

Notes on bribery and the control of corruption

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Existing models of corruption that allow for bribery have ignored an important recursive problem. When an auditor or a policeman bargains over a bribe with a person he has arrested, he has to take into account the fact that he may, in turn, be caught for taking this bribe and be involved in a similar bargain, but from the other side. The purpose of this paper is to provide a simple model for capturing this recursion. Having done so, it goes on to analyse some conditions for the control of corruption. These turn out to be different from what conventional wisdom suggests.

1. The problem

A person, Z , is considering committing a crime or an act of corruption, like evading income tax or accepting a bribe. Let the benefit to him from this act be B units, the probability of getting caught be p , and the penalty be f . The problem confronting Z is allegedly a simple decision problem in which he has to only calculate the expected cost associated with the corrupt act (in this case this is pf) and commit the crime if this is less than the booty (in this case B). This is the standard model of crime and corruption [e.g. Becker (1968)]. One can complicate the description by bringing in utility functions, non-neutral attitudes to risk and wealth effects – but we want to argue here that there is a more fundamental problem with this model and its many variants that have appeared in the literature.

This is especially true in the case of bribery. Suppose that in the above model the crime in question involves person Z taking a bribe of amount B , and that Z is caught after the crime by policeman 1. In the standard model he then has to pay a penalty of f which goes to the government. But clearly we should allow for the fact that he may try to bribe policeman 1. Especially

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since the original crime was supposed to involve bribery, there is no reason now to assume that bribery is not possible.

If we allow for bribery and policeman 1 is treated as a rational homo oeconomicus, then what we have confronting us now is a standard bargaining problem involving Z and 1. If they fail to reach an agreement (about the appropriate size of the bribe), then we shall suppose that Z will have to pay the penalty f which will be handed over to the government and 1 will get nothing. Hence, the official penalty plays the role of determining where the threat-point (or 'fall-back utility') of the two agents is. It is worth noting straight away that even if no one pays penalties in the society, the size of the penalty can play a role in crime control because it can influence the equilibrium level of the bribe.

In the above bargaining problem we shall determine the outcome by applying the standard Nash solution. But the application of the Nash solution is not as easy as may appear at first sight.

To explain the difficulty let us assume that in this society, bribe-giving is not considered a crime; only bribe-taking is. Nothing essential is lost by this assumption of asymmetry as is demonstrated later in footnote 4.

Suppose now that Z gives policeman 1 a bribe of B_1 . To compute the Nash solution we need to know how much 1 benefits from this. The problem is complicated by the fact that after 1 takes the bribe, he in turn can be caught by policeman 2. Hence, although he gets B_1 to start with, in the end his expectation is lower. The chain continues and our modelling will depend on whether we think of this as a finite or an infinite chain. Empirically, bribes moving up a hierarchy are well known [see, for example, Wade (1988)]; our aim here is to give this theoretical structure.¹

We begin by considering the *infinite-chain* case. To solve the Nash bargaining problem at any stage we need, in some sense, to know what will happen in all future stages. An important aim of this paper is to formalise the above problem in a way that allows us to pose the infinite regress problem in a manageable way. After doing that, we consider some variants of the model and discuss how the penalty size and the probability of detecting corruption can be used to control corruption in a society.

2. Nash bargaining and equilibrium bribe

In developing a formal structure it is useful to begin by restating rigorously some of the remarks of the previous section.

If a person is caught taking a bribe of B units, he is expected to pay a

¹Cadot (1987) has also discussed bribery in a model with a hierarchical administration. But his model is different and, in particular, is not concerned with the problem of recursion which is central to our analysis. See, also, Rose-Ackerman (1975) for a model in which the government uses an intermediate agency to perform certain economic tasks.

penalty or fine of $f(B)$. So f is the *penalty function* specified by the country's law.

The probability of getting caught after taking a bribe is p . For simplicity we assume that p does not depend on B . The real number p and the function f are both controlled by the government and are exogenous to our model.²

Next we define the central feature of our model – the *bribe function*, ϕ . If a person is caught having taken a bribe B , he can get away by paying a bribe of $\phi(B)$. The bribe function is endogenous. It is determined by Nash bargaining and by taking into account the infinite regress problem discussed in section 1. Fortunately the infinite regress can be captured by a simple one-shot recursive procedure.

