CORRUPTION: OUTBRIBING THE COMPETITION

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Abstract: We extend the prototypical models of corruption to a setting of multiple agents (donors) attempting to bribe the same body of officers. The model recognizes that corruption is a complex many-faceted phenomenon involving several layers of players (bureaucracies, committees, companies, and criminal partnerships) with dissimilar and conflicting interests. Three main ingredients drive corruption outcomes: competition among donors, uncertainty and coordination among the officers' types, and the individual payoffs of bribing. We analyze market failures and inefficiencies arising from the strategies and interactions of these parties. A policy maker may then want to design indirect anti-corruption policies based on triggering information asymmetries and adverse selection effects exploiting synergies within pools of officers and in this way impede the formation of certain criminal groups.

Keywords: Corruption, bribe, adverse selection.

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1. Introduction

Corruption continues to be a central issue in the governance of institutions (public, private or mixed) -a phenomenon that costs the European economy around 120 billion euros per year. The World Bank considers anti-corruption as the heart of the Sustainable Development Goals and achieving the targets set for Financing for Development. The lack of a generalized theoretical foundation and ambiguous effects of many initiatives to combat corruption, keep this issue as a very big challenge for both scholars and practitioners. Big government scandals that have been exposed, suggest that corruption in the government sector is a pressing current issue, which entails dangers to social cohesion because officers' unwarranted behavior for personal gains undermines the public trust to governance of institutions. It is only natural that the subject of corruption has been extensively studied by economists both theoretically and empirically. There is a multitude of models dedicated to the study of this subject and the development of suitable policies to counteract the emergence of corruption. Yet, we find that there are some important aspects of corruption that have not been given sufficient attention in the literature. This paper is an effort to highlight those and demonstrate how they make a difference in the way we view and tackle corruption.

One such element is the presence of competing parties which attempt to bribe a bureaucrat. For example, two firms each trying to exclude the other from a competition for a public project, or have conflicting interests regarding urban planning by municipal authorities (e.g., the location of a new metro station), or regarding alternative types of defence systems and so on. Though it is widely recognized that often the root of corruption lies in the presence of competing interests, there is scarce reference in the literature to competing parties who offer bribes by way of influencing bureaucrats towards different actions. In standard models and empirical studies, corruption is viewed as a bilateral affair between a bribe donor and a bureaucrat who agrees to take a certain action in return. While this approach may suffice in some cases (e.g., cases of 'petty' corruption), it fails to fit well some important corruption cases where public officers may face pressures from various quarters towards different (often opposite) directions. This is more often the case in what is referred to as 'high' corruption (e.g., public procurement of large projects). Clearly the presence of conflicting interests is not a trivial matter for the analysis of a corrupt situation, so one intended contribution of our study is to extend the analysis of corruption to two bribe donors who may attempt to influence the same body of bureaucrats.

In pursuing this direction several challenging issues emerge. For starters, the cost benefit considerations of bribery become more complex. This is because the incentives of bureaucrats to accept a bribe in return for taking certain actions, depend on bribes offered from rival parties in order to take alternative actions. More specifically, the bribe required by a bureaucrat in order to take a certain action, depends not only on their individual characteristics (i.e., their 'type') but also on the bribe offers they receive from other parties. At the same time, the incentive of each party to bribe in order to influence the action of a bureaucrat, in addition to the benefit from getting their way, is beefed up by the possible loss from rivals getting theirs. We see here that the presence of conflicting interests uncovers motives of corruption that are not accounted for in the existing literature: some donors may be compelled to bribe merely in order to deter bureaucrats from accepting bribes from a rival with opposing interest. In fact, it is conceivable that bribery may be the consequence of a situation, where each party believes that the self interest of the other will lead them to engage in illicit deals with bureaucrats. Obviously, from a methodological point of view the above considerations require the treatment of corruption as an equilibrium phenomenon, where the bribe and corruption extent are endogenously determined from the interaction between competing parties and bureaucrats.

We embed the aforementioned elements of our approach in a context of bribery of pools of bureaucrats, representing uncertainty regarding the bureaucrat who acts as decision maker (and/or their type). Interestingly, this framework is homeomorphic to situations where decisions are literally taken inside committees (e.g., for funding a project), or decisions involving a chain of hierarchy in a bureaucracy, so influencing the actions of an officer may require cutting into the deal the chain of command overlooking them. Notwithstanding the interpretation, we remark that one key issue is that this source of uncertainty, is controlled by the authorities who can 'manage' it to their advantage, by strategically selecting the candidate bureaucrat(s) for taking a decision. Once we recognize that information asymmetries play an important role in the conclusion of corrupt deals, it makes sense to consider the detrimental effects of adverse selection as an indirect anti-corruption tool. The idea is to use the opportunity created by the presence of uncertainty, to *elicit* adverse selection effects which will unravel bribery temptations, i.e., situations where the interest in an exchange unravels because of its uncertain value, leading to a reduction of the willingness to pay which in turn further reduces the expected value of an exchange and so on.

With respect to anti corruption policy, our study contributes three ideas. First that, when there are multiple interests involved, the willingness of each party to bribe and hence the measures required to avert corruption, may be underestimated. This is because in addition to the value of each party getting their way, the possible costs from another party getting their way must be reckoned with. Second, the anti corruption efforts may be facilitated when the effort of parties to outbid each other is internalized in the reservation bribes of bureaucrats. Third, we highlight how uncertainties and information asymmetries can be suitably managed in order to limit corruption. In this way indirect anti-corruption measures can be developed around the idea of 'managing' uncertainty in order to trigger severe adverse selection effects which will unravel bribery temptations. Such measures can be very effective because they operate as anti-corruption tools through self interest rather than enforcement, i.e., they are 'soft power' policy tools.

We believe that our approach will be useful in informing empirical studies, as we highlight some underpinnings of corruption that have not been given proper attention. For instance, that besides the valuations of bribe donors, those of other interested parties (also in terms of losses) may be explanatory variables for the level of bribes or extent of corruption. Also, the existence (or not) of intertwined interests may well explain the variability of bribes across sectors, regions or countries.

Let us turn to discuss our approach and results in relation to the literature.

1.1. **Relation to the literature.** A common definition of corruption is the misuse of a position of authority for personal gain rather than for the benefit of the party that bestowed that position (see, e.g., [31] and [23]). This misuse of authority usually involves breaking rules or protocols (see [3]). A most prevalent type of corruption is when authorized individuals accept a monetary payoff (a bribe) in exchange for taking a specified action desired by the donor of the bribe. Studies have investigated the amount of bribes paid to police [24], judges [21], politicians [30] and port and border post officials [28], or the value of political connection on firms' stock price (e.g., [12], [13]) and on loans [16].

With few exceptions, the study of bribery has developed along two approaches. In one the bureaucrats are seen as *a priori* corrupt and act as rent seekers, demanding a bribe in order to take some action. A prototypical model along this line is [29]. Usually these models derive conclusions regarding the maximum bribe extracted by bureaucrats. In another direction bureaucrats are *a priori* corruptible and may (or not) accept a bribe in order to take some action. Usually these models derive conclusions regarding the minimum bribe required by bureaucrats in order to take some action. A prototypical model along this line is [4]. Each of these approaches focuses on different aspects of corruption and apply to diverse situations in this multifaceted phenomenon. Here we develop our model along the latter approach mainly because we would like to demonstrate how corruption arises endogenously rather than *a priori* assumed. As the examples we mentioned before indicate, we are thinking of situations where a bureaucracy decides an action that affects the interests of multiple parties. In turn, each party may wish to bribe by way of influencing that decision towards an action in their own favour, which however is to the disadvantage of others.

