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Strategic Analysis of Petty Corruption: Entrepreneurs and Bureaucrats

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Abstract

This paper develops a game-theoretic model of "petty corruption" by government officials. Such corruption is widespread, especially (but not only) in developing and transition economies. The model goes beyond the previously published studies in the way it describes the structure of bureaucratic "tracks," and the information among the participants. Entrepreneurs apply, in sequence, to a "track" of two or more bureaucrats in a prescribed order for approval of their projects. Our first result establishes that in a one-shot situation no project ever gets approved. This result leads us to consider a repeated interaction setting. In that context we characterize in more detail the trigger-strategy equilibria that minimize the social loss due to the system of bribes, and those that maximize the expected total bribe income of the bureaucrats. The results are used to shed some light on two much advocated anti-corruption policies: the single window policy and rotation of bureaucrats.

"Corruption is found to be one of the most damaging consequences of poor governance characterized by lack of both transparency and accountability. Corruption lowers investment and hinders economic growth and human development, by limiting access to basic social services as well as increasing the cost of their delivery. It also increases poverty, subverts the financial system, and undermines the legitimacy of the state. Thus, corruption is anti-poor, anti-development, anti-growth, anti-investment, and inequitable. The cost of corruption to a nation is very high".

Transparency International (Report 2003)

1 Introduction

1.1 Background

Corruption, defined roughly as the abuse of public office for private gain,[1] has generated an immense literature. The well-known book by Rose-Ackerman (1999) has some four hundred items in the list of references, and, for shorter useful surveys, one can turn to Andvig (1991), Bardhan (1997), Lambsdorff (2001), and the collection of articles edited by Elliott (1997). Perhaps the sheer volume of this literature (which we do not attempt to survey here) is a testimony to the fact that corruption – in its many forms – is not of recent origin, and not just limited to developing economies or the economies in transition from a command to a market system. Indeed, over the years, allegations of corruption have been important in political debates and in ushering major political changes in many countries at different stages of development.[2] However, in many recent estimates or "rankings" of corruption, developing countries and transition economies have figured prominently, and policy makers in those economies as well as international agencies interested in accelerating the pace of economic development have been justifiably concerned with the impact of corruption on productive efficiency, growth, poverty and the proper utilization of economic assistance.

In this paper we focus on game-theoretic modeling of "petty corruption". In some cases the term "petty corruption" is used in the context of relatively small bribes. However, even in this usage it has been rightly noted that "pettiness of corruption refers only to the size of each transaction and not to its total impact on government income or policy" (Scott, 1972, p. 66). In typical examples of petty corruption, the "private" citizens (often owners of businesses or managers of firms) are engaged in dealing with low-level government bureaucrats regarding transactions involving the filing of appropriate tax returns, payment of important duties, clearance of regulatory or licensing requirements, application for government benefits (loans from state-owned banks, subsidies, jobs...) or approval of specific privileges (driver's license, passport, registration of a new firm as a legitimate business activity that complies with the laws on minimum wages, workers' safety, safe construction standards, environmental hazards,...). The "basic ingredients of corruption" emphasized by Klitgaard (1988, p. 75) include (1) government monopoly, (2) discretion in interpreting "laws," in deciding who is eligible for benefits, and in what constitutes proper documentation and procedure, and (3) lack of direct accountability. These appear in various ways. Some are subtle - a polite request or suggestion for a small "baksheesh" (in the Indian subcontinent) to expedite decision-making, the much discussed "speed money," - and some are crude - a threat to derail the review and approval process; "to stop the file immediately" (Bardhan, 1997, p. 1324)]. As one might expect from elementary economic analysis, the exercise of the monopoly power of the bureaucrat typically results in a redistribution of income from the applicant to the official, but it may also result in a loss of efficiency, a so-called "dead-weight loss". The latter can occur if an economic activity (i.e., a project) that would have been profitable without the payment of a bribe becomes unprofitable net of the bribe, and hence is curtailed or even abandoned in the presence of the extortionary regime. In the theoretical models that we develop, conditions for the persistence of petty corruption and consequent social losses can be precisely identified. The game-theoretic approach typically leads to models with multiple equilibria, and the presence of multiple equilibria in turn raises the possibility of moving from a current "bad" equilibrium to one that is socially superior. The question of how to make such a move has apparently not received much attention in game theory (see, however, Tirole, (1996)). We indicate in some detail applications of our analytical framework to two themes of particular interest in the literature on anti-corruption policy: (a) the "single window" or "one stop shop" procedure (replacement of a track of bureaucrats by a single bureaucrat) and (b) rotation of bureaucrats.[3]

One of the motivations behind our model specifications is the extensive discussion of the system of "multiple approvals" or "multiple verifications" that characterize the interaction between the citizens and the bureaucrats in the Indian subcontinent, and on the link between such systems and pervasive petty corruption, and the resultant effects on India's development programs.[4] N. Vittal, India's Vigilance Commissioner argued, (citing UNDP calculations) that India's GDP "will go up by 1.5 per cent" if the corruption levels of India are brought down to those of Scandinavian countries [Vittal in Gupta (2001, Chapter 2)]. And even after some fifteen years of liberalization and reforms, the project approval process has remained a source of major irritation.[5] In their widely cited article, Shleifer and Vishny (1993) argued that "competing bureaucracies, each of which can stop a project from proceeding, hamper investment and growth around the world, but especially in countries with weak government" and gave Russia as a prime example (pp. 615-6). Rose-Ackerman (1999) specifically referred to corruption discouraging the flow of foreign direct investment to developing countries (p. 3).[6] Thus, the models we are developing should be of interest to a broad group of developing and transition economies.

