WORKING PAPER

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Prevention and detection in bribery-affected public procurement

Claudio Weber Abramo[1]

Transparência Brasil

crwa@uol.com.br

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Summary

Three factors dominate the outcome of a tender in public procurement: 1) The amount of the penalties those found guilty of corruption are subjected to; 2) The efficiency of control and enforcement mechanisms; 3) The intrinsic vulnerability of the system. A fourth factor, the (prior) probability of a participant cleanly winning a contract, plays no role in the decision to bribe or not to bribe. In environments where regulations are lax and controls do not function, cleanly participating in tenders is irrational. Restricting the study to unit prices in markets for standard goods and services, an increase in one single firm's propensity to bribe induces the same behaviour upon the others ("bad apple effect"), and therefore the likelihood of firms to bribe tends to uniformity. Competition unsettles the equilibrium, so that, ceteris paribus, the overall likelihood of bribing tends to a maximum determined by the control mechanisms. The factors affecting the expectation of public officials are the same, with the added feature that usually public officials have no rewards for not taking bribes. For both participants and agents, simple methods to empirically determine parameters and to evaluate whether or not bribery probably prevails in a given market are suggested. The vulnerability stemming from the formal regulations directly influence the likelihood of bribing, while the efficiency of controls can be fed-back into that likelihood. The system's tendency to deteriorate points to policy strategies aimed at continuously perfecting the regulations and the control mechanisms. There are two basic mechanisms whereby tenders are biased: by unlawful acts and by lawful manipulation of conditions. While evidence as to the occurrence of the former is relatively easy to obtain, hard evidence of bribery associated to the latter can only arise from discovering secret exchanges of money, which in turn requires expensive investigation techniques. On that basis it is argued that continuously acting on the regulations to diminish the opportunities for manipulation of conditions has a more profound effect on the overall efficiency of the system, including but beyond control of corruption, than striving to enhance detection.

Keywords: Control, corruption, public procurement, regulation.

JEL classification numbers: D44, D84, H57, K23.

1 Decision factors in tenders

A tender in public procurement is an event whereby a State organism (the "principal") calls for offers from private firms ("participants") to furnish goods or services. Auctions (as in privatizations) also fall in the category of procuring. A surrogate for the principal (the "agent") conducts the process and awards the ensuing contract. A set of rules defines the conditions under which interested parties are allowed to participate and how the agent reaches the decision about the winner. These rules are enforceable within a certain administrative boundary – usually a whole country, but sometimes regional and/or municipal subdivisions, as well as publicly owned companies, have some latitude in defining specific rules. In some countries, there are no national regulations and each organism conducts procurement following its own rules. International financing institutions establish rules for procurement conducted with their money. International communities, as the European Union, likewise bind member countries to uniform regulations for procurement involving amounts above certain thresholds.

Responsibility for enforcing the regulations fall on the agents, and ideally interested parties can interpose objections according to some administrative procedure that is specified in the regulations. In some environments, members of the public can do likewise. Recourse to the Judiciary to contest administrative decisions is in principle possible, but of course there are countries where exercising the right to contest is difficult or impossible in practice.

Being the primary interface between the public and private sectors, public procurement is particularly vulnerable to distortions aimed at favouring particular suppliers. Public officials use the rules to restrict the participation of interested firms and direct the outcome to someone. One can safely say that in virtually all cases such intervention happens in return for a bribe.

Bribery in public procurement can begin, and it often does, before the procurement itself takes place: A supplier pays a bribe to a high-placed official, often elected, to include a (not necessarily needed) project in the appropriate budget. From there on, the dice are

loaded and the briber gets the contract. After a tender is concluded and the corresponding contract is signed, it comes the execution phase. Again, this is potentially affected by distortions whereby in return for a bribe those responsible for overseeing the execution turn a blind eye to partial or non-performance. A common scheme to bias purchases is to over-specify the more expensive components of a project, which are undercosted by the pre-arranged winner. The latter gets the contract, because his price was less than the competitors'. During execution, the contractor furnishes cheaper but still safe and performing components (they were intentionally over-specified, after all), oversight ignores the deviation from specifications, the firm pockets the difference and pays a kickback to the official.

By-products of bribery in procurement are overpricing, substandard goods and services, unfinished projects, unnecessary works and many other waste-generating effects. This is immediately harmful to public interest. Competition among firms is replaced by a stratified system of cartelised groups arranged by size and specialties.[2] Partitioning of markets and price-fixing are stimulated. Firms become prisoners of a pecking order and forced to play a game in which big players hold the trumps. Sectors subjected to such market distortions cannot evolve healthfully. Innovation and personnel training are stifled, because cost-saving efforts cannot compete with unfair advantages given to others. Concentration limits the creation of jobs. Therefore, corruption in procurement harms competition.[3]

What about the converse? It is usually held[4] that one remedy against corruption is to enhance competition, but it must be registered that recent research points to possible qualifications to this. Celentani and Ganuza (2002) contend that the relationship between competition and corruption is ambiguous. They model a situation where a government

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[2] Besides these general remarks, this note will not address cartel-related collusion.

[3] See e.g. Mauro (1995 and 1998), Tanzi and Davoodi (1998), Søreide (2002).