In either of the approaches mentioned, the models do not fit well cases where there are intertwined interests involved in bribery. For instance, in the setup of [7], which is along the first strand, there are conceivably conflicting interests, but the strategic behavior of bribe donors is assumed away. Similarly, in models of the latter strand (see, e.g., [31] and [23]), when there are multiple intertwined interests the incentives of bureaucrats to engage in corruption are no longer tied down from the outset, but rather determined endogenously from the strategic behavior of bribe donors. Accounting for the potential existence of intertwined interests in bribery situations could be useful for empirical studies. For instance, studies such as [30] could improve by including explanatory variables that capture the existence of rival interests.

The element of competition in a corruption environment has been addressed in the literature in terms of bureaucrats competing for bribes. A prototypical model to that effect is [29] where competition between bureaucrats is captured by a model inspired by oligopoly. However, existing models of corruption do not account for competition between bribe donors with conflicting interests. This does nor fit well the acknowledgement that bribery of bureaucrats is often the result of the presence of competing interests. For example, [10] documents a high profile case where a firm paid bribes to bureaucrats specifically in order to exclude rivals from competitions. It seems sensible to expect that the competition between bribe donors raises the stakes and affects the effectiveness of anti-corruption measures. This may explain the widely ranging levels of bribe and depth of corruption in developing countries observed in [18]. Developing countries try to attract foreign direct investment, but international investors have to compete with local interests while having little access to the local political structure. The case presented in [10] is a typical example. In this paper we would like to address this gap in the literature by incorporating in our model competition among bribe donors.

Our approach requires the study of corruption in an equilibrium framework, which captures the forces created by diverse interests. In some existing equilibrium models of corruption, the bribe is exogenously fixed and the level of corruption is determined endogenously. For instance, in [1] the level of bribe is used as an outside option that determines the allocation of talent between the private and public sectors. In [4] a fixed bribe level serves the determination of corruption via an incentive constraint. By contrast the models in [7], [11] and [29] determine the bribe levels by the rent seeking behavior of bureaucrats, but there is no strategic interaction involved as corruption is *a priori* assumed rather than emerging endogenously. In our model both the bribe and extent of corruption are determined endogenously via interactions of donors and bureaucrats. The determinants of the equilibrium bribe and level of corruption turn out to be the detection, judicial and sanction environment determined by the authorities, which is in line with existing corruption models, but also the attitudes of bureaucrats towards distorting their duties and the values of donors in getting their way, which are not covered by existing models.

The aforementioned elements that we wish to highlight, introduce exogenous and endogenous uncertainties. The former refers to personal characteristics (types) of bureaucrats and the latter to strategic interaction between donors. The literature has documented that uncertainty reduces corruption through its effect on the perception of the size of the bribe that would be acceptable by a corrupt individual (e.g., [17], [19]). Other authors have highlighted the effects of uncertainty about other aspects of a corrupt environment. For example, [27] argue that under incomplete information with respect to the intrinsic moral cost of one's potential corruption partner, bribe donors have an incentive to bid lower and bribe receivers bid higher, thus reducing the probability that a corrupt transaction occurs in a random matching. Finally, it has been argued that uncertainty reduces corruption through its effect on the perception of the probability of being detected (see [8], [6]).

We focus instead on the adverse selection effects associated with uncertainty, because those can serve as a tool to tackle corruption. Some authors have used similar ideas in other contexts. For example, [15] and [20] use such failures to inhibit exchange in illicit markets. The former established a search model in which low switching cost induces moral hazard between sellers and buyers, and obtained a unique equilibrium where a mass of sellers always chose quick one-time profit and offer zero quality drugs.[1] The latter builds a model of illicit trade of credit data in an online forum and the reputation system that sustains trade. He proposes to penetrate the market with a number of sellers who cheat and buyers who slander the seller, so that both the market clearing price and the quantity of data provided drop. However, both the quality of drugs and the authenticity of credit data are tangible trade objects. By contrast, what a bribe is paid for is often not obvious.

To recap, in this paper we would like to develop a model where corruption is an equilibrium phenomenon, determined by the strategic interaction between a bureaucrat who chooses how to act and two bribe donors who are interested in influencing the bureaucrat's action

[1] However, in [22] it is demonstrated how decentralized trade may ameliorate the average quality of the goods traded.

towards different directions. Extending this setup to unknown (types of) bureaucrats who act as decision makers, allows us to substantiate the idea of triggering failures of bribery. This is a promising way to tackle corruption especially when a decision about a project or policy, e.g., the location of the new city center, or the financial budget plan for the next year and so on, involves values which may be far beyond the pay scales of bureaucrats who are responsible for making such decisions. We show that the interest to bribe could completely unravel if the (types of) bureaucrats and their likelihood of being selected in position of authority are chosen appropriately so that, in view of the competition between rival donors, the expected value of bribery becomes smaller than the bribe necessary to corrupt the bureaucrat with any positive probability.

The presentation is structured as follows. In the next section we present a model of a game that encapsulates the principles we discussed above. In the following section we develop the main result of the paper. Some discussion and concluding results follow at the end.

2. A model of corruption decisions

2.1. **Costs of corruption.** We view 'bureaucrats' summarized in a set I, as confronted with a range of alternative choices of actions, corresponding to an interval $[x, z] \in \Re$. For example, the interval $[x, z]$ may correspond to alternative locations of a public project (e.g. a library) or a level of penalty to be imposed on an offender. Another interesting interpretation is to think of points in the interval as corresponding to randomization between two choices x and z, representing the probability that a bureaucrat would adopt either choice. Each bureaucrat receives a monetary income $w > 0$ and chooses an action $y \in [x, z]$. The bureaucrat's preferences over the available actions are represented by a utility function $u_h(y, w)$, which is twice continuously differentiable, bounded and strictly concave in y. We assume that $D_y^2 u_h < 0$ and $D_w u_h > 0$. These preferences serve to represent the inhibitions (moral, risk, loss of future income etc) of the bureaucrat engaging in corruption.

For each bureaucrat $h \in I$, let $\overline{x}_h \in [x, z]$ denote the most preferred action, i.e., $u_h(\overline{x}_h, w) > u_h(y, w)$, $\forall y \in [x, z]$. This action $\overline{x}_h$ is understood as the one that a bureaucrat would execute by default. For any given $y \neq \overline{x}_h$, one can compute the income necessary to interest the bureaucrat into deviating to the action y over $\overline{x}_h$, i.e., the minimum bribe necessary to corrupt the bureaucrat: $u_h\left(y, w + B_h^0(y)\right) \equiv u_h(\overline{x}_h, w) + \delta_h(y)$, where $\delta_h(y) > 0$ is a parameter which is controlled by the authorities and represents the effect of anti-corruption policies. In other words, the corruption incentive of a bureaucrat must be stronger, the more intense the anti-corruption measures, e.g., the more likely the detection and prosecution, the harsher the punishment and so on.

We do not enter into a discussion of specific anti-corruption measures (e.g., monitoring, detection, punishment etc) and their potency.[2] It suffices for us that such measures inhibit, to some degree or another, the temptation of public bureaucrats to engage in corruption. The function $B_h^0(y)$ is akin to the 'reservation bribe' in the literature.

Suppose now that two donors $i = 1, 2$ offer 'bribes' b_i respectively, in return for the bureaucrat taking some corresponding actions z_i. The minimum bribe necessary to interest the bureaucrat to choose the action z_i over z_j can be computed as follows:

$$u_h\left(z_i, w + \hat{b}_h(z_i; z_j, b_j)\right) \equiv u_h(z_j, w + b_j) + \delta_h(z_i) \tag{1}$$

Thus the income $B_h(z_i; z_j, b_j) = \max\{\hat{b}_h(z_i, b_j), B_h^0(z_i)\}$, represents the minimum bribe necessary to lure the bureaucrat to commit to the action z_i, as opposed to either $\overline{x}_h$ or z_j.[3] In other words a bureaucrat would accept a bribe b_i, over a competing b_j offered by the other donor if and only if $b_i \geq B_h(z_i; z_j, b_j)$ because

$$\begin{aligned} u_h(z_i, w + b_i) &\geq u_h(z_i, w + B_h(z_i; z_j, b_j)) \\ &= u_h(z_j, w + b_j) + \delta_h(z_i) \end{aligned} \tag{2}$$

An interesting observation is that in our setup reservation bribes vary with the valuations of bureaucrats of the corresponding actions required. For instance, a steep reservation bribe may reflect bureaucrats' reluctance to take the corresponding action, either for ethical or for anti corruptions reasons (e,g, an infraction easier to detect). As the actions z_i are fixed in this paper, we skip these arguments in the notation and simply write $B_h(b_j)$

[2] See [18] for a discussion of the cross-countries efficiency of anti-corruption policies.