Compared to the entire published literature on corruption, the literature on game-theoretic analyses is rather limited. Various aspects of corruption have been studied from this point of view, such as: bribery to avoid the payment of taxes (Marjit et al., 2000) or the enforcement of regulations against pollution (Mookerjee and Png, 1992, 1995); bribery to avoid prosecution for crimes or to influence anti-crime policies (Dal Bo et al., 2003); corruption in procurement auctions (Burguet and Che, 2004; Compte et al., 2005). Further references can be found in these publications, in (Bardhan, 1997), and in (Mishra, 2005). We are not aware of any previous game-theoretic analysis of bribery to obtain permits that explicitly models the structure of bureaucratic "tracks", the sequence of applicants, and the information flows among the participants. The dynamic structure of the model also leads to a multiplicity of equilibria. Our analysis enables us to provide information about the set of equilibria and how this set depends on the parameters of the model.

1.2 Summary of Results

In the basic model, a sequence of entrepreneurs may apply to a "track" of two or more bureaucrats for approval of their projects. Each entrepreneur has a project that has a specific (expected present) value that would be realized if the project were approved. This value is known to the entrepreneur, but not to the bureaucrats. However, its probability distribution is common knowledge. The entrepreneur must apply to each bureaucrat in the track in a prescribed order, and her project is approved if and only if every bureaucrat in the track approves it. Each bureaucrat may demand a bribe as a condition of approval. At any step in the period the entrepreneur may refuse to pay the bribe, in which case she leaves the process and the value of her project is not realized, although she loses the total amount of bribes paid up to that point. If her project is approved by the entire track, she then receives the value of the project, minus the total amount of bribes paid. The payoff to a bureaucrat in that period is the amount of the bribe he receives, if any, and the bureaucrat's total payoff in the game is the expected sum of discounted bribes he receives.

It is important to distinguish between two types of interventions by a bureaucrat when an entrepreneur plans an investment project. In order to get formal approval, each project typically has to conform to certain "requirements" (e.g., by satisfying some safety standards or meeting appropriate norms on financing....) A bureaucrat *may reject a qualified project* if a demanded bribe is not paid. On the other hand, a bureaucrat may *approve an unqualified project* in exchange for receiving a corresponding bribe that he demands. Thus the bribes demanded for the approval of qualified and unqualified projects may be different. We refer to the phenomenon of the approval of unqualified projects as "capture," as distinct from the phenomenon of demanding a bribe for the approval of a qualified project, which we refer to as "hold up" or "pure extortion". For simplicity of exposition, in the formal model (Section 2) we assume that all *the projects are qualified and focus on* "hold up." Section 3.2 provides some informal comments on "capture." A more complete formal treatment (with detailed proofs) of both types of intervention is given in Lambert-Mogilianky, Majumdar and Radner (2005) [to be referred to as L-M-R].

We make the following assumptions about the information that the players have about the actions of the other players:

1. Players remember their own actions and those of the players they transact with.

2. Within any single period, no bureaucrat knows the bribes demanded by the other bureaucrats.

3. Every player learns the actions of the other players in previous periods, perhaps with some delay.

With some additional technical assumptions we can show:

1. In a one-period version of the game (only one entrepreneur), there is no equilibrium in which the project is approved with positive probability. On the other hand, there is an equilibrium in which the entrepreneur refuses to apply to even the first bureaucrat in the track, no matter what the value of her project (within the range of its probability distribution). The latter is called a *null-strategy-profile equilibrium*. The result provides a natural motivation for dynamic models.

2. In the sequential version of the game, if the bureaucrats are sufficiently patient (discount factor close enough to unity), then there are many equilibria, and we describe a large family of them that we call *trigger strategy profile (TSP)* equilibria.

3. For any given profile of strictly positive normal bribe demands, if the bureaucrats are sufficiently patient, then there is a TSP equilibrium that sustains those bribes (a "folk theorem"). Hence, for a sequence of bureaucrats' discount factors approaching 1, there is a corresponding sequence of TSP equilibria that approach "social efficiency".

We also examine in more detail two "extreme" TSP equilibria. First, a *second-best equilibrium* minimizes, in the set of *all equilibria of the sequential game*, the total social loss caused by the bribe system. We show that:

4. Among the second-best equilibria there is one that is a TSP. In other words, the second-best social loss can be attained with a TSP equilibrium.

5. If the track is replaced by a single bureaucrat, then the second-best equilibrium bribe total will be *smaller*.

The other extreme equilibrium maximizes the total expected bribe income within the family of TSP equilibria; call such a TSP equilibrium a *bribe-income-maximizing equilibrium* (BIME). Call a bribe profile *first-best for the bureaucrats* if it maximizes the total bribe income without the constraint that it be an equilibrium. One can show that, if a BIME is not first-best for the bureaucrats, then (corresponding to the result (5) above):

6. If the track is replaced by a single bureaucrat, then the total bribes in the BIME will be *larger*.

The conclusions (5) and (6) are relevant to an oft-proposed policy recommendation that in any jurisdiction the track of multiple bureaucrats should be replaced by a single "window" to which the entrepreneur can apply. Our analysis shows that *one cannot conclude that such a change will unambiguously result in an increase in social efficiency.*

Our results also enable us to assess another much-advocated reform, the rotation of bureaucrats among tracks. The multiplicity of equilibria again makes the results ambiguous. However, our analysis suggests that, under certain plausible circumstances the *rotation policy will actually result in a decrease in social efficiency.* (Section 2.3).