[4] As Rose-Ackerman (1996, 1999) and others.

agency procures a non-homogeneous good that can be produced according to different levels of quality, the decision mechanism being dependent both on price and quality. They show that an increase in competition can lead both to lower and to higher corruption, in the latter case because the purchasing agent is able to manipulate the assessment of "quality" to bias the tender. More broadly, a positive relationship between competition and economic efficiency is partially challenged by Hong and Shum (2002). Studying the dynamics leading to equilibrium in certain types of tenders, they find that the average procurement cost for the principal strictly increases with the number of participants, and corroborate the finding with data from the New Jersey (US) Department of Transportation. However, the effect is only observed in some types of contracts, not all. Studying certain models of auctions, Compte and Jehiel (2002) find that although more competition lead to better welfare in symmetric auctions (all bidders share the same information), the opposite happens in asymmetric auctions: The introduction of one additional participant holding information the others do not share lowers the welfare.

In this note we will look at the process after the decision to launch a project was taken. We will refer to the "tender" as the whole mechanism beginning with the announcement that the principal will take offers from firms (bids) to conduct the project and ending with the signing of the contract between the winner firm and the principal. Execution will not be addressed.

Tenders can be modelled as a two- or more-participant game affected by a number of decision factors. Players can participate not using expedients aimed at directing the outcome for themselves (that is, cleanly), or they can bribe to win. In a clean tender, the decision is automatically reached on the the basis of the lower offered price, or involves a public agent's decision (based on considerations of "quality" arising from participants' offers), or some combination of these. As prices are objectively comparable but "quality" is not, the third type of decision process conflates into the second. These biddings are especially prone to rigging, due to the discretionary power exercised by the agent. See Burguet and Che (2002) for a modelling exhibiting the diseconomies ensuing from this type of procurement: Participants are stimulated to pay bribes in order to win, the cost of

procurement rises and the efficient participants more likely lose. Although the vulnerability of "quality" assessments is amply recognised, this method of evaluating bids is admissible in many legal environments. In particular, the guidelines of International Financing Institutions as the World Bank do not prohibit its use. Those guidelines supersede national legislations when projects are financed by IFIs, making the corresponding outcomes more prone to corruption in countries where judgements on "quality" are not admitted.

Here we will consider tenders in which the decision is a mix of price and other variables, including a "quality" evaluation. The joint distribution of these variables translates for each participant into a certain probability of winning. The factors that determine the outcome of a tender are, in principle:

The probability of a bidder winning a clean tender.

The likelihood of participants deciding to bribe.

The penalties applicable to firms found guilty of bribery. We will only consider measurable penalties, thus leaving out "moral" ones.[5]

The probability of bribers being caught, arising from the efficiency of the control mechanisms in place.

The mathematical treatment will remain at the elementary level.

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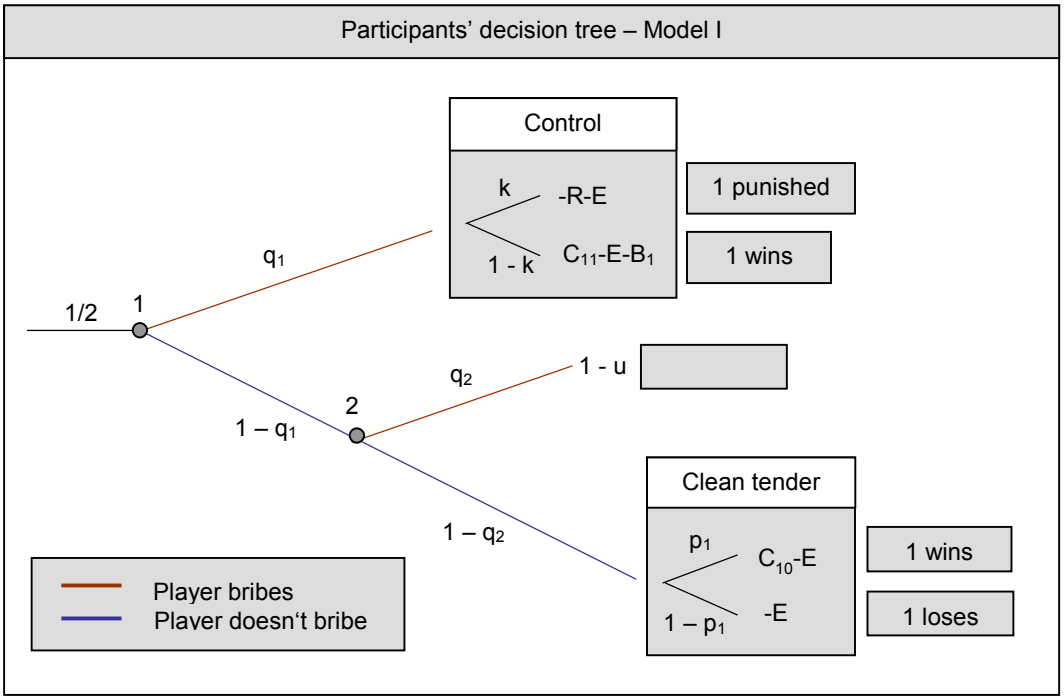
[5] As e.g. in Klitgaard (1991), Chapter 3, in reference to the factors influencing agents' decisions. It must be pointed out that the treatment in this source, as in others that consider moral penalties, is only metaphorical. Besides the problems of quantifying morals, observe that including a moral penalty raises the matter as to corresponding advantages possibly to be included among the rewards of cleanly winning a contract. Also, completeness would require examining moral awards stemming from bribery.

2 A decision model

Using the elements just listed, the decision tree governing an two-participant (**1** and **2**) bidder's game is the following. The game starts by selecting at random one participant to be the first to play. The branches inside the boxes do not belong to the decision tree proper, representing the alternatives that are not subjected to the players' will, leading to the outcomes. We will refer to this model as "Model I".