[3] Observe that if we fix the bribe of one donor to zero, e.g., set $b_j = 0$, we are back in the standard setup with a single donor.

for the minimum bribe required from donor i, when the opponent offers the bribe b_j. A few observations are in order:

LEMMA 1. *(Monotonicity of minimum bribe)* $\frac{\partial B_h(b_j)}{\partial b_j} > 0$.

Proof: see the Appendix.

The above lemma demonstrates that, when confronted with multiple bribe offers, bureaucrats may play one donor against another in order to increase their payoff. On the other hand the offer of multiple bribes raises an issue of commitment, in the sense that bureaucrats might be inclined to accept (or be indifferent between accepting) more than one bribe. The following lemma establishes the impossibility of acceptance of both bribes, i.e., a bureaucrat would accept at most one bribe (and commit to the corresponding action).

LEMMA 2. *(Commitment)* $b_i \geq B_h(b_j) \Rightarrow B_h(b_i) > b_j$.

Proof: see the Appendix.

In conclusion a bureaucrat $h \in I$ can be represented by the pair $(\overline{x}_h, B_h)$, as per the analysis above. We assume that the set I can be partitioned into types in a finite set $P = \{(\overline{x}_t, B_t) : t = 1, 2 \ldots, T\}$, i.e., that there is a mapping $c : I \rightarrow P$. Given $D \subset I$, the proportion of each type of bureaucrat in D is $\mu_D(t) = \frac{\#(c^{-1}(t) \cap D)}{\#D}$. This measure represents the probability that a certain bureaucrat in the set D will act as decision maker. It is important to keep in mind that the set D as well as the measure μ is in the discretion of the authorities.

We adopt the following assumption regarding the order of the characteristics of the different (types of) bureaucrats

ASSUMPTION 1. *For any pair of types $t, k \in T$ the order of minimum bribes does not depend on the competing bribe offer, i.e., if for some b, $B_t(y_i; y_j, b) < B_k(y_i; y_j, b)$ then $B_t(y_i; y_j, b') < B_k(y_i; y_j, b')$, $\forall b'$.*

This assumption requires that the order of minimum bribes across different types does not depend on the bribe offered by the competing donor. According to lemma (1) minimum bribes vary with the bribe offer of the competing donor, so the above assumption requires that this variation is orderly. It conveys the intuition that the relative difficulty to bribe a certain type of bureaucrat t, as opposed to another type k is the same regardless of the competing offer.

2.2. **Benefits of corruption.** The decision of a bureaucrat to take a certain action may have consequences for the interests of some parties, which we refer to as 'donors'. These could be individuals, interest groups, firms and so on. Here we will consider two donors indexed by $i = 1, 2$, who prefer most the actions z_i respectively. We denote by $V_i^j = u_i(z_j)$, $V_i^t = u_i(\overline{x}(t))$, for $i, j = 1, 2$ and $t \in T$, the value of each action to each donor, denominated in monetary units. The idea of competition among the two donors is captured by the following definition, which requires that each donor prefers the bureaucrats' fullback choice rather than the other donor getting their way.[4]

Definition 1. *We say that two bribe donors have* ***rival interests*** *if for $i = 1, 2$ and $j \neq i$, $V_i^i > V_i^t > V_i^j$, $\forall t \in T$.*

As already mentioned, corruption is understood as bureaucrats changing their action from their most preferred point $\overline{x}(c(h))$ to some z_i, in exchange for a monetary payoff.[5] Clearly the 'value for money' to the bribe donor depends on the individual who accepts the bribe. But this is not all. The donor's value for money also depends on whether or not the bureaucrat who accepts it, were ready to take up a rival bribe and carry out an action that would be even less desirable! In other words the motive to bribe is twofold: to elicit the most preferred action and at the same time prevent a rival from succeeding to bribe, i.e., 'avoid the worse'.

In order to formalize these ideas, the benefit for the *ith* donor from bribing a bureaucrat can be construed as follows. Given a rival bribe offer b_j, consider the set of bureaucrats who would be ready to accept it $C^j = \{k \in H : b_j \geq B_k(0, z_i)\}$. The benefit for the *ith* donor from successfully bribing a bureaucrat $h \in H$ is:

- $V_i^i - V_i^{c(h)}$ if $h \notin C^j$

[4]The case of correlated donor interests is also very interesting and can be handled by our model, but we will not take up this case in the present paper.

[5]Equivalently, corruption is the receipt of a monetary payoff in order for bureaucrats to misrepresent their preferences.

- $V_i^i - V_i^j$ if $h \in C^j$

We are not aware of any reference to the bottom case in the literature, though it has implications for anti-corruption measures, which is the reason we chose to include this in our model.[6] In what follows, for brevity let's denote by $E_i^t = V_i^i - V_i^t$ the value of each type $t \in T$ to donor $i = 1, 2$.

2.3. **The role of anti-corruption policies.** The anti-corruption policies developed by authorities are in most cases a combination of 'stick and carrot' measures, which regard the detection (e.g., internal auditing) and punishment of corrupt practices on one hand, and rewards (e.g., salaries, bonuses) of bureaucrats on the other. The exercise for anti-corruption authorities is to setup the environment of decision making, in a way so that the group of individuals that a bribe donor might find interesting to corrupt is minimized and ideally empty. In a nutshell, the role of anti-corruption policies is to link the distributions of the values V_i^j, $V_i^{c(h)}$ and the values B_h. Specifically, according to existing models, anti-corruption measures are designed with a view to achieve the goal that for as many bureaucrats as possible the minimum bribe required is greater than the donor's value of the bureaucrat not taking their default action, i.e.,

$$\bullet \quad B_t^0(z_i) > E_i^t, \; t = 1, 2, \ldots, T \tag{3}$$

In terms of our model, anti corruption measures associated with detection and punishment influence the minimum bribes B_h required by bureaucrats via δ_h, while salaries or bonuses influence them via the preferences of bureaucrats for higher income. There is a long and diverse literature that evaluates the varying success of such measures. [7]

Our model suggests that the failure of some measures may be due to underestimation of the expected benefits of bribe donors, as the rivalry between them raises the stakes, so the bureaucrats' salaries, penalties for corruption etc dwarf in view of the monetary values at stake. In order for anti-corruption measures to be effective in the cost-benefit sense, they should rather achieve the target $B_h^0(z_i) > V_i^i - V_i^j$ (the minimum bribe required is greater than the value of the bureaucrat not taking the rival's preferred action) for as many $h \in H$

[6] In absence of a rival donor $C^j = \emptyset$ only the top case applies, which is standard in the existing literature.

[7] See [2], [9], [11], [14], [19], [32].

as possible, which is harder to achieve.

Here, we do not wish to dwell into the potency of the various anti corruption policies. The contribution of our model to the anti corruption discussion is that alongside the known anti corruption measures, the authorities may generate uncertainty which serves as a tool to amplify the effectiveness of its policies. In this respect we should not forget that the authorities have the discretion of selecting the candidate bureaucrats and the probability they may act as decision makers, i.e., the function c. Recall that the distribution of c determines the support and probability of each (type of) bureaucrat acting as decision maker. The upshot is that, as we demonstrate in the next section, the likelihood of choice of alternative (types of) bureaucrats can be done in a way so that the desired limitation of corruption can be achieved via the adverse selection effects it generates.