2 A Formal Model

2.1 A One-Stage Game

The players in the one-stage game consist of a single entrepreneur (EP) and a single *track* of N bureaucrats (BUs), with $N \geq 2$, arranged in a specific sequence. In order to get her project approved, EP must apply to and *obtain approval from each of the* BUs *in the prescribed order* (i.e. BU_1 first, then BU_2 etc.). If the project is rejected by any one BU, the game ends and EP does not proceed further in the track.

Here is the complete description of the extensive form of the game. Let V denote the project's potential value, which is uniformly distributed on some closed interval, which we may normalize to be $[0, 1]$. The probability distribution of V (the "prior") is common knowledge, but the realized value of V is known only to EP.

If and when EP applies to BU_n she incurs a cost $c > 0$. For convenience of exposition, this cost is assumed to be the same for all BUs. The cost c is known to *all* the players. If EP applies to BU$_n$, let $b_n \geq 0$ denote the bribe demanded by him. The project is approved if and only if the bribe is paid. The bribe is demanded on a "take-it-or-leave-it" basis, so that if EP refuses to pay the bribe the game ends. It is assumed that the BUs do not observe the bribes demanded by the other BUs.

Let $a_n = 1$ or 0 according as EP does or does not apply to BUn. If she does apply, she incurs the application cost $c > 0$ and *then* learns the magnitude b_n of the bribe demanded by BU$_n$. Let $p_n = 1$ or 0 according as EP does or does not pay the bribe. Note that if $a_n = 0$ or $p_n = 0$ then the game is over. Thus, if $a_n = 0$ we have $p_n = 0$ and if $p_n = 0$ then $a_m = 0$ for all $m > n$.

Call the part of the game in which EP faces BUn the *nth step* $(n = 1, ..., N)$. The action taken by EP in step n is the pair (a_n, p_n). The action taken by BUn in step n is, of course, b_n.

For $n \geq 1$, let H_n denote the history of the game through step n, i.e., the sequence of actions taken by all players through step n. A strategy for EP is a sequence of functions, $\alpha = \{A_1, P_1, ..., A_N, P_N\}$, which determine EP's actions according to:

$$a_n = A_n(V, H_{n-1}), \tag{1}$$

$$p_n = P_n(V, H_{n-1}, a_n, b_n).$$

(Here H_0 denotes an exogenous constant, the "prehistory of the game.")

Since BU$_n$ does not know the magnitudes of any previously demanded bribes, his strategy for the game is the magnitude of the bribe he demands:

$$b_n \geq 0. \tag{2}$$

To complete the description of the game, we must describe the players' payoff functions. The payoff for BU$_n$ is the bribe he demands, if it is paid, i.e.,

$$U_n = p_n b_n. \tag{3}$$

The payoff for EP is the value of the project if the project is approved, less the sum of the application costs and bribes paid (whether or not the project is completely approved). Thus EP's payoff is

$$U_0 = p_N V - \sum_{1 \leq n \leq N} (a_n c + p_n b_n). \tag{4}$$

Finally, without loss of generality, assume:

$$0 < Nc < 1. \tag{5}$$

(Otherwise, no project would be profitable.)

As usual, a Bayes-Nash *equilibrium* of the game is a profile of strategies such that no player can increase his or her expected pay-off by unilaterally changing his or her strategy. A strategy is (weakly) *undominated* if there is no other strategy that yields the player as high a payoff for all strategy profiles of the other players, and a strictly higher payoff for some strategy profile of the other players. For our first result, we shall confine ourselves to equilibria in undominated strategies.

Theorem 1 *There is no equilibrium in which the project is approved with positive probability.*

We sketch here a proof of the theorem by contradiction. First observe that for an equilibrium in undominated strategies, the bribes demanded by the BUs must be strictly positive. Hence, if EP ever applies to the *last* BU_N, he infers that EP *has already* incurred a positive cost, [and this is true *even if* the application cost is zero]. This inference influences the size of the bribe he demands. One can verify the following calculation:

Suppose that the EP has applied to BU_N, *and* BU_N *infers that, for some* M *such that* $0 \leq M \leq 1$, the project's value V, satisfies $M \leq V \leq 1$, *Then* BU_N's *optimal bribe is*:

$$b_N = \max\left\{M, \frac{1}{2}\right\}. \tag{6}$$

Suppose that in an equilibrium BU_N demands a bribe $b_n > 0$. Then EP will apply to BU_1 if and only if

$$V \geq \sum_{n=1}^{N}(c + b_n) \equiv M$$

But conditional on $V \geq M$, BU_N's optimal bribe is

$$b_N = \max\left\{M, \frac{1}{2}\right\} \geq M = Nc + \sum_{n=1}^{N-1} b_n + b_N > b_N \tag{7}$$

Hence, $\mathrm{Prob}\{EP \text{ applies to } \mathrm{BU}_1\} > 0$ implies that b_N is *not* an optimal response to other players' strategies, contradicting the supposition that the original strategy profile was an equilibrium.