We assume that if a bribe-taker is caught, he indulges in Nash bargaining with his captor in deciding on the bribe. If the bargain fails, the bribe-taker has to pay the penalty (which goes to the government) and the captor gets nothing. In working out the bargaining solution it has to be kept in mind that the captor, should he take a bribe, risks being caught by another person.

Keeping this in mind and using Nash bargaining we can define an equilibrium bribe function as follows.

The function ϕ is an *equilibrium* if and only if, for all $B \geq 0$,

$$\operatorname{argmax}_B [f(B) - B'] [B' - p\phi(B')] = \phi(B).$$

To understand the equilibrium definition fully, it may be useful to write the above equation a little more elaborately as follows:

$$\operatorname{argmax}_B [(B - B') - (B - f(B))] [B' - p\phi(B')] = \phi(B).$$

Suppose person n has been caught by person $n+1$ for having taken a bribe of B . Now n is trying to give a bribe to $n+1$. If he can get away by giving a bribe of B' , then his net gain is $[(B - B') - (B - f(B))]$. This is so because if the bargain fails, n falls to n 's threat level which is $B - f(B)$. Now look at it from $n+1$'s point of view. If he accepts a bribe of B' , his net gain is $B' - p\phi(B')$. It must be remembered that on his way home with a bribe of B' there is a probability p he will be caught and he will then in turn have to pay a bribe of $\phi(B')$. Since we are interested in the Nash bargaining solution we find out the equilibrium value of B' by maximizing the multiplication of the net gains.

²There is an incentive aspect to bribe, stemming from the fact that, after apprehending a criminal, a policeman is entitled to a bribe income. We would therefore expect the probability of catching a criminal to depend positively on the size of the bribe. In a larger setting bribes could affect the *nature* of economic equilibrium. For instance, in a system of queuing for government licences or quotas, bribes could be a mechanism for moving up the queue [for related work, see Lui (1985)].

Since the equilibrium B' thus derived is the bribe that n has to give for having taken a bribe of B , B' must be equal to $\phi(B)$.

In the completely general case the existence of equilibrium is difficult to prove, let alone characterise. Also, there is a problem of interpreting the Nash solution. As is well known, the standard Nash solution was developed for the case where the feasible set is convex [see, for example, Friedman (1986)]. Although some of the other bargaining solutions, like that of Kalai and Smorodinsky (1975), can be adapted for the non-convex case, the same is not true of the Nash solution [Anant, Basu and Mukherji (1990)].

Here we use a simplifying assumption that ensures the relevant convexity, guarantees existence, and allows us to characterise the equilibrium. From now on we focus on a linear penalty function:

$$f(B) = FB, \quad \text{where } F > 0. \quad (1)$$

In this case the equilibrium bribe function is easily deduced to be

$$\phi(B) = FB/2. \quad (2)$$

Hence, the amount of the bribe that has to be paid is half the amount of the fine.

Let us check, in terms of the exogenous variables p and F , as to how corruption may be controlled in this society.

It will not be worthwhile for a person to take a bribe of B if his net expected gain from this is non-positive. Clearly his net expected gain, given (1) and (2), is given by $X \equiv (1-p)B + p[B - (FB/2)]$. If bribing is to be stopped, X has to be less than or equal to zero for all B . This will be so if and only if

$$pF \geq 2 \quad (3)$$

What is interesting is to compare this with a society in which if you are caught for taking a bribe, B , you have to pay the fine FB . This is the standard model. In the standard model taking a bribe is not worthwhile if and only if

$$(1-p)B + p[B - FB] \leq 0 \quad \text{or} \quad pF \geq 1. \quad (4)$$

Comparing (3) and (4) it is clear that, once we make allowance for using bribery to get away from having to pay the penalty for an initial crime, the problem of crime control is much more difficult (pF has to be ≥ 2) than is supposed on the basis of the standard model (where pF has to be ≥ 1).

Observe also that although in our model (suppose $pF < 2$) the penalty is

never paid, the penalty nevertheless is an instrument that can be used to curb corruption. It is a less efficient instrument than originally supposed, but an instrument all the same. So the wisdom occasionally expressed in popular fora, namely that if a penalty is always evaded through bribery then we may as well not have the penalty, is wrong. The penalty influences the equilibrium bribe and can therefore be an indirect instrument of control. This is, in a sense, a similar idea to the one developed in Huberman and Kahn (1988), where agents write contracts knowing that these will be renegotiated away later on. This is because the initial contract influences the threat-point of the renegotiation bargain.