In order to illustrate this point, suppose that the authorities choose a combination of anti-corruption measures, which achieve the target that the minimum bribe required by each (type of) is in some way 'proportionate' to the value they offer to the bribe donor:

(4)

- $B_t^0(z_i) > \mu_H(t)E_i^t,\ t = 1, 2, \ldots, T$

A comparison with (3) makes clear the effect of uncertainty on anti-corruption measures. Observe that when $\mu_H(t) = 1$, i.e., the decision maker (type) is observable, (4) collapses to the standard anti-corruption dictum (3). On the other hand, the less the likelihood of a bureaucrat (type) $\mu_H(t)$, the easier the anti-corruption target (4) is achieved. Notice that (4) does not exclude the possibility that $E_i^t > B_t^0(z_i)$, i.e., bribing is still desirable for donors, because the cost-benefit difference is favorable. Hence, the requirement above is far less demanding than the standard anti-corruption target suggested in the literature. As we will show in the next section this may suffice if the authorities take advantage of the uncertainties involved in corrupt deals.

3. Equilibrium levels of bribe and corruption and the role of adverse selection

As we already observed, the presence of intertwined interests warrants the consideration of corruption as the outcome of equilibrium between forces engendered by the interaction of those interests. For this reason we proceed to set up a game that captures all the principles we developed in the previous sections, in order to study the emergence of corruption at equilibrium and demonstrate how adverse selection effects can affect it.

In order to fix ideas let us consider the following situation, which represents the idea of decision taking by an unknown (type of) bureaucrat, in terms of their inhibitions to accept bribes and their default actions: an action represented by an element in an interval $[x, z]$ is to be decided.[8] A choice of an action will be decided by a 'committee' (say a jury) $H \subset I$ of bureaucrats, each of whom proposes an element in this interval and the decision is determined as the average of the proposed actions.

Suppose now that the decision to take a certain action affects the welfare of some 'donors' indexed $i = 1, 2$, who prefer most the actions z_i respectively. Each donor is interested in as many bureaucrats as possible proposing the element z_i -so that the likely decision (the average) is as close to it as possible- and may be willing to pay a bribe to this effect. The donors' strategy sets can be taken to be $S_i = \Re_+$, for $i = 1, 2$. Bureaucrats on the other hand receive a salary w and may accept either bribe offer or reject them both. Recall that according to lemma (1) bureaucrats will accept at most one bribe. Thus, the decision to accept or reject either bribe can be conveniently represented by a pair $t_h = (t_h^1, t_h^2) \in \{(1, 0), (0, 1), (0, 0)\}$, where $t_h^i = 1$ ($t_h^i = 0$) corresponds to 'accept' ('reject') the bribe offered by donor $i = 1, 2$. Those bureaucrats who accept the bribe offered by the ith donor, i.e., $t_h^i = 1$ propose the point z_i and those who reject both bribes, i.e., $(t_h^1, t_h^2) = (0, 0)$, propose their most preferable action $\overline{x}(c(h))$. In return, those bureaucrats who accept the bribe b_i will split the bribe amongst themselves and those who reject both bribes simply receive their salary w. In other words, given a profile of strategies t_h for each

[8] Alternatively, a point in the interval can be construed as the probability that either x or z will be decided.

$h \in H$, each bureaucrat receives a kickback $\frac{t_h^i}{\sum_{h\in H} t_h^i} b_i$, where 0/0 is defined to equal zero.[9]

The key in this setup is that the donors offer a bribe bill to those who agree to switch their proposal to z_i, but are oblivious to what these bureaucrats would have proposed in absence of a bribe, i.e., how far the bribe changes their proposal. In other words the distortion of the proposals (and hence their value to the donor) varies among the corrupt bureaucrats, yet they all receive the same bribe.

Let us consider a game that proceeds sequentially. In the first stage, each donor may offer a bribe bill b_i, to those willing to propose z_i, for $i = 1, 2$. Then, the second stage contemplates a simultaneous move subgame among the bureaucrats, where each one may (or may not) accept to be bribed. A behavioral strategy for bureaucrats is a mapping $s_h : S_1 \times S_2 \to D$. Let S_h denote the collection of behavioral strategies of individual h and $S = \prod_{h\in H} S_h$. Once strategies are executed the payoffs to the donors $i = 1, 2$ and individuals respectively are as follows[10]:

$$\pi_i(b_1, b_2, t) = \frac{1}{\#H} \sum_{h\in H} \left[t_h^1 V_i^1 + t_h^2 V_i^2 + (1 - t_h^1 - t_h^2) V_i^{c(h)} \right] - \left(\frac{\sum_{h\in H} t_h^i}{\sum_{h\in H} t_h^i} \right) b_i \tag{5}$$

$$\pi_h(b_1, b_2, t) = \sum_{i=1}^{2} t_h^i u(c(h), w + \frac{1}{\sum_{h\in H} t_h} b_i, z_i) + (1 - t_h^1 - t_h^2) u(c(h), w, \overline{x}_{c(h)}) \tag{6}$$

Notice that in expression (5) when $t_h^i = 1$ the corresponding bureaucrat has signed up to the bribe and proposes the point z_i. When $t_h^1 = t_h^2 = 0$ the corresponding bureaucrat has not signed up to any bribe and proposes $\overline{x}(c(h))$. The interpretation is that the payoff to the donor depends on the average of the proposals by all bureaucrats. Correspondingly, in expression (6) when $t_h^i = 1$ the corresponding individual has accepted the bribe offered by the ith donor and receives the 'corrupt' payoff $u(c(h), w + \frac{1}{\sum_{h\in H} t_h} b, z)$. When $t_h^1 = t_h^2 = 0$ the corresponding bureaucrat has not signed up to any bribe and receives the 'fallback' payoff $u(c(h), w, \overline{x}(c(h)))$.

[9]The equal split of the bribe simplifies matters but is not essential. A more general distribution rule is possible at the cost of inessential technical complications.

[10]Recall our convention that divisions by zero are defined to equal zero.

DEFINITION 2. *An equilibrium is a collection of strategies $(b_1, b_2, s) \in S_1 \times S_2 \times S$, which form a subgame perfect Nash equilibrium (SPNE) of the two-stage game with payoffs as defined above.*

An equilibrium is characterized by the sets of bureaucrats who accept either bribe offer, which we refer to as 'acceptance sets':[11]

$$C^1 = \{h \in H : s_h(b_1, b_2) = (1, 0)\},\ C^2 = \{h \in H : s_h(b_1, b_2) = (0, 1)\}$$

The corresponding payoffs to the donors and individuals are respectively:

$$\pi_i(b_1, b_2, s) = \frac{1}{\#H}\left[\#C^1 V_i^1 + \#C^2 V_i^2 + \sum_{h \in H \setminus C^1 \cup C^2} V_i^{c(h)}\right] - \frac{\#C^i}{\#C^i} b_i \tag{7}$$

$$\pi_h(b_1, b_2, s) = \begin{cases} u(c(h), z_1, w + \frac{1}{\#C^1} b_1),\ h \in C^1 \\ u(c(h), z_2, w + \frac{1}{\#C^2} b_2),\ h \in C^2 \\ u(c(h), \overline{x}(c(h)), w),\ h \in H \setminus C^1 \cup C^2 \end{cases} \tag{8}$$

Equation (7) shows that the payoff of the *ith* donor increases the more individuals take the action z_i instead of the alternative z_j or their fallback action $\overline{x}(c(h))$. Therefore, the donors' payoff is increasing when more bureaucrats accept their bribe and choose z_i.

The following proposition shows that it is always possible to construct acceptance sets for each bribe offer. It will be very useful in the sequel for the discussion of equilibrium in the game.