Remark 1 *Observe that, for* $N \geq 2$, *the theorem is valid even when* $c = 0$.

We shall now construct a family of strategy profiles for which *no EP applies to the first BU, and hence no project is ever approved.* A strategy profile in this family will be called a *null strategy profile* (NSP). We shall then show that there exists an NSP that is an equilibrium.

A particular NSP is characterized by N parameters, $b_n^{'}$, $n = 1, ..., N$. The parameter $b_n^{'}$ represents the bribe that EP expects BU_n to demand, and it is also the bribe that BU_n plans to demand. These parameters satisfy the conditions:

$$\begin{aligned} 0 &< b_n^{'} < 1; \text{ for } n < N, \\ \max\left\{1 - c, \frac{1}{2}\right\} &< b_N^{'} < 1. \end{aligned} \tag{8}$$

The *EP's* strategy is: for $1 \leq n \leq N$, EP applies to BU_n only if the value of her project is as large as the sum of the *expected* cost of completing the track, whereas she pays the *actual* bribe demanded only if the value of her project is as large as the sum of this actual bribe and the cost of completing the track if the remaining BUs demand their planned bribes.

The strategy of BU_n is: If EP applies to him, demand the bribe $b_n^{'}$.

As is common in game-theoretic analyses, we wish to confine attention to equilibria in which the strategies are in some sense "credible," which involves examining the behavior of the system "off the equilibrium path." To this end, for the purpose of the next theorem we find it convenient to replace the requirement that strategies be undominated by a condition that we call *admissibility*, which is in some sense more demanding, but also somewhat more complex to state. First, *a strategy of BU_n is admissible* if the bribe demanded is strictly between zero and one. *A bribe profile is admissible* if each BU's strategy is admissible. *A strategy for EP is admissible* if it is a best response to *some* admissible bribe profile.

For a BU, we alter somewhat the definition of undominated strategy. An admissible strategy for BU_n is *quasiundominated* if there is no other admissible strategy for him that yields him as high a payoff for all admissible strategy profiles of the other players, and a strictly higher payoff for some admissible strategy profile of the other players.

Finally, *an equilibrium strategy profile is admissible* if EP's strategy is admissible, and and each BU's strategy is admissible and quasiundominated.

Theorem 2 *Suppose that,*

$$\textit{for each } n, 1/2 < b_n' < 1;$$

then the corresponding NSP is an admissible equilibrium, and for every value of V, EP does not apply to BU_1.

The proof of the theorem is given the the Appendix.

Remark 2 *There may be other equilibria of the one-stage game in which the probability that EP's project is approved is also zero.*

At the risk of belaboring the obvious, we emphasize that, *in a NSP equilibrium, each player has a zero pay-off.* This property of a NSP equilibrium will be important in the framework of the "repeated game", where the threat of reverting to a NSP will, under certain conditions, deter a BU from deviating from "cooperative-like" behavior.

2.2 A 'Repeated' Game with Multiple Bureaucrats and a Sequence of Entrepreneurs

Suppose that the one-stage game of the preceding subsection is repeated in an infinite sequence of periods, with a succession of EPs with independent and identically distributed (IID) project values, but the same track of BUs. With a slight abuse of standard terminology, we shall call this game the *supergame*. Strictly speaking, the supergame is not a repeated game, since the EPs change from period to period. However, because the project values are IID, the method of analysis and the attainable results are similar to those of a strictly repeated game. In particular, repeating the one-stage null-strategy profile equilibrium in every period, regardless of the history of play in the previous periods, is an equilibrium of the supergame.

In the equilibria studied here, we call the bribes demanded on the equilibrium path the *normal bribes*. On the equilibrium path, an EP applies if her project value exceeds the application cost plus the normal bribes. Once she has applied, and learned the bribe demanded by BU_n she pays the bribe if her project value exceeds the bribe plus the sum of the remaining bribes and costs. Call this EP's *normal behavior*. We shall say that BU_n *defects* in a particular period if in that period he demands a bribe that strictly exceeds the normal bribe. If and when the EPs learn that a defection has taken place, then all players will play the null-strategy-profile of the one-stage game for T periods (where T, possibly infinite, is a parameter of the strategy profile). These T periods will constitute a *punishment phase*. After the punishment phase is over (if ever), the players will return to their normal behavior until the next defection, if there is one. Of course, on the equilibrium path there is no defection and no punishment phase. Since a defection (eventually) triggers a punishment phase, we shall follow a standard terminology and call such a strategy profile a *trigger-strategy profile (TSP).* Following Aumann's terminology, if T is finite then the TSP is called *relenting*, whereas if T is infinite, the TSP is called *grim.*

The set of equilibria of the supergame will depend crucially on what information the players in any one period have about the previous history of the game. We shall assume that, if a defection occurs, the EPs learn about it D periods later, where D is an *exogenously* determined parameter. We also assume that a BU remembers all previous transactions in which he is involved. We can demonstrate that, if the BUs' (common) discount factor is not too small, then there is a family of TSP equilibria for which there is a positive probability that EPs will apply to the BUs, pay the bribes demanded, and retain a positive surplus.