Player **1** has probability ½ of being the first to play. If **1** bribes, then **2** cannot bribe. Player **2** can only bribe if **1** plays cleanly. If **2** is the first to play, the tree is the same, swapping **1** and **2**. The various components have the following meanings:

- p_1 The probability of Player **1** winning the contract in open bidding (so that the probability of **2** winning is $p_2 = 1 - p_1$);
- u The systemic likelihood of bribing (the percentage of all contracts in the market in question that are biased);
- q_j The likelihood of player j bribing, depending on the probability of bribery occurring in that market (u), on the number of participants and on factors

peculiar to each j; if q_1, $q_2 \neq 1$, these likelihoods obey to $1 - u = (1 - q_1)(1 - q_2)$;

C_{j0} The value of the contract awarded to Bidder j if he is the winner in the absence of bribes;

C_{j1} The value of the contract won with a bribe B_j (and associated diseconomies) by Bidder j; we will consider an overprice in excess of the bribe, so that $C_{j1} - B_j > C_{j0}$;

E The regular expenses incurred in participating (excluding bribes; for simplicity, defined as the same for both participants and normalized to 0 in the sequel);

B_j The amount paid by j as a bribe;

R The penalty paid if a briber is caught red-handed; for simplicity, the same for both participants;

k The probability of a briber being caught given that the tender was rigged.

Now, if Bidder **1** decides to bribe, then he wins the contract, pays the bribe back and discounts the expenses. Bidder **2** is just a bystander. Because **1** bribed, he incurs in the risk of paying the penalty R with probability k. If Bidder **1** decides not to bribe, then it is Bidder **2**'s turn to play. He can decide either to bribe or not to bribe. If he does bribe, he gets the contract under the same conditions just stated. If **2** decides not to bribe, then the tender is openly contested and the contract goes to **1** with probability p_1 or to **2** with probability $1 - p_1$. Whatever the case, players pay the amount corresponding to the expenses to participate.

Choosing the best strategy for playing the game depends on the vulnerability of the tender (the probability u), on the risk of being caught in bribery (the penalty R and the probability k) and on the probability of cleanly winning the contract. Suppose that the conditions are lax. Suppose also that there are penalties (of whatever size), but that the likelihood of a briber being caught is small. Bidder **1** evaluates that if he bribes, the contract would be his with small risk of incurring in penalties. He also reasons that if he refrains from bribing, then the opponent will evaluate the situation similarly, so his decision would be to bribe. Therefore, in order not to be duped, **1**'s decision again would be in favour of

bribing. If **2** knows that **1** did not bribe, then he holds all the trumps. Observe that for either participant, the probability of cleanly winning the contract does not play a role in the reasoning. Such is the situation in corrupted environments.

If the opportunities to bribe (u) are few and the likelihood of being penalised for bribery (k) is high, then it would be better to take one's chances in the open bidding process. And for this one must enhance one's own probability of offering the lower price and/or other conditions in order to win (by cutting costs, developing better production processes etc.). If everybody does that continuously over time, prices fall down (and the law of diminishing returns takes hold). Of course, if the opportunities to attempt bribery are few, then on average bidders will decide to bribe less often. If, furthermore, bribes are often detected when practiced, then the risk grows and the rational justification to bribe loses weight.

The situation can be seen in the probabilities. From the decision tree, and taking into account that **1** can either be the first or the second to play, it follows that the probabilities for the outcomes are ($q_1, q_2 \in (0,1)$):

P(**1** wins cleanly) = $p_1(1 - u)$

P(**1** wins with a bribe and is not caught) = $\frac{1}{2}q_1(1 - k) + \frac{1}{2}q_1(1 - q_2)(1 - k) =$
$= (q_1 - \frac{1}{2}q_1 q_2)(1 - k)$

P(**1** bribes and is punished) = $(q_1 - \frac{1}{2}q_1 q_2)k$

Thus, for the random variable X_1 = "outcome for Bidder **1**", and remembering that the expenses E were normalized to 0, the expectation $E(X_1)$ is

$$E(X_1) = (q_1 - \tfrac{1}{2}q_1 q_2)[(1 - k)(C_{11} - B_1) - kR] + p_1 (1 - u)C_{10}. \qquad (\mathbf{2.1})$$

Generalising to n players, the game begins with a random selection of an ordered sequence of play. Participants have probabilities $\{p_j \mid j = 1\ldots n;\ \Sigma p_j = 1\}$ of winning in open tender and $\Theta = \{q_j \mid j = 1\ldots n;\ q_j \in (0,1)\}$ of bribing if the opportunity arises. Let $\overline{\Theta} = \{(1 - q_j) | q_j \in \Theta\}$ and $\overline{\Theta}_j = \overline{\Theta} - \{(1 - q_j)\}$. For each pair (i,j), let $\prod_i^j = \{\gamma : I_i \to \overline{\Theta}_j\}$. The probabilities are

$$1 - u = \prod_{j=1}^{n} (1 - q_j) \,. \qquad (\mathbf{2.2})$$

P(j wins cleanly) = $p_j\,(1 - u)$

P(j wins with a bribe and is not caught) = $\frac{1}{n!} q_j \sum_{i=0}^{n-1} \prod_{i}^{\wedge j} (1 - q_i)(1 - k)$

P(j bribes and is punished) = $\frac{1}{n!} q_j \sum_{i=0}^{n-1} \prod_{i}^{\wedge j} (1 - q_i)k$

where the products $\prod_{i}^{\wedge j}$ span $\prod_{i}^{j}$.