3. Elite forces and finiteness

F and p are not the only variables a government uses to control crime and corruption. Creating a special elite civil service that is highly paid and trained to block (at least petty) corruption has been tried by most nations. To see the impact of this, let us incorporate this into our model of section 2. There are two ways of doing this.

3.1. The hierarchical elite

First, we shall suppose that if a person Z is caught for an initial crime, he can bribe policeman 1 to get away, policeman 1 can bribe policeman 2, etc.; but the chain is not endless. After the n th round of bribery the police officer one encounters belongs to the elite civil service and he (yes, let us assume) is incorruptible. In other words, we wish to consider a finite model analogue of the previous model. In studying this we shall retain the linearity assumption (1).

We have to solve the problem by backward induction. Consider the n th round. Person i who had taken a bribe of B has been caught by person j . Now i is trying to bribe j . In working out the Nash bargaining solution, we have to keep in mind that if j accepts a bribe of B' and is then himself caught, he will have to pay a penalty of FB' . There is no further getting away. Hence, the Nash bargaining solution between i and j is given by

$$\operatorname{argmax}_{B'} [FB - B'] [B' - pFB'] = \phi_n(B), \quad (5)$$

where $\phi_n(B)$ is the bribe a person has to give in the n th round if he is caught having taken a bribe of B . It is easy to check that, if $pF < 1$, then

$$\phi_n(B) = FB/2, \quad (6)$$

which is exactly the same as (2). This being so, for all earlier stages, t , the bribe function will be exactly the same, namely $\phi_t(B) = FB/2$.

In other words having an incorruptible elite service blocks corruption after the n th round but, surprisingly, leaves the structure of bribery unchanged in the earlier stages.

It is however interesting to note that in this case the conditions for the control of corruption are not the same as those following (2), although (6) has the same form as (2). To see this, note that (6) is valid if $pF < 1$. This is because $pF > 1$ implies that $B' - pFB' < 0$. From (5) it is clear that the n th bribe-taker (i.e. the last bribe-taker) would in such a situation make a loss by taking a bribe B' , no matter what value B' takes. Hence the n th person would not take a bribe if $pF \geq 1$.

Suppose now $pF \geq 1$, and consider the $(n-1)$ th policeman. Since the n th policeman will not take a bribe, it is as if the n th policeman belongs to the incorruptible elite service. So our $(n-1)$ th policeman's decision problem is identical to the n th policeman's decision problem discussed in the above two paragraphs. But in that case we know that if $pF \geq 1$, the policeman will not take a bribe. So the $(n-1)$ th policeman will not take a bribe. It follows, by backward induction, that if $pF \geq 1$, corruption will not occur.³

3.2. *The mingling elite*

It is possible that the incorruptible policemen (elites) are uniformly distributed across different layers ($n = 1, 2, \dots$), unlike the previous case where one particular layer consisted only of elites. Assuming the fraction of incorruptible policeman in each layer to be same (say equal to d), d can be viewed as the probability that a corruptible officer (or person Z) assigns to his superior officer (the one who apprehends him) being of the incorruptible type.

Following our earlier method it is obvious that the equilibrium bribe, $\phi(B)$, is worked out from the following:

$$\operatorname{argmax}_B [FB - B'] [B' - p\{(1-d)\phi(B') + dFB'\}] \equiv \phi(B).$$

Differentiating the left-hand expression with respect to B' , setting it equal to zero and solving it, gives us $B' = FB/2$ or $\phi(B) = FB/2$.

To deter corruption the government will now have to set

³As always, the backward-induction argument is predicated upon a tenuous information structure. It presupposes that policeman 1 knows that policeman 2 knows that ... that policeman $(n-1)$ knows that policeman n is incorruptible. Small violations of this information assumption could alter the results as we know from standard works in game theory [e.g. Kreps, Milgrom, Roberts and Wilson (1982)].

$$p(1+d)F \geq 2. \quad (7)$$

This is easily checked. To select an optimal control mechanism the government will have to figure out the costs of raising p , d and F , then minimise this sum subject to (7). It is interesting to note that if $d=0$, (7) becomes $pF \geq 2$, which is our model of section 2, and if $d=1$, we get $pF \geq 1$, which is the conventional view.