If the bribes demanded are all zero, then all projects for which $V > c$ will be approved. We shall call this the *economically efficient* outcome. We shall show that as the discount factor approaches unity, there is a sequence of equilibria that approach "economic efficiency".

Here is a more formal description of the model. Let $V(t)$ denote the potential project value of the EP in period t, who is denoted by EP(t), where $t = 0, 1, 2, ...ad\ \text{inf}$. The project values are independent and uniformly distributed on the unit interval, which fact is common knowledge. Only EP(t) knows the realized value of $V(t)$. The track of BUs is the same in all periods. In each period t, EP(t) and BUs play the one-stage game defined in the previous subsection. With an obvious corresponding notation, the action variables in period t are $b_n(t)$, $a(t)$, $p(t)$. A player's strategy determines, at each period, his or her actions as a function of his or her information about the past history of play. The payoff of each BU is the sum of his discounted one-period payoffs, where the (constant) discount factor is denoted by δ, and $0 < \delta < 1$. A NSP in this dynamic context with a sequence EP(t) of entrepreneurs is defined by modifying equations () and (), writing $a_n(t)$, $p_n(t)$ instead of a_n, p_n.

The following assumption is made about the information available to the players.

Assumption. *At the beginning of period t, all the current players know the history of all defections (if any) in all periods up to and including period* $t - D$, *where* $D \geq 1$ *is an exogenously given parameter. Only* $EP(t)$ *knows value of her project. All players know the history of the transactions in which they participated.*

Finally, assume that the application cost, c, satisfies

$$0 < Nc < 1, \tag{9}$$

and is the same for all EPs.

The trigger strategy profiles (TSPs) for the supergames will now be defined. First, *normal bribes* (b_n) demanded by the BUs are all strictly positive, and satisfy:

$$\gamma_1 \equiv \sum_{n=1}^{N}(c+b_n) < 1. \tag{10}$$

Secondly, for $n \geq 2$, write

$$\gamma_n \equiv \sum_{m\geq n}(c+b_m) = (N-n+1)c + \sum_{m\geq n} b_m.. \tag{11}$$

The *normal behavior* of each EP(t) is given by:

$$a_n(t) = 1 \quad \text{iff} \quad V > \gamma_n \quad \text{for} \quad n \geq 1, \tag{12}$$

$$p_n(t) = 1 \quad \text{iff} \quad V > b_n + \sum_{m>n}(c+b_m). \tag{13}$$

If at period t no defection has occurred in the past, then the BUs demand the normal bribes. If a defection by a BU occurs at period t, then the BUs demand the same bribe as in period t for the next (D-1) periods. Thereafter they demand the bribes $(b_n^{'})$ in the NSP profile, for the next $T \geq 1$ periods, where T remains to be specified. In period $(t+D+T)$, the clock is restarted with normal bribes until the next phase, if any.

Although different EPs could in principle use different strategies, without essential loss of generality we restrict the TSPs to those in which all EPs use the same strategy. If at period t, no defection has occurred, then EP(t) behaves "normally." If the first defection occurs at period t, then for the next (D-1) periods, EP(t) still behaves normally, but during periods $t+D, ..., t+D+T-1$ (the punishment phase) the EPs do not apply at all . At period $(t+D+T)$, the EPs begin to behave normally again, until the next defection (if any). To sum up, during a punishment phase after learning about a defection, the players are using a NSP.

Theorem 3 *For any trigger strategy profile (TSP) satisfying the preceding conditions, there exist δ^* and T^* sufficiently large such that, for all $\delta \geq \delta^*$ and $T \geq T^*$, the TSP is an equilibrium of the supergame. Furthermore, as the discount factor approaches unity, there is a sequence of TSP equilibria that approach "economic efficiency".*

The proof uses a standard argument adapted to our framework; see L-M-R.

Remark 3 *One can show that the social loss is an increasing function of the total of the normal bribes: $B \equiv b_1 + ... + b_N$.*

2.3 Extreme Equilibria of the Repeated Game

In this subsection we examine the properties of two classes of "extreme" equilibria of the repeated game with multiple bureaucrats, within the class of trigger strategy profile equilibria studied in the previous section. The equilibria in the first class, called "second-best", maximize the social surplus in the set of *all* equilibria. An important property of second-best equilibria is that replacing the track with a single bureaucrat *increases* the social surplus. The equilibria in the second class (called BIME) maximize the total expected bribe income of the bureaucrats. For discount factors close enough to one, it is possible for a BIME to achieve the maximum expected bribe income that would be possible if the bureaucrats were able to collude, i.e., act as a monopoly. If this "collusive outcome" is not attainable as a BIME, then replacing the track with a single bureaucrat *increases* the expected bribe income, and *decreases* social surplus. We shall comment on the implications of these results in Section 4 below.

For the formal proofs of the results in this subsection, see L-M-R.

2.3.1 Second-Best Equilibria

By a *second-best equilibrium* (SBE) is meant an equilibrium that minimizes (in the set of all equilibria) the loss in expected total social surplus due to the system of bribes. The outcome implemented in a SBE will be called a *second-best outcome*. We show elsewhere (see L-M-R) that a second-best-outcome *can be* implemented by a grim trigger-strategy profile equilibrium, i.e., with a trigger-strategy profile for which the punishment period lasts forever ($T = \infty$). The kind of argument that leads to Theorem 3 also shows that as the discount factor approaches unity the SBE approaches economic efficiency.