PROPOSITION 1. *Given $(b_1, b_2) \in S_1 \times S_2$ there is $C^i \subset H$, $i = 1, 2$ such that*
-For $h \in C^i$: $B(c(h), b_j) \leq \frac{b_i}{\#C^i}$, (individuals in C^i accept the bribe b_i).
-For $h \notin C^i$: $B(c(h), b_j) > \frac{b_i}{\#C^i + 1}$, (individuals not in C^i reject the bribe b_i).

Proof: see the Appendix.

The appendix features an example to help clarify the meaning of the above proposition. We can now establish that for any given signals of bribes by the two donors, the body of bureaucrats will split into 'camps' who accept either offer or none, in a way so that no one would prefer to switch camps.

[11]The proportion of the union of these sets to the total corresponds to the 'depth of corruption' as defined in [18].

PROPOSITION 2. *Given* $(b_1, b_2) \in S_1 \times S_2$ *there is* $\overline{s}(b) \in S$ *which is a Nash equilibrium in the second stage of the game.*

Proof: see the Appendix.

We can proceed to study now some facts regarding the equilibrium of our game, which we establish as elementary lemmas. Define $B_{C^i}(b_j) = \max\{B(c(h), b_j) : h \in C^i\}$.

LEMMA 3. *(Effect of type variety) At a SPNE where* $b_i > 0$ *the following must hold:*

$$b_i = (\#C^i)B_{C^i}(b_j) \tag{9}$$

Proof: see the Appendix.

The conclusions of the last lemmas give rise to the following corollary.

COROLLARY 1. *At a SPNE the payoffs for the two donors and bureaucrats are respectively*

(10)

$$\pi_i(b_1, b_2, \overline{s}) = \frac{1}{\#H}\left[\sum_{h\in C^1}(V_i^1 - V_i^{c(h)}) + \sum_{h\in C^2}(V_i^2 - V_i^{c(h)}) + \sum_{h\in H} V_i^{c(h)}\right] - (\#C^i)B_{C^i}(b_j),\ i = 1, 2.$$

$$\pi_h(b_1, b_2, \overline{s}) = \begin{cases} u(c(h), z_1, w + B_{C^1}),\ h \in C^1 \\ u(c(h), z_2, w + B_{C^2}),\ h \in C^2 \\ u(c(h), \overline{x}(c(h)), w),\ h \in H \setminus C^1 \cup C^2 \end{cases} \tag{11}$$

One possibility that could arise at equilibrium is described by the following proposition, which states that at equilibrium one bribe donor is 'outgunned' by the strong interest of another who corrupts all bureaucrats in his favor. However, the equilibrium bribe is higher than it would be required in absence of competition.

PROPOSITION 3. *(The effect of fire power) Suppose that:*
(i) $\forall h \in H\ \frac{1}{\#H}E_1^{c(h)} \geq \#HB_H(V_2^2 - V_2^1) - (\#H - 1)B_{H\setminus\{h\}}(V_2^2 - V_2^1)$.
(ii) $V_1^1 \geq \#HB_H(V_2^2 - V_2^1)$.
Then the strategies $b_1 = \#H\ B_H(V_2^2 - V_2^1)$, $b_2 = V_2^2 - V_2^1$ *and* $s_h(b_1, b_2) = (1, 0)$, $\forall h \in H$, *form a SPNE.*

Proof: see the Appendix.

We can proceed to study now the equilibrium of our game when the authorities have setup the distribution of values of the game as in (4).

PROPOSITION 4. *(Complete unraveling) Under an anti-corruption policy that achieves (4), no bribing is a SPNE of the game, i.e., the profile $b_1 = b_2 = 0$, and for $h \in H$,*

$$s_h(b) = \begin{cases} (0,0) & (b_1, b_2) = (0,0) \\ \overline{s}_h(b) & (b_1, b_2) \neq (0,0) \end{cases} \tag{12}$$

where the function $\overline{s}(b)$ is defined in the proof of proposition (2), is a SPNE strategy profile.

Proof: see the Appendix.

4. Discussion

The setup and the game we developed in the previous sections, summarize our view of how bribes and corruption levels are determined as an equilibrium. The determinants (fundamentals) of the equilibrium bribe and corruption are the valuations of the donors and the minimum bribes reflecting the attitudes of bureaucrats towards breaking rules, as well as the the limitations they face from anti corruption policies, such as monitoring, sanctions,[12] salaries[13] etc.

In a bare bones version of our model where the (type of) bureaucrat in position of authority is known, i.e., when $\#H = 1$, proposition (3) represents the classic scenario where a bribe donor with high valuation succeeds to corrupt the bureaucrat. In our full fledged model this proposition demonstrates how uncertainty magnifies the 'firepower' required for such an outcome.

Our point is that the effectiveness of anti corruption policies can be amplified via the adoption of sophisticated anti corruption practices based on our experience of 'market failures'. In order to substantiate this point we embedded our framework into an uncertainty environment, where the (type of) bureaucrat is unknown, which serves well to exemplify how adverse selection effects can be exploited to the advantage of anti-corruption authorities. Proposition (4) is akin to Akerlof's unraveling of the 'lemons market', albeit in a strategic framework. A key element in the above setting is that all the types of bureaucrats who choose to be corrupt share the bribe. This can be understood to reflect the classical scenario where bribe donors are uncertain as to the exact decision maker, or unable to

[12]See [25] who points out the drawbacks of such policies.

[13]See [5], [4] and [9] who advocate salary increases, but also [32], [26] or [14] who cast doubts as to their effectiveness.

distinguish (types of) bureaucrats. Consequently, they signal a single monetary payoff to every (type of) individual, oblivious as to the value of their service or whether they were ready to accept a rival bribe.

The heterogeneity which is responsible for the unraveling of bribing in the game presented in the previous section, originates from three sources. First, from the varying 'reservation bribes' of individuals, which reflect the different moral codes or other inhibitions of bureaucrats. This is in line with the existing literature. Second, from the varying value of the service that a bureaucrat offers in return for a bribe. This is a novelty proposed in this paper, which is based on the intuition that bureaucrats have some discretion over the actions they take, so the distortion from their default action and hence the benefit for the donor is variable. Third, from the intentions of individuals to accept or reject rival offers. This is another new element proposed in this paper which is a consequence of competition among donors.

The aspect of competition among bribe donors reveals some interesting aspects of corruption. Certainly the rivalry between bribe donors raises the stakes and hence inflates the bribes necessary to lure bureaucrats to their respective camps. Notice that in our model the offer of a bribe, besides the direct benefit for the bribe donor, has some indirect benefits as well. First, the offer of a bribe may attract some bureaucrats to switch camp. Second, even when it is unsuccessful in enticing bureaucrats to corrupt, a bribe offer raises the costs of bribing for the rival and hence deters the corruption of some bureaucrats by the rival. This last point deserves some attention because it offers a view of the emergence of corruption from a perspective that is not obvious in the literature. Namely, that one may be compelled to offer bribes merely in order to deter bureaucrats from accepting rival bribes. In other words, corruption may be the consequence of a 'bad' equilibrium, where each donor thinks that the other will engage in corruption. At equilibrium such beliefs are fulfilled. In conclusion, the competition among bribe donors increases their motives to involve in corruption. However, one should not jump to conclusions regarding the effects of rivalry on the level of corruption. The effect of competition on the number of corrupt bureaucrats is hard to gauge *a priori*, but it is certainly possible to have less corrupt bureaucrats.