Other telling probability is:

$$\text{P}(j \text{ loses} \mid j \text{ did not bribe}) = 1 - p_j \prod_{i \neq j} (1 - q_i) \,, \qquad (\mathbf{2.3})$$

Eqs. (**2.2**) and (**2.3**) furnish didactic information on the tendency of bribery spreading and becoming pervasive. Take, for example, a market with five participants, all with a similar propensity to bribe of, say, 10%. Then, the likelihood of tenders conducted in that market being corrupted is about 41%. Suppose that the probabilities of cleanly winning are normally distributed around 1/n. Then, from (**2.3**) it follows that a non-bribing new entrant in that market will lose with a probability of about 90%, while the probability of losing in clean tender would be 83%. Thus, for the new entrant, cleanly participating in tenders with the other five is not rationally justifiable. The entrant's rational decision will be either to refrain from participating or to enter according to the rules of the environment, namely, bribing. In some markets, renouncing to participate is not a real option, because it would entail desisting altogether from the market and choosing some other business.

The expectation for Bidder j is

$$\text{E}(\text{X}_j) = \frac{1}{n!} q_j \sum_{i=0}^{n-1} \prod_{i}^{\wedge j} (1 - q_i) \; [(1 - k)(C_{j1} - B_j) - kR] \; + p_j\,(1 - u) C_{j0}. \qquad (\mathbf{2.4})$$

We are interested in examining the conditions for equilibrium in this set-up, that is, what must hold in order for $\text{E}(\text{X}_i) = \text{E}(\text{X}_j)$ for all pairs (i,j). As it stands, (**2.4**) is too general to

allow for an analytic solution, so we will impose a few restrictions. Firstly, we will use unit prices instead of full contract values. With this, we can reasonably impose that $p_j C_{j0}$ are normally distributed around $(\frac{1}{n} C_0, \sigma)$ and likewise $C_{j1} - B_j$ are normally distributed $(\overline{C}_1, \xi)$, with some standard deviations σ and ξ. These constraints are intuitively justified in markets dealing with standard goods and services (such as e.g. routine public works). Full contracts including m components are then described by m-dimensional vectors. In the sequel, we will restrict the reasoning to unit prices and will not explicitly generalise to full contracts. Under these conditions, Bidder j's expectation remains within bounds

$$\frac{1}{n!} q_j \sum_{i=0}^{n-1} \prod_{i}^{\wedge j} (1 - q_i) \; [(1 - k)(\overline{C}_1 \pm \alpha\xi) - kR] + \frac{1}{n} C_0 \pm \beta\sigma$$

with some probability depending on α, β. Irrespective of α and β, equilibrium is achieved when $q_j = q$ for all j, that is, when all players have the same propensity to bribe. As $E(X_j)$ is strictly increasing with q_j, the equilibrium is unstable. If one player starts bribing more often than the others, then, in order not to end up with lower expectations, the others follow suit and adopt the same strategy. This might be called the "bad apple effect". Moreover, as competition in the market tends to unsettle equilibria, ceteris paribus if somebody starts bribing more often, the others will follow his lead. Over time, the propensity to bribe tends to a maximum determined by the efficiency of the control mechanisms. There is no "good apple effect": Any player who bribes less often loses more often.

Getting back to eq. (**2.4**) with the equilibrium condition in place, the summation of products reduces to

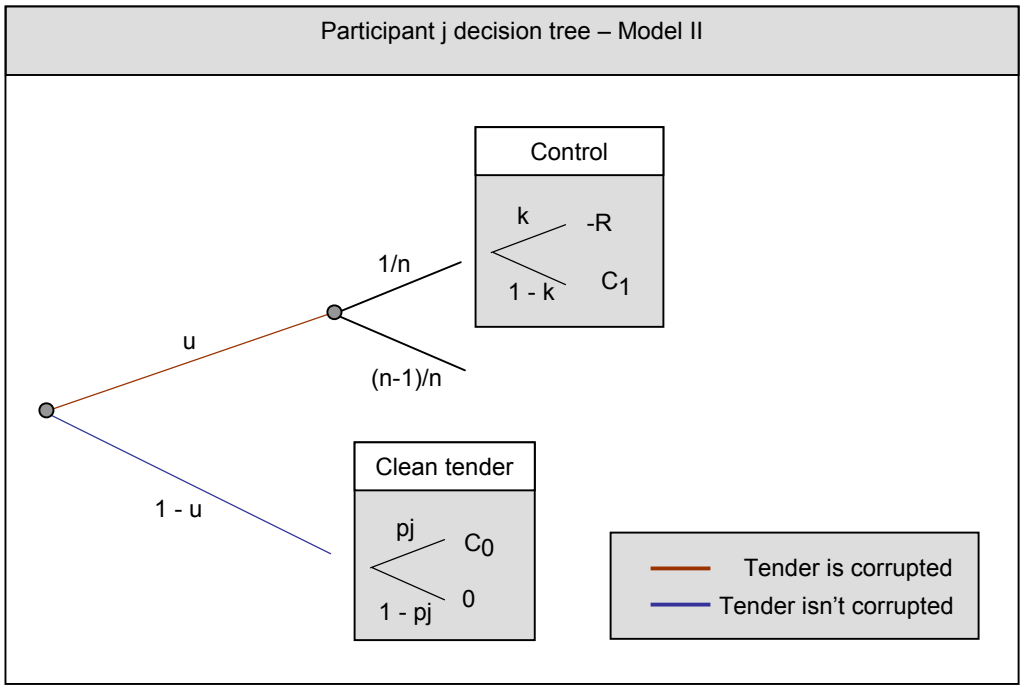
$$(\mathrm{n} - 1)!\, q \sum_{i=0}^{n-1} (1 - q)^i \; .$$

