefore the condition is,

$$q < \frac{\delta}{1-\delta}(\pi' - \pi)(1-\nu)\frac{1-\delta(1-\beta)}{1-\delta(1-(\nu+\beta))}$$

Reacalling that $\pi' - \pi = q\frac{\mu^2}{2}$, this is

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

This inequality never holds, if $\delta < \frac{1}{1+\mu^2/2}$: when $\nu = 0$, it is the same condition (with opposite direction), and as ν gets larger, the right hand side of the previous equation goes down. So this is a proof that without coordinating punishments (if collusion breaks, then no reporting, which is equilibrium if there are no unilateral incentives to report) we don't have that the threat of collusion sustains collusion. The intuition is that corruption taxes both collusive and competitive payoffs proportionally, hence the value of collusion falls more than the value of competition (the punishment phase).

5.2 Corruption sustains collusion with retaliation against

Now, suppose instead that in case there is a defection in bidding, then L firms stop cooperating both in reporting and in bidding. That is, a (detected) deviation will trigger competition and unopposed bribing for ever more. In case of no defection in bidding, the payoff is still given by (4). On the other hand, defecting when it is the firm's turn to lose means a payoff of

$$(1-\nu)\left(q + \delta\widehat{V}^D\right) + \nu\left(-\frac{c}{2} + \delta V^H\right),$$

where

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

Thus, no defection requires

$$q < \delta\left(V^D - \widehat{V}^D\right)$$

Let $R = \frac{1-\delta(1-\beta)}{1-\delta(1-(\nu+\beta))}$. We can obtain first,

$$\begin{aligned}\widetilde{V}^D - \widehat{V}^D &= \frac{1}{1-\delta}\left[\pi - \nu\left(\frac{c}{2} + \pi\right)R - (1-\nu)\pi\right] \\ &= \frac{\nu R}{(1-\delta)}\left[\frac{\pi\delta\nu}{1-\delta(1-\beta)} - \frac{c}{2}\right].\end{aligned}$$

Since $V^D - \widehat{V}^D = V^D - \widetilde{V}^D + (\widetilde{V}^D - \widehat{V}^D)$, this is the additional punishment that results from defecting due to the other firm L stopping cooperating in reporting. Using (7) and $\pi' - \pi = q\frac{\mu^2}{2}$,

$$V^D - \widehat{V}^D = \frac{R}{1-\delta}\left[\frac{\pi\delta\nu^2}{1-\delta(1-\beta)} + \left[(1-\nu)q\mu^2 - \nu c\right]\frac{1}{2}\right].$$

Thus, the condition for no deviation in bidding is that

$$q < \frac{\delta R}{1-\delta}\left[\frac{\pi\delta\nu^2}{1-\delta(1-\beta)} + \left[(1-\nu)q\mu^2 - \nu c\right]\frac{1}{2}\right]. \tag{8}$$

When $\nu \to 0$, now the condition converges to $\delta \geq \frac{1}{1+\frac{\mu^2}{2}}$ again, but the right hand side of (8) is not necessarily decreasing in ν.

Define δ^{CR} as the infimum of the set of δ such that (8) is satisfied. Also, let $\delta^{NC} = \frac{1}{1+\mu^2/2}$, that is, the minimum discount factor at which collusion could be supported in the absence of corruption.

Proposition 4 *There exist parameter values such that $\delta^{CR} < \delta^{NC}$. Moreover, this is so for large values of ν and small values of β.*

Proof. Proof: From (8) with equality, we obtain that δ^{CR} is a root of the quadratic equation $0 = A\delta^2 + B\delta + C$, where

$$\begin{aligned}
A &= (1-\beta)\left(\nu\frac{c}{2q} - (1-\nu)\frac{\mu^2}{2}\right) + (1-\mu)\mu\nu^2 - (1-(\nu+\beta)), \\
B &= 2-(\nu+\beta) + (1-\nu)\frac{\mu^2}{2} - \nu\frac{c}{2q}, \\
C &= -1
\end{aligned}$$

As $\beta \to 0$, and we let $\frac{c}{q} = (1-\mu)\mu\nu\frac{\delta}{1-\delta\beta}$, the minimum value at which there is no incentives to unilaterally report (so that the expressions we use for payoffs are the correct ones), the quadratic expression converges to $0 = D'\delta^3 + A'\delta^2 + B'\delta + C'$, where

$$\begin{aligned}
D' &= (1-\mu)\mu\nu^2\frac{1}{2} \\
A' &= (1-\mu)\mu\nu^2\frac{1}{2} - (1-\nu)\left(1+\frac{\mu^2}{2}\right), \\
B' &= 1 + (1-\nu)\left(1+\frac{\mu^2}{2}\right), \\
C' &= -1.
\end{aligned}$$

Evaluating the expression $D'\delta^3 + A'\delta^2 + B'\delta + C'$ at $\delta = \delta^{NC}$, we obtain

$$(1-\mu)\mu\nu^2\frac{1}{2}\left(\delta^{NC}\right)^2\left(1+\delta^{NC}\right) - \nu\left(1-\delta^{NC}\right).$$