With respect to anti-corruption policy the message of this paper is threefold. First, that some measures may be failing because the intensity of the measures required in order to avert corruption is misconstrued, due to underestimation of the benefits of the donors. This is the case especially when the rivalry between donors raises the stakes, to levels where the bureaucrats' salaries, penalties for corruption etc, may pale in front of the monetary values involved. As we saw, in order for anti-corruption measures to be effective they should raise reservation bribes to a level that outweighs not merely the bribe donor's value of getting their way, but in addition their damage from someone else getting their way. This is far more difficult if at all possible to achieve, because the stakes are much higher. Second, that anti-corruption targets may be facilitated by the donors' effort to outbid each other, which raises the reservation bribes of bureaucrats. Hence, selecting decision makers whose default intentions lie in between the desired actions of the donors is a good way to generate rivalry, by way of entrapping donors in an outbidding race, may be a wise practice. Third, that the effectiveness of anti corruption measures can be enhanced if the authorities use the presence of uncertainty effectively. We should not forget that the authorities have the advantage of selecting the membership and population of the potential decision makers, e.g., the candidate bureaucrats or a committee or bureaucracy. Besides the obvious, that a bribe donor would have to pay more individuals in order to secure a favorable decision, the variability of their contribution creates nuance about the benefits from bribing them and hence averts the temptation of doing so.

5. Conclusions

Economics research has mainly focused on the development of methods to control corruption phenomena, which are based on suitable variables (such as wages, monitoring and penalties) that directly influence the incentives of individuals. We propose that these anti-corruption measures can become more effective, by influencing the environment in which individuals operate and thus suppress temptations to engage in corrupt practices in an indirect way. In particular, since such illicit transactions often require to evaluate uncertainties about the characteristics of the individuals involved, authorities could show some creativity by devising anti-corruption practices which maximize the detrimental effects of adverse selection.

In order to substantiate this view, we offered an equilibrium model of bribery that departs from the literature in several dimensions.

of 'types' of bureaucrats involved in a decision. Whereas the literature views bribing as a contractual situation between a bribe donor and a bureaucrat, we considered situations where there are competing interests in corrupting bureaucrats. We believe that this is an issue worthwhile addressing as it arises frequently in cases of serious corruption, such as procurement of public contracts (e.g. defence), design of infrastructure projects and so on. In addition, we focused on situations where a bribe is advanced to some unknown types of bureaucrats, which can be construed also literally as a committee or a whole line of bureaucracy. As we saw these elements involve consideration of multi-agent incentives, so they require some creative thinking because they are not well covered by the standard anti-corruption recipes. The present paper is by no means exhaustive but rather a step in pursuing this line of studying anti-corruption.

The model we presented here lends itself to broader studies of corruption. Two directions that appear promising are as follows. First, our model facilitates the study of corruption when the bribe donors choose strategically both the bribe and the action required. Also bureaucrats may be selecting strategically their default actions. In this way the distortions caused by bribery will be determined endogenously. Second, our model can be stylized and enriched with an active role for authorities, in order to study suitable combinations of anti corruption policies. In particular, since our model incorporates competing interests, it seems well placed for the study of political connections (see [12] and [13]). This line can be taken further to address corruption at the political level, in terms of setting anti corruption policies in a way that favors certain interests against others.

6. Appendix

Proof of lemma 1:

By definition of the minimum bribe acceptable from the ith donor when the jth donor makes the offer (y_j, b_j) we have

$$u_h\left(y_i, w + b_h(y_i; y_j, b_j)\right) \equiv u_h(y_j, w + b_j) + \delta_h(y_i)$$

Differentiating this identity with respect to b_j we obtain

$$\frac{\partial u_h}{\partial I}\left(y_i, B_h(y_i; y_j, b_j)\right) \frac{\partial B_h}{\partial b_j} = \frac{\partial u_h}{\partial I}\left(y_j, b_j\right))$$

Thus, it follows that

$$\frac{\partial B_h}{\partial b_j} = \frac{\partial u_h/\partial I\left(y_i, B_h(y_i; y_j, b_j)\right)}{\partial u_h/\partial I(y_j, b_j)} > 0$$

Proof of lemma 2:

We start with proving the following claim

$$b_i \geq B_h(b_j) \Rightarrow u_h\left(z_j, w + B_h(b_i)\right) > u_h\left(z_i, w + B_h(b_j)\right)$$

By way of contradiction, suppose that for some $h \in H$,

$$u_h\left(z_i, w + B_h(b_j)\right) \geq u_h\left(z_j, w + B_h(b_i)\right)$$

It would then follow that

$$\begin{aligned} u_h\left(z_i, w + B_h(b_j)\right) &\geq u_h\left(z_j, w + B_h(b_i)\right) \\ &= u_h\left(z_i, w + b_i\right) + \delta_h(z_i) \\ &> u_h\left(z_i, w + b_i\right) \end{aligned}$$

But this implies $B_h(b_j) > b_i$ which is a contradiction.

So we conclude that indeed $b_i \geq B_h(b_j) \Rightarrow u_h\left(z_j, w + B_h(b_i)\right) > u_h\left(z_i, w + B_h(b_j)\right)$.

Therefore

$$\begin{aligned} u_h\left(z_j, w + B_h(b_i)\right) &> u_h\left(z_i, w + B_h(b_j)\right) \\ &= u_h\left(z_j, w + b_j\right) + \delta_h(z_j) \\ &> u_h\left(z_j, w + b_j\right) \end{aligned}$$

It follows that $B_h(b_i) > b_j$ as claimed $\square$

Proof of Proposition 1:

We prove the proposition for $i = 1$. Let $\{1, 2, \ldots, \hat{T}\}$ index $c^{-1}(H)$ (the types of players included in H) in accenting order, i.e., $B(t, b_2) < B(t+1, b_2)$ for $t = 1, 2, \ldots, \hat{T} - 1$.

We distinguish the following cases:

Case I: For each $b_1 < B(1, b_2)$

In this case take $C^1 = \emptyset$ which is as desired because $b < B(t, b_2)$, for $t = 1, 2, \ldots, \hat{T}$.

Case II: For each $b_1 \geq \#H \cdot B(\hat{T}, b_2)$

In this case take $C^1 = H$ which is as desired because $\frac{b_1}{\#H} \geq B(t, b_2)$, for $t = 1, 2, \ldots, \hat{T}$.

Case III: For each $B(1, b_2) \leq b_1 < \#H \cdot B(\hat{T}, b_2)$

In this case let t_b be the smallest index so that

$$\#\left(\bigcup_{r \leq t_b} H_r\right) B(t_b, b_2) > b_1$$

Note that the hypothesis of Case III ensures that such a t_b exists.

- If $\left(\#\left(\bigcup_{r \leq t_b - 1} H_r\right) + 1\right) B(t_b, b_2) > b_1$ then take $C^1 = \bigcup_{r \leq t_b - 1} \#H_r$. Observe that by the definition of t_b it must be

$$\begin{aligned} \#C^1 \cdot B(t_b - 1, b_2) &= \#\left(\bigcup_{r \leq t_b - 1} H_r\right) B(t_b - 1, b_2) \\ &\leq b_1 \end{aligned}$$

Notice that

-For $h \in C^1$: $B(c(h), b_2) \leq B(t_b - 1, b_2) \leq \frac{b_1}{\#C^1}$

-For $h \notin H^1$: $B(c(h), b_2) \geq B(t_b, b_2) > \frac{b_1}{\#C^1 + 1}$

so the set C^1 is as desired.