Noting that $q \sum_{i=0}^{n-1} (1 - q)^i = u$,

using the mean values $\overline{C}_1$ and $\frac{1}{n} C_0$ and simplifying the notation we get:

$$\mathrm{E} = \mathrm{E}(\mathrm{X}_j) \approx \frac{1}{n} u\,[(1-k)\overline{C}_1 - kR] \; + \frac{1}{n}(1-u)C_0. \qquad (\mathbf{2.5})$$

With this, the game becomes equivalent to a game in which, first, it is determined with probability u if it will be affected by bribery. If it is, the participant who bribes is selected at random with probability $1/n$. If the tender is not corrupted, then the tender is cleanly contested. Thus, the corresponding decision tree can be depicted as follows (hereafter referred to as Model II):



3 Empirical implications

Eq. (**2.5**) strictly decreases with k. For fixed u and R, the extrema are

$$\max(\mathrm{E},u,R) \approx \frac{1}{n}[u\overline{C}_1 + (1-u)C_0] \text{ for } k = 0$$

(the control mechanisms do not work at all) and

$$\min(\mathrm{E},u,R) \approx -\frac{1}{n}[R - (1-u)C_0] \text{ for } k = 1$$

(all instances of bribery are detected).

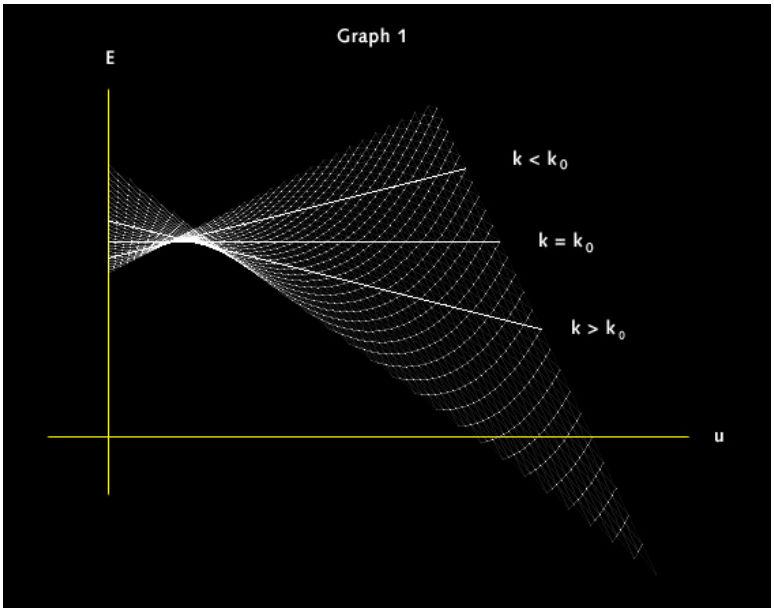
Let us now examine how (**2.5**) varies with u:

$$\frac{\partial \mathrm{E}}{\partial u} = \frac{1}{n}[(1-k)\overline{C}_1 - kR - C_0]. \qquad (\mathbf{3.1})$$

This is zero iff

$$k = \frac{\overline{C}_1 - C_0}{\overline{C}_1 + R} = k_0. \qquad (\mathbf{3.2})$$

E increases with u for $k < k_0$ and decreases for $k > k_0$. Graph 1 (corresponding to the projection of the surface defined by eq. (**2.5**) over the plane E x u) illustrates what happens:



k_0 corresponds to the level of control that makes the expectation equal to the expectation stemming from a clean tender. Anything above it corresponds to expectations coming from bribery. From eq. (**3.2**) it follows that if $\overline{C}_1$ (the unit component of the liquid value of the "dirty" contract after the bribe is discounted) is equal to C_0, then $k_0 = 0$ and for all $k > 0$ the

expectation will be less than the expectation arising from a clean tender. Therefore, in order to secure a higher expectation, participants will overprice their offers above the bribe.[6]

This observation furnishes a method to empirically evaluate a system's control/enforcement efficiency. We can tentatively use as u the perceptions of participants in a given market about proportions of biased tenders; say, 20%. Suppose that the overprice $\overline{C}_1 - C_0$, likewise assessed by surveys and cross-market price comparisons, is about 10%. Suppose further that the market in question defines penalties of ca. 10% of a typical contract's value (such low values occur when penalties are limited e.g. to forfeiture of guarantees).[7] Suppose tenders with five participants. Given these premises, eq. (**3.2**) gives for the "threshold" control factor the level of 8.3%. Together with the 20% informed by the perceptions, this gives about 1.7% over all tenders. So, in order for the control and enforcement mechanisms to be adequate to the system's vulnerability and to the penalties available, the detected fraudulent tenders should be at least 1.7% of the total tenders. This is then compared with the number of actual cases of biased tenders that are detected and punished in that environment. If the observed level is less than 1.7% of the total tenders, it can be concluded that the control mechanisms are insufficient to deal with the propensity to bribe in that environment.

As an assessment of the overprice in tenders might be subjected to controversy, instead of reasoning on the basis of eq. (**3.1**). a second-best alternative to determine the system's parameters is to equate eq. (**2.5**) to the expectation arising from a clean tender in that environment, considering that bribery exists. In other words, by making

$$\mathrm{E} = \frac{1}{n}(1-u)C_0.$$

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6 Kim (2000) argues to the contrary, namely, that firms do not gain from bribery, all such profits going to agents.

7 There are countries where bribers are not subjected to penalties ($R = 0$), as e.g. Ecuador and Colombia. In those countries, controls should be 100% effective in order to exert any influence on participants' expectations.