3.3. The finite case with no elite

To complete our line of enquiry we ought to discuss a case where the hierarchy is finite, as in subsection 3.1, but there is no elite force at the top of the hierarchy. The chain of auditors and super-auditors stops at the n th level, and at the n th level a bribe can be taken with no fear of being apprehended. In this case if the $(n-1)$ th policeman is caught by the n th policeman for having taken a bribe of size B , the bribe he has to give in order to get away, $\phi_n(B)$, is clearly given by

$$\operatorname{argmax}_B [FB - B'] [B'] = \phi_n(B).$$

It follows that $\phi_n(B) = FB/2$. Moreover, for all earlier stages the same is true. That is, $\phi_t(B) = FB/2$, for all $t = 1, \dots, n$.

4. Corruption and chain arrests

We have thus far worked with the assumption that when a person is apprehended for some act of corruption, the chain of corruption preceding him is left unearthed. Another possible assumption is to go to the other polar end and suppose that if the k th policeman is caught for having taken a bribe, then *all* the earlier bribe-takers in the chain are caught. It is difficult to decide a priori as to which is a better assumption. If a person is caught red-handed taking a bribe, it may be realistic to assume that the entire chain of corrupt acts, starting from person Z , can be unearthed. Therefore, in the absence of empirical evidence it is worthwhile considering the case of 'chain arrests' as well.

The infinite case (i.e. the counterpart of the model of section 2) is straightforward. We shall throughout this section make one assumption for simplicity. Suppose the k th policeman unearths a chain of bribe-taking from person Z , through policeman 1 to policeman $(k-1)$. We shall assume that each arrested person bargains independently with their arrester, namely policeman k . In the infinite case the probability of person Z being caught for having taken a bribe, B , by policeman 1 is p . Suppose he bribes him and

'gets away'. The probability of policeman 1 being caught by policeman 2 and therefore of Z being caught by policeman 2 (remember arrests occur in chains now) is p . Therefore, when Z takes a bribe of B , the probability of being caught by policeman 2 is p^2 , and, by an extension of the same argument, the probability of being caught by policeman t is p^t . It follows that the bribe he has to give policeman 1, $\phi(B)$, is given by

$$\operatorname{argmax}_{B'} \left[FB - \left(\frac{1}{1-p} \right) B' \right] \left[B' - p \left(\frac{1}{1-p} \right) \phi(B') \right] = \phi(B),$$

since $1 + p + p^2 + \dots = 1/(1-p)$. Hence $\phi(B) = (1-p)FB/2$.

It follows that the expected aggregate bribe that Z has to pay is

$$\frac{(1-p)FB}{2} (p + p^2 + \dots) = p \frac{FB}{2}.$$

As before, corruption is curbed if $pF > 2$.

The finite case (i.e. the counterpart of the model of subsection 3.3) is, however, much more interesting. Let us suppose that the n th stage is the last one and there is no incorruptible elite force involved. Let B be the amount of bribe taken by the i th policeman and B_0 the bribe taken by Z. Consider the n th round. Thus policeman n has arrested all the bribe-takers. Let $\phi_{ni}(B)$ be the bribe that person i has to pay to policemen n when arrested by n . We follow the convention that if $i=0$, then the reference is to person Z. Since getting away at the last stage means complete acquittal, it follows that

$$\phi_{ni}(B) = \operatorname{argmax}_{B'} [FB - B'] [B'] = \frac{FB}{2} \quad i = 0, \dots, n-1.$$

Now consider the penultimate round. Thus policeman $(n-1)$ has made a chain arrest of $0, 1, \dots, (n-2)$ for having taken bribes (remember 0 here refers to Z). Clearly if i has taken a bribe of B he has to pay policeman $(n-1)$ a bribe as given below

$$\begin{aligned} \phi_{(n-1)i}(B) &= \operatorname{argmax}_{B'} \left[FB - B' - p \frac{FB}{2} \right] \left[B' - p \frac{FB'}{2} \right] \\ &= \left(1 - \frac{p}{2} \right) \frac{FB}{2}, \quad i = 0, \dots, n-2. \end{aligned}$$

Proceeding similarly, it can be shown through some tedious but simple algebra that if Z is caught by 1 for having taken a bribe of B , he has to pay a bribe of

$$\left(1 - \frac{p}{2} - \frac{p^2}{4} - \cdots - \frac{p^{n-1}}{2^{n-1}}\right) \frac{FB}{2}.$$