• If $\left(\#\left(\bigcup_{r\le t_b-1} H_r\right)+1\right) B(t_b,b_2) \le b_1$ then identify a subset $D \subset H_{t_b}$ as follows. Consider the function $f(x)=\left(\#\left(\bigcup_{r\le t_b-1} H_r\right)+x\right) B(t_b,b_2)-b_1$, where $0 \le x \le \#H_{t_b}$. We have that $f(\cdot)$ is continuous and

$$\begin{aligned} f(0) &= \#\left(\bigcup_{r\le t_b-1} H_r\right) B(t_b,b_2)-b_1 \\ &< \left(\#\left(\bigcup_{r\le t_b-1} H_r\right)+1\right) B(t_b,b_2)-b_1 \\ &\le 0 \end{aligned}$$

$$\begin{aligned} f(\#H_{t_b}) &= \left(\#\left(\bigcup_{r\le t_b-1} H_r\right)+\#H_{t_b}\right) B(t_b,b_2)-b_1 \\ &= \#\left(\bigcup_{r\le t_b} H_r\right) B(t_b,b_2)-b_1 \\ &> 0 \end{aligned}$$

We conclude that there exists $x^\star \in [0,\#H_{t_b}]$ such that $f(x^\star)=0$, i.e.,

$$\left(\#\left(\bigcup_{r\le t_b-1} H_r\right)+x^\star\right) B(t_b,b_2)=b_1$$

Choose a $D \subset H_{t_b}$ where[14] $\#D=[x^\star]$ and define $C^1=\left(\bigcup_{r\le t_b-1} H_r\right)\cup D$. We have

$$\begin{aligned} -\text{For } h\in C^1:\ B(c(h),b_2) &\le B(t_b,b_2) \\ &= \frac{b_1}{\#\left(\bigcup_{r\le t_b-1} H_r\right)+x^\star} \\ &\le \frac{b_1}{\#\left(\bigcup_{r\le t_b-1} H_r\right)+\#D} \\ &= \frac{b_1}{\#C^1} \end{aligned}$$

[14] We denote by $[x]$ the integer part of x.

$$
\begin{aligned}
-\text{For } h \notin C^1: \; B(c(h), b_2) &\geq B(t_b, b_2) \\
&= \frac{b_1}{\#\left(\bigcup_{r \leq t_b - 1} H_r\right) + x^\star} \\
&> \frac{b_1}{\#\left(\bigcup_{r \leq t_b - 1} H_r\right) + \#D + 1} \\
&= \frac{b_1}{\#C^1 + 1}
\end{aligned}
$$

so C^1 is as desired in this case as well.

In conclusion, given any $b_1 > 0$ we can construct $C^1 \subset H$ as claimed □

Example 1. *Consider a set of individuals* $\{1, 2, 3, 4\}$ *with reservation bribes corresponding to two types as follows:* $B(c_1, b_2) = 1$, $B(c_i, b_2) = 3$ *for* $i = 2, 3, 4$.

-For $b_1 \geq 12$ *the whole pool* $C = \{1, 2, 3, 4\}$ *accepting the bribe* b_1 *is the only possibility.*

-For $9 \leq b_1 < 12$ *there are three possibilities, where any three member pool including individual* 1 *could conceivably be corrupt:* $C_1 = \{1, 2, 3\}$, $C_2 = \{1, 2, 4\}$ *and* $C_3 = \{1, 3, 4\}$, *where individuals receive a bribe* $\frac{b_1}{3}$ *each, which is at least equal to their respective reservation bribes.*

-For $6 \leq b_1 < 9$ *there are three possibilities, where any two member pool including individual* 1 *could conceivably be corrupt:* $C_1 = \{1, 2\}$, $C_2 = \{1, 3\}$ *and* $C_3 = \{1, 4\}$ *with individuals receiving a bribe of* $\frac{b}{2}$ *each, which is at least equal to their respective reservation bribes.*

-For $1 \leq b_1 < 6$ *the only possibility is where individual* 1 *is corrupt:* $C = \{1\}$.

-For $b_1 < 1$ *the only possibility is where no individual is corrupt.*

This example also demonstrates how unraveling happens as we go down the possible bribe values. Observe that the individual with the lowest reservation bribe is always included in every corrupt pool. Agents with higher reservation bribes would drop out of any corrupt pool as we lower the bribe payment.[15]

Proof of proposition 2:

Given $(b_1, b_2) \in S_1 \times S_2$, we proceed by applying proposition (1) iteratively as follows

Step I Construct a subset $D_1 \subseteq H$ of all individuals who accept the bribe b_1, along the

[15]One could extend the model and assign beliefs on the possible pools that can form a Nash equilibrium for each bribe bill. This would make expected payoffs symmetric for each player type. In the interest of simplicity, we do not pursue this argument here.

lines of proposition (1).

-For each $h \in D_1$ we have

• $\frac{b_1}{\#D_1} \geq B(c(h), b_2)$

• By lemma (2) $B\left(c(h), \frac{b_1}{\#D_1}\right) > b_2$.

-For each $k \notin D_1$, by construction we have

• $B\left(c(k), b_2\right) > \frac{b_1}{\#D_1+1}$.

• $B\left(c(k), b_2\right) \geq B\left(c(h), b_2\right)$, $\forall h \in D_1$.

If $D_1 = H$ take $C^1 = H$, $C^2 = \emptyset$.

If $H \setminus D_1 \neq \emptyset$ construct a subset $D_2 \subseteq H \setminus D_1$ of all individuals who, given $\frac{b_1}{\#D_1}$ accept the bribe b_2, along the lines of proposition (1).

-For each $h \in D_2$ we have

• $\frac{b_2}{\#D_2} \geq B\left(c(h), \frac{b_1}{\#D_1}\right)$

• By lemma (2) $B\left(c(h), \frac{b_2}{\#D_2}\right) > \frac{b_1}{\#D_1}$.

-For each $k \notin D_2$ we have

• $B\left(c(k), \frac{b_1}{\#D_1}\right) > \frac{b_2}{\#D_2+1}$.

• $B\left(c(k), \frac{b_1}{\#D_1}\right) \geq B\left(c(h), \frac{b_1}{\#D_1}\right)$, $\forall h \in D_2$.

If $D_1 \cup D_2 = H$ take $C^1 = D_1$, $C^2 = D_2$.

Step II If $H \setminus D_1 \cup D_2 \neq \emptyset$ we construct a subset $D_3 \subseteq H \setminus D_2$ of all individuals who, given $\frac{b_2}{\#D_2}$ accept the bribe b_1, as follows:

By the forth bullet point in Step I, and assumption (1) we have for $k \notin D_1$,

$$B\left(c(k), \frac{b_2}{\#D_2}\right) \geq B\left(c(h), \frac{b_2}{\#D_2}\right), \ \forall h \in D_1$$

Hence, we can form the set D_3 by complementing D_1 along the lines of proposition (1), i.e., $D_1 \subseteq D_3$.

-For each $h \in D_3$ we have

• $\frac{b_1}{\#D_3} \geq B\left(c(h), \frac{b_2}{\#D_2}\right)$

• By lemma (2) $B\left(c(h), \frac{b_1}{\#D_3}\right) > \frac{b_2}{\#D_2}$.

-For each $k \notin D_3$, we have

- $B\left(c(k), \frac{b_1}{\#D_3}\right) > \frac{b_1}{\#D_3+1}$.
- $B\left(c(k), \frac{b_2}{\#D_2}\right) \geq B\left(c(h), \frac{b_2}{\#D_2}\right)$, $\forall h \in D_2$.

Proceeding the same way we construct a subset $D_4 \subseteq H \setminus D_3$ of all individuals who, given $\frac{b_1}{\#D_3}$ accept the bribe b_2, where we have $D_2 \subseteq D_4$.

If $D_3 \cup D_4 = H$ take $C^1 = D_3$, $C^2 = D_4$.

Step III If $H \setminus D_3 \cup D_4 \neq \emptyset$ repeat Step II as necessary. Notice that this procedure can last at most $n = \#H$ steps. We can take then the sets $C^1 = D_{2n-1}$, $C^2 = D_{2n}$.

Define now for $h \in H$, the behavioral strategy profile

$$\overline{s}_h(b) = \begin{cases} (1,0) & h \in C^1 \\ (0,1) & h \in C^2 \\ (0,0) & H \setminus C^1 \cup C^2 \end{cases}$$

This profile constitutes a Nash equilibrium in the second stage because

-For each $h \in C^1$ we have

- $\frac{b_1}{\#C^1} \geq B\left(c(h), \frac{b_2}{\#C^2}\right)$ (accept bribe b_1).
- $B\left(c(h), \frac{b_1}{\#C^1}\right) > \frac{b_2}{\#C^2} > \frac{b_2}{\#C^2+1}$ (reject bribe b_2).