This leads to a "clean" threshold of

$$k_0^1 = \frac{\overline{C}_1}{\overline{C}_1 + R};$$

now replacing $\overline{C}_1$ by C_0 (the average unit price in that market) and making $r = \frac{R}{C_0}$, we get

$$k_0^1 \approx \frac{C_0}{C_0 + R} = \frac{1}{1+r}.$$

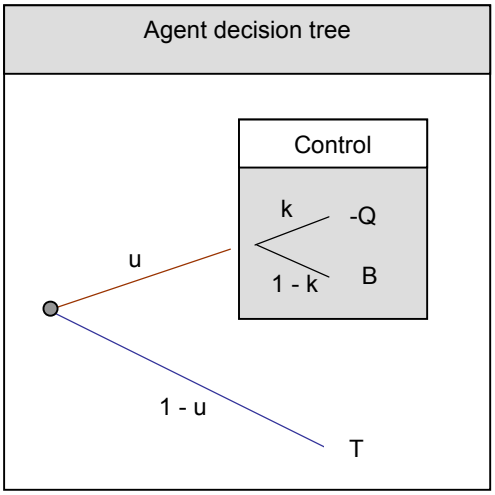
This can be used as a rule of thumb to assess a system's efficiency in curbing bribery in tenders.

4 Public officials

Now for the side of agents. Given a tender, the factors affecting their decisions are similar as for firms, and in some cases the same:

- u The likelihood of bribing occurring in the tender;
- B The amount received as a bribe;
- Q The penalty paid if a bribee is caught red-handed;
- k The probability of a bribee being caught;
- T (At least in principle), a reward awarded to the agent if the tender is not corrupted.

The agent's decision tree is thus



The strategy for public officials is straightforward. If the system easily allows for agents exercising discretion, then the likelihood of their deciding to take bribes is high. If they take bribes, then they benefit from the amount B of the bribe, incurring in the corresponding risk. Note that, as normally $T = 0$, differently from firms there are no material gains to be earned by public officials that do not take bribes.

The probabilities governing the public official "game" are:

P(PO wins a bribe) = $u(1 - k)$

P(PO is punished) = uk

P(PO does not take a bribe) = $1 - u$.

And the expectation for the random variable Y = "outcome for PO" is

$$E(Y) = u[(1 - k)B - kQ] + (1 - u)T \qquad (\mathbf{4.1})$$

so that, again, everything works in favour of bribery prevailing, moreover considering that T is usually zero.[8] This is nothing more than the classical problem with the public sector: There are no direct material incentives for not abusing power. As a matter of fact, upon examining equilibrium conditions in sealed-bid auctions, Lengwiler and Wolfstetter (2000)

[8] Klitgaard (1991) introduces a moral penalty together with Q. See footnote 5, above.

argue that bribe-taking could be eliminated in an economically efficient manner if procuring agencies adopted a simple profit-sharing contract with their officials, similar to those used by auction firms.

Similarly to what was done in the case of firms, we can identify empirically measurable parameters to ascertain a system's efficiency in curbing corruption in tenders. Eq. (**4.1**) is positive till the control/enforcement factor k reaches a certain level, getting negative from that point on. The turning point k_0 depends on the ratio between the penalty and the bribe, thus (for $u \neq 0$): $k_0 = 1/(r + 1)$, where $r = Q/B$. It is obvious that defining stiff penalties for public officials has a strong effect on the requirements for the control mechanisms. Thus, for $r = 100$, $k_0 \approx 1\%$, and for $r = 200$, $k_0 \approx 0.5\%$.

This shows that the prevalence of corruption in environments where penalties for corrupt public officials exist (and they always exist in some form) is a direct consequence of almost complete lack of control and enforcement – in these environments, perforce the control probability is less than the k_0 threshold.

Conversely, in a given environment, equation (**4.1**) might help policy-makers define parameters to control corruption among public officials that deal with public procurement. Suppose a department that purchases goods or services with an average contract value of C. Let $B = \pi C$, where π is a percentage over C (information about which is collected in the market, as is commonly done in surveys), and let W be the average annual wage individually earned by the agents in question. Suppose that the percentage of public officials involved with procurement that are punished for bribery is k. Define $Q = \delta W$. We want to find the level of δ that makes the expectation (**4.1**) negative. This turns out to be

$$\delta = \frac{\pi C}{W}\left(\frac{1}{k} - 1\right). \qquad (\mathbf{4.2})$$

Thus, for $C = 100$, $\pi = 5\%$, $W = 50$ and $k = 1\%$, the minimum δ turns out to be about 10. That is, given those parameters, in order for the control mechanisms to work, penalties should amount to at least ten times the income individually received by officials. (When more than one official is involved with tenders, π must be divided by this number, perhaps

not uniformly – usually there is a "pecking order"). Of course, from (**4.2**) one can express any other variable as a function of the others. For instance, in order to determine maximums for contract values that agents earning W can become involved with, or conversely, what minimum salary a functionary should earn in order to be authorised to work with procurement involving contracts of value C.[9]

The advantage of targeting control mechanisms on public officials is that, differently from firms, they are directly subsumed to administrative regulations. Programs aimed at perfecting control mechanism can more easily impose new procedures on officials than on private firms. As the risk factor k is in principle the same for both firms and officials, bettering control and enforcement over the latter directly acts on firm's expectations and, thus, on their behaviour.

5 Factors influencing the likelihood of bribing

In the model developed so far, we did not constrain the probability u. However, there are conditions operating on the environment that influence the propensity to bribe. The most obvious is the formal conditions governing tenders. If the institutional conditions too easily allow for public officials to artificially erect entry barriers – and thus to introduce biases in tenders –, then bribery becomes easier. Lax public procurement systems allow for too many opportunities for public officials to erect entry barriers in return for bribes. Stricter systems strive to eliminate such opportunities.