Here is a heuristic explanation of why second-best outcomes can be attained in the class of grim trigger-strategy profile equilibria, which we shall denote by $\mathcal{G}$. First, each EP participates for a single period, and she has no short-run incentive to deviate from her equilibrium strategies in a TSP equilibrium (neither in a normal phase nor in a punishment phase). Second, although the BUs have such a short-run incentive in a normal phase, they are deterred by the threat of triggering a switch to a punishment phase. Furthermore, if the punishment phase lasts forever, then a BU's payoff is zero forever once a defection is detected (after D periods). But zero is the lowest payoff that a BU can receive, and so the threat of triggering a switch to an infinitely long punishment phase is "maximal". [Technically, zero is each BU's *maxmin payoff*]. Hence an equilibrium that minimizes the social loss in the set $\mathcal{G}$ also minimizes the social loss in the set of all equilibria. We note that there may be second-best equilibria that are not in $\mathcal{G}$, but in what follows we confine our attention to those in $\mathcal{G}$.

Theorem 4 *If the track of N bureaucrats is replaced by a "single window" of one bureaucrat, but with an application cost Nc, then the total second-best equilibrium bribe is strictly reduced.*

Let $\mathcal{G}(T)$ denote the class of TSP equilibria for a given length, T, of the punishment phase. Thus, in the preceding definition of second-best equilibria, $\mathcal{G} = \mathcal{G}(\infty)$. Define a *third-best equilibrium given T* to be one that minimizes social loss in the class $\mathcal{G}(T)$. One can show that, for each T, the preceding theorem is true for third-best equilibria given T.

2.3.2 Bribe-Income-Maximizing Equilibria

By a *bribe-income-maximizing-equilibrium (BIME) given T* is meant an equilibrium that maximizes the total expected bribe income of the BUs in the class $\mathcal{G}(T)$. Let

$$k = \frac{(1-\delta^D)}{1-\delta^{D+T}}. \tag{14}$$

Note that, since D and δ are given exogenously, then if T is fixed, so is k. In the following two theorems, it is to be understood that T is fixed, and is not mentioned explicitly.

If k is small enough, but still positive, then the BUs can attain in equilibrium the maximal collusive expected bribe income.

Theorem 5 *If k is sufficiently small, then there is a BIME in which the total expected bribe income is the maximum possible, and $B = (1 - Nc)/2$.*

Theorem 6 *If k is sufficiently small, but not so small that the maximum collusive bribe income can be attained in equilibrium, then for any BIME with $N > 1$ bureaucrats, replacing the track with a single BU and the same total application cost increases the total expected bribe income.*

3 Interpretations, Implications and Extensions

3.1 Corruption Hold-up

The inefficiency of equilibrium in our model is an instance of the well-known phenomenon of *hold-up*. Since the equilibrium bribes are strictly positive, when an entrepreneur faces the second or later bureaucrat in the track, she has already incurred a sunk cost, even if the cost of application is zero. (If the cost of application is strictly positive, then hold-up occurs even with the first bureaucrat). The inefficiency can be reduced, but not eliminated, in the repeated game by the implementation of trigger-strategy equilibria (Theorem 3). The key parameter here is

$$k = \begin{cases} (1-\delta^D)/(1-\delta^{D+T}), & T < \infty, \\ 1-\delta^D. & T = \infty. \end{cases}$$

Recall that δ is the discount factor, D is the delay of the information about past transactions, and T is the length of the "punishment phase" after a defection. As in the preceding section, let $\mathcal{G}(T)$ denote the class of TSP equilibria for a given T, and define a *third-best equilibrium given* T to be one that minimizes social loss in the class $\mathcal{G}(T)$. One reason to consider cases in which T is finite ("relenting trigger strategies") is that it may be behaviorally unrealistic to expect that the the participants will be able to adhere to grim trigger strategies (T infinite) in the presence of increasing pressure to "relent" and try a fresh start.

Since both δ and D are exogenous, whereas T is a parameter of the equilibrium, one can think of the class $\mathcal{G}(T)$ as being equivalently parameterized by k. One can show that the smaller k is, the more efficient are the corresponding third-best equilibria, and *a fortiori* so are the second-best equilibria (Section 2.3.2). The mediating parameter, k, is a decreasing function of δ and T, and an increasing function of D. Thus the more patient the bureaucrats are (the larger δ is), the more efficient are the outcomes in the third-best equilibria or, alternatively, the shorter can be the punishment phase to sustain a given level of efficiency. On the other hand, the longer the delay in getting information about past transactions (D), the less efficient are the third-best equilibria. However, note that a smaller value of k can lead to a *decrease* in efficiency in some other equilibria, as the analysis of the bribe-income-maximizing shows (Section 2.3.2).

The one-stage game provides an extreme cost of hold-up. In this case there is no equilibrium in which any project is approved, but there is an equilibrium in which no project is approved (Theorems 1 and 2). This last equilibrium provides the threat that forms part of the trigger-strategy equilibria.

Our structure of delayed information is only one of many possible models of what the players might learn about past transactions. In particular, one might consider a model in which some entrepreneurs become informed, possibly with delay ("insiders"), and others ("outsiders") are uninformed ($D = \infty$). If the bureaucrats can identify the insiders and outsiders, this produces a wedge between firms so outsiders never enter the market, which reduces competition.