Note that δ^{NC} is independent of ν. As $\nu \to 1$, the expression approaches

$$\begin{aligned}
&(1-\mu)\mu\frac{1}{2}\left(\delta^{NC}\right)^2\left(1+\delta^{NC}\right) - \left(1-\delta^{NC}\right) \\
= \;& (1-\mu)\mu\frac{2(4+\mu^2)}{(2+\mu^2)^3} - \frac{\mu^2}{2+\mu^2},
\end{aligned}$$

which is positive (for $\mu > 0$) if

$$2\left(1-\mu\right)\left(4+\mu^2\right)-\mu\left(2+\mu^2\right)^2>0.$$

We may write this inequation as

$$\Phi = 2\left(1-\mu\right)\left(2+u\right)-\mu u^2>0,$$

where $u = 2+\mu^2$, so that $\mu = (u-2)^{\frac{1}{2}}$. Note that

$$\begin{aligned}\frac{d\Phi}{du} &= 2\left(1-\mu\right)-2\mu u-\frac{d\mu}{du}\left(2(2+u)+u^2\right)\\ &= 2-\left[2\mu(1+u)+\frac{d\mu}{du}\left(4+2u+u^2\right)\right],\end{aligned}$$

and $\frac{d\mu}{du} = \frac{1}{2\mu}$ in $(0,1)$. For $\mu < 1/2$, $\frac{d\mu}{du} > 1$, and so the expression is negative, since the seconde term in the square bracket is larger than 4. Also, for $\mu \geq 1/2$ the expression is negative since $2\mu(1+u) > 1+u = 3+\mu^2 > 3$. Thus, in $(0,1)$, Φ is decreasing. Moreover, at $\mu = 0$, $\Phi = 8$, and at $\mu = 1$, $\Phi = -9$. Thus, there is $\mu^* \in (0,1)$ such that $\Phi = 0$ when evaluated at μ^*. For smaller values, $\Phi > 0$, and the result follows. In fact, using Mathematica, we can compute $\mu^* = .608$. ■

6 Conclusion

Cartels and bribes are unfortunately common features of public procurement, though the relationship between cartels and bribery, or collusion and corruption, is still not fully understood. There is no good evidence nor a sistematic theoretical analysis of the various way in which the two phenomena can interact, although considerale advancements has been done in the analysis of complementarities beween the phenomenons in procurement, on which there is also considerable case-study evidence.

Since previous work has already extensively analized the strong and evident complementarities between the two phenomenons in procurement, here we adopt an completely orthogonal viewpoint, stressed in particular by Dixit (2015a,b), that of free rider problems and the need of coordination in private agents' incentives to fight of corruption.

In a stylized model where a buyer must repeatedly procure a good through a potentially corrupt agent that can overstate the quality offered by a 'hit-and-run' rougue producer in exchange for a bribe. High quality long-term suppliers can observe and report this corruption, thereby causing the agent to be replaced, but at a cost, and the replaced agent initially honest may turn corrupt with time. We show that competing suppliers face indeed a free riding problem in reporting that the higher future rents expected by cartel members may alleviate (rents effect). We further show that - as trade associations in Dixit (2015a,b)

- a cartel between long-term high quality suppliers may further help by enforcing coordinated reporting and thereby allowing to share corruption-reporting costs among suppliers (coordination effect). Finally, we find that these gains from fighting corruption may make cartels viable even when they would not have been so in the absence of corruption (corruption-driven cartels). This final result suggest a new impoortant reasons why governments, if able to, should invest resources in fighting corruption rather than delegating to the private sector: preventing private sector cartelization. The result could offer one possible explanation (certainly non-exclusive) why the extent of legal cartelization in the past decades in european countries is so strongly negatively correlated to most commonly used measures of perceived and observed coorruption.

7 References

References

[1] Burguet, R., Ganuza J. and J. García-Montalvo, (2018), 'The Microeconomics of Corruption', in *Handbook of Game Theory and Industrial Organization*, L. Corchón and A. Marini (eds.), Elgar.

[2] Dixit, A., (2015a), "Corruption: Supply-side and demand-side solutions." In Development in India: Micro and Macro Perspectives, eds. S. Mahendra Dev and P.G. Babu, Springer, pp. 57-68.

[3] Dixit, A. (2015b), "How Business Community Institutions Can Help Fight Corruption." World Bank Economic Review, 29 (suppl 1): S25-S47."

[4] Lambert-Mogiliansky, A., (2011), "Corruption and Collusion in Procurement - strategic complements," published in the *International Handbook on the Economics of Corruption*, Ed. S. Rose-Ackerman and Tina Soreide, pp. 108-141...

[5] Lambert-Mogiliansky, A., Sonin K., (2006), "Collusive Market-Sharing and Corruption in Procurement," *Journal of Economics & Management Strategy*, Vol 15/4, 883-908.

[6] Lambert-Mogiliansky, A., Compte O., Verdier T., (2015), "Competition and Corruption in Procurement", *Rand Journal of Economics*.

[7] Levine, D.K., Mattozzi, A. and S. Modica, (2018), "Trade Associations: Why not Cartels," manuscript, European University Institute.

[8] Luz, R. D. and G. Spagnolo, (2017), "Leniency, Collusion, Corruption and Whistleblowing," *Journal of Competition Law & Economics*, Vol. 13, Issue 4, Pages 729–766.

[9] Superti, C., (2009), "Addiopizzo: Can a Label Defeat the Mafia?" *Journal of International Policy Solutions,* 11, 3-11.