Another factor influencing the propensity to bribe is the efficiency of the control mechanisms (k). If controls are effective, then it is natural to expect that they will have a dampening effect on the propensity to bribe. We can inject this into u as a feedback and put

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[9] See Van Rijckeghem and Weder (1997) for a discussion on the relationship between public official wages and corruption, based on data collected in 25 countries.

$u = \mathbf{f}(k,s)$, where s is a factor depending on the formal regulations. Function **f** is constrained by

$$\frac{\partial \mathbf{f}}{\partial k} \leq 0 \text{ and } \frac{\partial \mathbf{f}}{\partial s} \leq 0 \text{ for all } k,s; \qquad (\mathbf{5.1})$$

with

$$k \to 0, s \to 0 \Rightarrow u \to 1;$$

and, for now (see below),

$$k \to 1, s \to 1 \Rightarrow u \to 0.$$

In general, functions of the type $\mathbf{f}(k,s) = a + b\mathbf{g}(k)\mathbf{h}(s)$, with **g** and **h** individually obeying (**5.1**) and suitable a and b, would do. The following examples satisfy the conditions:

$$\mathbf{g}(k) = (1-k)^n \text{ for all } n > 0;$$

$$\mathbf{h}(s) = \frac{\sigma}{\sigma - 1}(1 - \sigma^{s-1}) \text{ for all } \sigma \neq 0,1.$$

and a = 0, b = 1.

However, economic actors do not statically accept whatever constraints the environment establishes, but rather find ways to neutralise them. This means that we could further shape function $u = \mathbf{f}(k,s)$ by positing that in fact it depends also on time and

$$\frac{\mathrm{d}u}{\mathrm{d}t} > 0 \text{ if } \frac{\mathrm{d}k}{\mathrm{d}t} \leq 0 \text{ and } \frac{\mathrm{d}s}{\mathrm{d}t} \leq 0.$$

That is, if the system does not evolve, then the likelihood of bribing grows. With this in hand, and taking into account the conditions (**5.1**) on **f**, we can derive that in order for an environment to at least remain stable ($\mathrm{d}u/\mathrm{d}t = 0$), the following must hold:

$$\left|\frac{\partial \mathbf{f}}{\partial s}\right| \frac{\mathrm{d}s}{\mathrm{d}t} + \left|\frac{\partial \mathbf{f}}{\partial k}\right| \frac{\mathrm{d}k}{\mathrm{d}t} = \frac{\partial \mathbf{f}}{\partial t}$$

and in particular if $\frac{\mathrm{d}k}{\mathrm{d}t} = 0$ (controls stagnate), then s must grow over time according to

$$\frac{\mathrm{d}s}{\mathrm{d}t} = \frac{1}{\left|\frac{\partial \mathbf{f}}{\partial s}\right|}\frac{\partial \mathbf{f}}{\partial t},$$

and likewise swapping *s* and *k*.

For a system to remain healthy, the institutional framework and the control mechanisms must always evolve, and when one stagnates, the other must make up for the "time-drag" effect by evolving more rapidly. If both *s* an *k* stop, then *u* grows, tenders becomes more and more biased and the efficiency of the system deteriorates. The approximate dependency of $u = \mathbf{f}(k,s,t)$ on *k*, *s* and *t* would be ascertainable only empirically.

6 Prevention vs. detection

As we have seen, at least in principle control mechanisms play a fundamental role in public procurement systems. If controls function very well, then other factors negatively influencing the likelihood of bribing need not be as strong. However, control mechanisms are difficult and expensive to devise, maintain and apply. Furthermore, enforcement of penalties applied to culprits of detected bribery requires a well-functioning Judiciary system, something that it is not guaranteed to exist in many countries.

Acts of corruption in general can be divided into two categories: Those that originate in unlawful acts and those that come from lawful manipulation of regulations. The first are the easiest to detect, given that controls exist. For instance, if a public official falsely attests that a contract is being executed according to specifications, then in order to identify wrongdoing it suffices to compare the latter with the former. Fundamentally, evidence as to the wrongdoing exists. Once a public official and a firm break the law, the fact that money changed hands is only a detail, and bribery may be presumed, even if perhaps not punished. Directly proving that bribery occurred is always very difficult, due to the secret nature of the act. Corrupt people do not issue receipts and bribers avoid registering this type of financial dealings in their books. Tracing money across bank accounts, phantom firms, go-

betweens and fiscal heavens is not an easy accomplishment, and the expenses involved preclude applying sophisticated investigation techniques in a day-to-day basis. This means that despite the critical role played by the efficiency of control and enforcement mechanisms in shaping the expectation of participants, one should not stake exaggerated hopes on it.

Cases of corruption of the second, "lawful", kind tends to be much less detected than cases of the first, "unlawful" kind. What is "lawful" corruption? For instance, suppose an environment where requirements for pre-qualification of firms to bid in tenders – such as thresholds for capital and/or liabilities, "technical experience" and so on – are freely defined by the agent. Then it is very easy to lawfully use such requirements to erect entry barriers to favour one participant at the expense of the others. As the restrictive conditions are perfectly legal, in order to prove that a tender was deliberately biased it becomes necessary to prove that a kickback was paid – and this is very difficult. In contrast, in an environment where conditions are not subjected to public officials' whims, directing tenders is more difficult. A perfect system would completely eliminate opportunities for public officials to erect entry barriers, and thus would restrict corruption to unlawful acts. Therefore, while punishments and controls are the factors exerting the strongest effect on the financial expectation of both firms and public officials involved in tenders, their continuous application is expensive and improbable. Acting on the institutional environment produces a more profound effect on the system's efficiency – and far beyond simple corruption –, making controls less critical. Furthermore, as argued above, the institutional framework must evolve continuously over time in order to catch up with the evolving techniques the actors develop to maximise their expectations.