Hence the *total* expected bribe payment by Z would be given by

$$\begin{aligned} p \left(1 - \frac{p}{2} - \cdots - \frac{p^{n-1}}{2^{n-1}}\right) \frac{FB}{2} + p^2 \left(1 - \frac{p}{2} - \cdots - \frac{p^{n-2}}{2^{n-1}}\right) \frac{FB}{2} + \cdots + p^n \frac{FB}{2} \\ = p \frac{FB}{2} \left(1 + \frac{p}{2} + \cdots + \frac{p^{n-1}}{2^{n-1}}\right). \end{aligned} \quad (8)$$

For large n – more precisely, as n goes to infinity – (8) reduces to $pFB/(2-p)$. Hence, Z would not commit the initial crime of B if and only if

$$B \leq \frac{pFB}{2-p}.$$

In other words, corruption is curbed if

$$2 \leq p(F+1).^4 \quad (9)$$

Expression (9) is interesting because, unlike in all the other cases considered in this paper, p and F are shown here to play asymmetrical roles in the control of corruption. There is a widespread view that since increasing the probability of detecting corruption, namely p , is usually an expensive affair entailing an expansion of the police force, whereas raising the penalty, F , can be achieved relatively costlessly, by the stroke of a magisterial pen, it is better to control corruption by a greater reliance on F . Condition (9) coaxes us gently in the other direction since it shows that raising p a little

⁴We have throughout assumed that only *bribe-taking* is a crime. It is easy to extend our model to the case where *giving* a bribe is also considered a crime. Remaining within the linear framework, suppose the penalty for *giving* a bribe of B is GB . Given this assumption, it is possible to check by the method of Nash bargaining and recursion, used above, that if Z is caught for having taken a bribe of B , he will have to pay policeman 1 a bribe of $FB/(2+pG)$ in order to get away. And it is easily checked that the *total* expected bribe payment (i.e. once for taking and several times for giving) would be once again $pFB/2$.

has a more powerful thwarting effect on corruption than is suggested by the conventional models as captured by (4), or even (3).

5. Concluding remarks

There are several directions that can be pursued from here. An obvious venture is to endogenize p and d . Recall that d is the probability that, if one is caught by a policeman, the policeman will turn out to be incorruptible. Moreover, an incorruptible policeman or auditor in our model is someone who does not accept bribes, no matter what the net benefits. It could, however, be argued that although an incorruptible person never takes a bribe, the fraction of the police and auditor population that chooses to be incorruptible depends on how 'expensive' it is to be incorruptible (not on a case-by-case basis, but in equilibrium). This would endogenize d and raise the possibility of multiple equilibria since it may be more expensive to be incorruptible if more people are corrupt.⁵

Turning to p , note that while it is the size of the elite force, within the police force or tax collectors that affects d , p is directly related to the size of the police force or tax collectors, C . To the extent that raising C is costly, a government may have to settle for a lower p than is technically possible. It is possible to derive more specific expressions by attributing a specific social welfare function to the government and filling in the positive features of the model.

Our model suggests another route for endogenizing p which does not require C to be endogenous. Note that the probability of detecting corruption depends not just on the size of the police force but also on the effort it exerts. Increased effort diminishes a person's utility through the reduction of leisure, but in our model, because of the presence of bribery, there is an offsetting aspect to this. Increased effort at catching corrupt people enhances one's 'bribery income'. Since an enhanced effort raises p , a fruitful line of enquiry would be to endogenize p by bringing the auditor's utility function, with leisure and income as arguments, into the analysis.⁶

Another matter worthy of future investigation is the use of rewards to auditors and policeman for reporting corruption. This can be especially interesting in the context of our model because while several variants show up the aggregate expected bribe by Z to be $pFB/2$, the underlying structure changes in ways such that different reward schemes can thwart corruption altogether. Thus, for instance, in some cases $pFB/2$ is obtained by summing over small expected bribes over long chains. Presumably in such cases a 'small' reward scheme can be incentive enough for an auditor to turn in a

⁵The likelihood of multiple equilibria in models of corruption has been noted in the literature [e.g. Lui (1986), Cadot (1987)].

⁶Mishra (1991) has worked out a model with endogenous p and d in the case of $n=2$.

corrupt person because the bribe he can hope for, being just one person in the chain, will be relatively small.

In closing we wish to emphasize that the objective of this paper was simply to highlight a problem in the existing literature and to suggest a simple method for overcoming it. This method can be put to several uses. In this section we have tried to do no more than indicate some of these.

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