Our model of the bargaining between the entrepreneurs and bureaucrats is one in which the bureaucrats make "take-it-or-leave-it" demands to the entrepreneurs. At the other extreme, one might envisage that it is the entrepreneurs who make the take-it-or-leave-it demands, in which case the inefficiency would be eliminated, but the bureaucrats would receive no bribe income. In between these extremes there is a loss of efficiency. Anecdotal evidence suggests that reality is closer to the bargaining model that we have used here.

3.2 Capture

In this paper we conduct the analysis for the case in which all projects are qualified. In a more general version of the model (L-M-R), we consider a situation where the entrepreneur makes a decision whether or not to qualify prior to applying. The idea is that in order to qualify for approval formally, each project must conform to certain requirements (e.g., by satisfying some prescribed safety or fiduciary requirements). Typically, qualification entails a cost, which we assume is proportional to the value of the project. In the model of L-M-R this cost is incurred when the decision is made, i.e., before the entrepreneur applies.[7]

In this more general setting a bureaucrat can approve unqualified projects as well as qualified ones. The bribes demanded for the approval of qualified and unqualified projects may be different. The type of corruption related to the approval of unqualified projects is commonly referred to as "capture", as distinct from the phenomenon of demanding a bribe for the approval of a qualified project, which is referred to as "pure extortion."

The results in the paper extend to the case where both extortion and capture are present. We can show that the "second-best" equilibria are characterized by the fact that all projects for which entrepreneurs apply are qualified. In contrast, in the bribe maximizing equilibria (BIME) no project is qualified. In general, we cannot say whether approved projects are qualified or not. From the point of view of the players however, the cost incurred to qualify is "a pure loss". For any equilibrium with qualified projects, we can construct another equilibrium with unqualified projects that yields higher expected payoffs to both entrepreneurs and bureaucrats. This suggests that the presence of corruption in the application procedures is likely to induce losses in addition to preventing the realization of profitable project, namely losses due the realization of socially inefficient or harmful projects.

3.3 The Single-Window Policy

In the context of combating corruption in the procedures for applying for permits (e.g., for new businesses), a much-advocated reform is the so-called "single-window policy" or one-stop-shop. This policy has been interpreted in a variety of ways. A common feature is that the entrepreneur meets with only a single bureaucrat. But it is immediate that this single feature is insufficient to yield any effect. Indeed, assume that the track structure is left untouched. The entrepreneur still needs approval from a series of bureaucrats but only submits the application to one bureaucrat who sends it further on the track. We may have a case where the first bureaucrat demands the sum of the bribes and pays them out to the other bureaucrats in exchange for their approval. In Bulgaria this version of the single window policy has been implemented in some town with very limited success, as one would expect.[8] The confusion reflects the common view that the risk of bribery is due to the direct contact between the entrepreneur and the various bureaucrats. What actually matters is the actual extortion power associated with the decision. In the present paper we investigate a one-stop-shop policy with the following content. The N licenses are replaced by one single complex license that is delivered by one bureaucrat. Of course in many cases, in reality the multiplicity of licenses remains. You cannot merge, e.g., the Commercial Register with the Fire Department. What we have in mind is that the application is processed by experts who have no extortion power. This is an extreme version of reforms aimed at simplifying the application procedures, and in particular at reducing the number of independent bureaucrats whose approval is required to start or revise a project.

Theorems 4 and 6 shed some light on the potential value of such a reform. Paradoxically, the single-window policy does not always lead to a reduction in the bribe burden. Theorem 4 shows that a switch to a single window (with the same total cost of application) in the second-best equilibrium does reduce the total amount of the bribe, and hence reduces the social loss. In contrast with this optimistic result, Theorem 6 shows that this switch will *increase* the social loss in the bribe-income-maximizing equilibrium, unless the bribe income is already the maximum possible that could be obtained through collusion of the bureaucrats.

Of course, there may be reasons to recommend the single-window policy that are not reflected in our present model, such as the possible increase in the "transparency" of the approval process and the greater likelihood of detecting illegal activities. In Russia firms have reported a decrease in total application cost (including the bribes paid) following recent reforms (CEFIR 2002-2005 see www.cefir.org). The reforms were launched with much publicity and monitored by international organizations, including a World Bank project. They were effectively accompanied by an increase in transparency, including a stricter control of delays. [Using the threat of delays to persuade applicants to pay bribes is not part of our formal model. Such delays impose a cost on the applicant that is somewhere between that of immediate approval (zero delay) and outright rejection (infinite delay).]

3.4 Rotation of Bureaucrats

Our results enable us to assess another much-advocated reform, the rotation of bureaucrats among tracks. The standard argument in favor of such measures is that they reduce the opportunities for corrupt practices based on long-standing relationships. There are many possible rotation policies, and it is beyond the scope of this paper to discuss them all. Here is one that can be analyzed explicitly in the framework of our model. Suppose that each track has a constant per-period probability, π, of being replaced by another track with different bureaucrats. Thus $\pi = 0$ gives us our model of the infinitely repeated game with one track, and $\pi = 1$ gives us our model of the one-stage game. One can show that increasing this probability is formally equivalent to reducing the discount factor. This, in turn, increases the mediating parameter k (Section 2.3). Since there is a multiplicity of equilibria for each value of k, the effect of decreasing k is ambiguous without a rule that selects a unique equilibrium for each value of k. For example, if we focus on, say, the bribe-income-maximizing equilibria, then an increase in π leads to an decrease in social loss. On the other hand, in the third-best (and hence second-best) equilibria an increase in π leads to an *increase* in social loss.