In many environments, regulations are very lax and vague, mentioning only that tenders must be "fair", that "equal opportunity" must be guaranteed and so forth. For instance, this is how the guidelines for procurement issued by international financing institutions are framed. However, those terms are virtually devoid of meaning if taken in isolation. "Fairness" in things concerning the public interest is not something that can be left to the decision of one person, or of a group or persons, however well-meaning they may

be – "fair" should be what the law says is fair, doubful cases being resolved by the Judiciary.

As corruption stems from the the discretionary power of public agents, it follows that diminishing the latter favourably affects the former. This is why procurement law should be as much procedural as possible. Also, as public procurement regulation is nothing more than regulation applicable to certain markets, the matter should be primarily addressed from the economic perspective. This means that "fairness" and other desiderata for public markets should be explicitly defined in each case so as to stimulate competition, avoid entry-barrier-erecting prerogatives to individuals and generally strive for maximum efficiency. Finally, a requirement of openness for public markets requires that information held by the principal must be equally shared with interested parties (and the public).

Although the aim of this paper is not to advocate this or that set of regulations, it is worth briefly listing some features of public procurement regulations that help stimulate better efficiency:

1. Guaranteeing that regulations are uniform across all public organisms.[10] Different rules for different offices correspond to entry barriers and stimulate cartels.
2. Guaranteeing that all public purchases above a specified – and low – value are done by bidding, with a very limited set of exceptions (relating to catastrophes etc.). Provide for pre-procurement of "emergency" contracts.
3. Guaranteeing that all phases of a tender are separated by explicitly specified periods of time.

[10] Reasoning on the basis of a model, Ganuza and Hauk (2001) argue that different propensities to corruption hampers economic integration (entailing the adoption of common rules) between countries and, conversely, that the forces acting on integration can help reduce corruption in member countries.

4. Requiring that all information pertaining to a tender and the ensuing contract is made public. Not allowing for the terms of the contract to be altered by negotiations between the winner and the agent after adjudication.[11]

5. Requiring that the announcement of the tender maximally specify the object to be purchased, in order to avoid arbitrary decisions later, that adjudicate contracts to firms that offered characteristics not previously specified. As the procurement process must not depart from the equal information principle, such uninvited peculiarities should not be considered in the decision.

6. Requiring that formal conditions to participate (that is, requirements not involving the tender's nature, but only the firm's status) do not depart from reasonable factors and explicitly stated percentages; these requirements must be limited to firms' capital and liabilities, their compliance to national laws concerning taxes and labour obligations, and their not being blacklisted by reason of previous offences. Likewise as to contractual guarantees.

7. Prohibiting "previous experience" of firms as a criterion for pre-qualification. Firms cannot have experience, only persons can.

8. Prohibiting the requirement that firms own equipment or have certain types of professionals in their fixed payrolls. Equipment is rented and personnel is hired. But requiring from participants letters of intention from equipment suppliers to the effect that the latter will rent such equipment if the interested firm wins the contract. Likewise as to personnel.

9. Guaranteeing that the decision process is always explicitly stated in the announcement and is based exclusively on objectively measurable factors. In particular for standard goods and services, public works and systems using

[11] See Bös (2001) for an argument for negotiating the conditions of contracts after the tender is decided. However, his model does not include the possibility of corruption.

commodities as components (such as computer systems, telephony etc.), prohibiting the attribution of "grades" to items from a proposal, which is unavoidably subjective. While it is impossible to avoid a degree of subjectivity in certain tenders (as is the case of consultancy, or new technological solutions, or contests for projects), it is not true that subjectivity inherently intervenes in all types of tenders. Even in those cases, the decision should be attributed to bodies formed not only by public officials, but also by members of the public and/or the professions.

10. Defining stiff penalties for winners that refuse to sign contracts.
11. Providing for open mechanisms allowing the public to follow all procurement processes.
12. Guaranteeing that payments are made according to strict chronological order, so as to avoid the need for firms to "buy" from dishonest officials the right to be paid.
13. Guaranteeing that contract amendments are strictly limited to stated percentages and, when they happen, that they do not affect the structural elements of the contract.
14. Stiffly penalising non-performance of contracts.
15. Guaranteeing o participants and the public the right to administratively and juridically contest agents' decisions.
16. Providing for public blacklisting of corruptors. Firms that fail to observe the country's laws on fraud and corruption must be declared ineligible to participate in tenders during defined periods of time.
17. Explicitly criminalising corrupt behaviour both from public administrators and from corruptor firms' representatives.

If requirements as these are accepted as desirable, then it follows that their absence in a given environment is evidence of vulnerability. This observation points to a method to estimate the institutional health of countries in what regards public procurement. A first approximation to this was coordinated in early 2002 by the author,[12] within a project sponsored by Transparency International aimed at evaluating the vulnerabilities affecting public procurement in a number of Latin American countries. The methodology was based on the definition of 22 possible entry barrier-erecting opportunities and the identification of their presence in each environment.[13]

Developing numerical indicators able to at least partially capture an environment's institutional soundness and comparing them to other indicators (such as governance, rule of law, perceptions of corruption, as well as concentration and other econometric data) would help to better understand the factors affecting efficiency in public markets.

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[12] CWA et. al. (2002).

[13] The procedure was affected by lack of methodological uniformity and by the fact that in-country assessments were not subjected to independent counter-check.

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