-For each $h \in C^2$ we have

- $\frac{b_2}{\#C^2} \geq B\left(c(h), \frac{b_1}{\#C^1}\right)$ (accept bribe b_2).
- $B\left(c(h), \frac{b_2}{\#C^2}\right) > \frac{b_1}{\#C^1} > \frac{b_1}{\#C^1+1}$ (reject bribe b_1).

-For each $k \in H \setminus C^1 \cup C^2$ we have

- $B\left(c(k), \frac{b_2}{\#C^2}\right) > \frac{b_1}{\#C^1+1}$ (reject bribe b_1).
- $B\left(c(k), \frac{b_1}{\#C^1}\right) > \frac{b_2}{\#C^2+1}$(reject bribe b_2).

which completes our proof $\square$

Proof of Lemma 3:

We have $b_i \geq (\#C^i)B_{C^i}(b_j)$ for $i = 1, 2$. Suppose that, say, $b_1 > (\#C^1)B_{C^1}(B_2)$. Then for any b'_1 such that $(\#C^1)B_{C^1}(B_2) \leq b'_1 < b_1$, we would still have $B(c(h), b_2) \leq B_{C^1}(B_2) \leq \frac{b'_1}{(\#C^1)}$ for $h \in C^1$. Also, $\frac{b'_1}{(\#C^1+1)} < \frac{b_1}{(\#C^1+1)} < B(c(h), z)$ for $h \notin C^1$.
By choosing b'_1 sufficiently close to b_1 we can ensure that $B(c(k), b'_1) > \frac{b_2}{(\#C^2+1)}$, for $k \notin C^2$. Therefore the profile

$$s_h(b'_1, b_2) = \begin{cases} (1,0) & h \in C^1 \\ (0,1) & h \in C^2 \\ (0,0) & H \setminus C^1 \cup C^2 \end{cases}$$

is still a Nash equilibrium in the second stage.
However, in this case $\pi_i(b'_i, b_j, s) > \pi_i(b_i, b_j, s)$, contradicting the SPNE □

Proof of Proposition 3:

For the suggested strategies b_1, b_2 we have

- $\pi_1(b_1, b_2, s) = V_1^1 - \#H B_H(V_2^2 - V_2^1)$
- $\pi_2(b_1, b_2, s) = V_1^2$

Let b'_1 be a bribe not acceptable by some bureaucrat $k \in H$. Then
-If k does not accept the bribe b_2 we have

$$\pi_1(b'_1, b_2, s) = \frac{1}{\#H}\left[(\#H-1)V_1^1 + V_1^{c(k)}\right] - (\#H-1)B_H(V_2^2 - V_2^1)$$

-If k accepts the bribe b_2 we have

$$\pi'_1(b'_1, b_2, s) = \frac{1}{\#H}\left[(\#H-1)V_1^1 + V_1^2\right] - (\#H-1)B_H(V_2^2 - V_2^1)$$

Clearly $\pi_1(b'_1, b_2, s) > \pi'_1(b'_1, b_2, s)$.
From condition *(i)* of the proposition it follows that

$$\pi_1(b_1, b_2, s) - \pi_1(b'_1, b_2, s) \geq 0 \tag{13}$$

It follows that b_1 is best response to b_2.

Let now b_2' be a bribe acceptable by some bureaucrat $k \in H$. Then

$$\begin{aligned} u_k\left(z_2, w + B_k(b_1)\right) &\equiv u_k(z_1, w + b_1) + \delta_k(z_2) \\ &= u_k(z_1, w + B_k(V_2^2 - V_2^1)) + \delta_k(z_2) \\ &\equiv u_k(z_2, w + (V_2^2 - V_2^1)) + \delta_k(z_2) + \delta_k(z_1) \qquad (14) \end{aligned}$$

so clearly it must be $b_2' > V_2^2 - V_2^1$. In this case

$$\begin{aligned} \pi_1(b_1, b_2', s) &= \frac{1}{\#H}\left[\#C^2 V_2^2 + (\#H - \#C^2)V_2^1\right] - b_2' \\ &< \frac{1}{\#H}\left[\#C^2 V_2^2 + (\#H - \#C^2)V_2^1\right] - V_2^2 + V_2^1 \\ &= V_2^1 + \left(1 - \frac{\#C^2}{\#H}\right)\left(V_2^1 - V_2^2\right) \\ &< V_2^1 \\ &= \pi_2(b_1, b_2, s) \qquad (15) \end{aligned}$$

It follows that b_2 is best response to b_1. □

Proof of Proposition 4:

Let $b_j = 0$, $j = 1, 2$. We will show that $b_i = 0$, $j \neq i$ is a best response for donor $i = 1, 2$.
We have $\pi_i(0, 0, s) = \frac{1}{\#H}\sum_{h\in H} V_i^{c(h)}$.
On the other hand for any $b_i > 0$ we have

$$\begin{aligned} \pi_i(b_i, 0, \overline{s}) &= \frac{1}{\#H}\left[\#C^i V_i^i + \sum_{h\in H\setminus C^i} V_i^{c(h)}\right] - (\#C^i)B_{C^i}(b_j) \\ &= \frac{1}{\#H}\left[\sum_{h\in C^i}(V_i^i - V_i^{c(h)}) + \sum_{h\in H} V_i^{c(h)}\right] - (\#C^i)B_{C^i}(b_j) \\ &= \frac{1}{\#H}\left[\sum_{h\in C^i} E_i^{c(h)} + \sum_{h\in H} V_i^{c(h)}\right] - (\#C^i)B_{C^i}(b_j) \qquad (16) \end{aligned}$$

- **Case I** $C^i = \emptyset$

In this case $\pi_i(b_i, 0, \overline{s}) = \frac{1}{\#H}\sum_{h\in H} V_i^{c(h)} = \pi_i(0, 0, s)$.

- **Case II** $C^i \neq \emptyset$.

In this case denote $h^\star \in C^i$ the most valuable individual, i.e., $E_i^{c(h^\star)} = \max\{E_i^{c(h)} : h \in C^i\}$. We have $E_i^{c(h^\star)} \geq E_i^{c(h)}$, $\forall h \in C^i$, so $E_i^{c(h^\star)} \geq \frac{1}{\#C^i}\sum_{h\in C^i} E_i^{c(h)}$.
So by (4) we conclude that[16]

$$\begin{aligned}
B_{C^i}(b_j) &\geq B^0_{c(h^\star)}(z_i) \\
&> \mu_H(c(h^\star))E_i^{c(h^\star)} \\
&\geq \mu_H(c(h^\star))\frac{1}{\#C^i}\sum_{h\in C^i} E_i^{c(h)} \\
&= \frac{\#(c^{-1}(c(h^\star))\cap H)}{\#H\#C^i}\sum_{h\in C^i} E_i^{c(h)} \\
&\geq \frac{1}{\#H\#C^i}\sum_{h\in C^i} E_i^{c(h)} \qquad (17)
\end{aligned}$$

Therefore, $\frac{1}{\#H}\sum_{h\in C^i} E_i^{c(h)} - (\#C^i)B_{C^i}(b_j) < 0$ so

$$\begin{aligned}
\pi_i(b_i, 0, \overline{s}) &= \frac{1}{\#H}\left[\sum_{h\in C^i} E_i^{c(h)} + \sum_{h\in H} V_i^{c(h)}\right] - (\#C^i)B_{C^i}(b_j) \\
&< \frac{1}{\#H}\sum_{h\in H} V_i^{c(h)} \\
&= \pi_i(0,0,s) \qquad (18)
\end{aligned}$$

which proves that $b_i = 0$, is a best response for donor $i = 1, 2$ to $b_j = 0$ for $j \neq i$ $\square$

[16] This is exactly the 'lemons' effect.

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