One could argue that a long-lasting track provides the opportunity for the track to "migrate" from a low-bribe equilibrium to a high-bribe equilibrium. In this case, a rotation of the bureaucrats out of a track might be the occasion for moving the track back to an equilibrium that is socially preferable. However, from a theoretical point of view this is all speculative, since game theory does not yet provide a good theory of how equilibria are established in the first place (in the context of a multiplicity of equilibria), and how they might change through time.

3.5 Extensions

In a subsequent paper (in preparation), we introduce a third category of players, *intermediaries*. For a fee, intermediaries undertake to carry out for an entrepreneur the application process through the entire track. Using the methodology of the present paper, we analyze the set of equilibria, and how it depends on the parameters of the model. In particular, intermediaries may change the set of equilibrium outcomes by serving as an institutional memory of past behavior, and also by introducing an additional monopolistic element into the situation. Further research will study the effect of competition among intermediaries. An appropriate model is that of product differentiation. In this case, one can expect that different intermediaries would charge different fees and correspondingly offer services that differ in delay, reduction of detection, convenience, etc.

Other interesting topics that could be studied in this framework are: (1) competition among tracks, reflecting competition for investment by different countries or by different jurisdictions (states or cities) within a country; (2) supervision and enforcement.

4 Appendix

Proof of Theorem 2. First observe that, in a NSP, EP's strategy is an optimal response to the strategy profile of the BUs. From (8),

$$\sum_{m \geq N} (c + b_m^{'}) > c + b_N' > 1.$$

Hence, for all $V \leq 1, a_1 = p_1 = 0$, so EP will never apply to the track. Therefore, for all n, any bribe demand will result in a payoff of zero, so in particular, $b_n = b_n'$ is an optimal response to the other players' NSP strategy profile. It remains to show that this equilbrium is admissible. A NSP bribe profile is admissible, and hence so is the corresponding NSP strategy for EP. Thus it only remains to show that each BU's strategy is quasiundominated (see the definition preceding the statement of Theorem 2).

Recall that, according to the hypothesis of the theorem, for each n,

$$1/2 < b_n' < 1.$$

Let α'' denote a strategy for EP that is admissible with reference to an admissible bribe profile, say $\mathbf{b}^{''} = (b_1^{''}, ..., b_N^{''})$. For $1 \leq n \leq N$, define

$$\begin{aligned} M_k &= \sum_{m \geq k} (c + b_m''), \\ M &= M_1, \\ L_k &= \sum_{m \leq k} (c + b_m'') = M - M_{k+1}. \end{aligned}$$

If EP uses the strategy α'', and $M \geq 1$, then EP will not apply to the track, and the expected payoff to BU_n will be zero for all values of b. Therefore, without loss of generality, assume that

$$M < 1.$$

In this case, if BU_n demands a bribe equal to b, then his expected payoff will be

$$U(b) = \begin{cases} b(1-M), & 0 \leq b \leq L_n; \\ b(1-b-M_{n+1}), & L_n \leq b \leq 1. \end{cases} \tag{15}$$

[To see this, observe that if EP applies to BU_n, then she will pay the bribe b only if $V > b + M_{n+1}$. However, since EP is using the strategy α'', the fact that she has applied to BU_n implies that she has applied to the track, and therefore that $V > M$. Note that

$$b < L_n \Leftrightarrow b < M - M_{n+1} \Leftrightarrow M > b + M_{n+1},$$

in which case $V > M$ implies that $V > b + M_{n+1}$, i.e., the fact that EP has applied to the track implies that she will pay the bribe b. On the other hand, if $b > L_n$, then EP will pay the bribe only if $V > b + M_{n+1}$, which is not implied by the fact that she has applied to the track.]

Returning to the proof of the theorem, the first line of (15) is linearly increasing in b, and the second line is quadratic in b and reaches a maximum at

$$b^* = \frac{1 - M_{n+1}}{2}.$$

Hence, if $L_n > b^*$, then $U(b)$ reaches its maximum at $b = L_n$. Note that, since $b'_n > 1/2$, and $M_{n+1} \geq 0$,

$$b'_n > b^*.$$

Therefore, if we choose α'' such that $L_n = b'_n$, then

$$U(b) < U(b'_n) \text{ for all } b \neq b'_n,$$

which completes the proof that b'_n is quasiundominated, and thus completes the proof of the theorem.

Notes

[1]See Elliott (1997, p. 177), who cites Klitgaard (1991)

[2]After citing relatively recent instances of corruption and/or attempts to eradicate corruptions in Mexico, Ukraine, China, South Korea, Pakistan, Elliott (1997, p. 175) reminds us that "corruption scandals in recent years have also contributed to the downfall of governments in Ecuador, Brazil, Italy, and, India [and, one can surely add Philippines, Indonesia,...]. "Long-entrenched ruling parties have been weakened, including Japan's Liberal Democratic Party and Mexico's Institutional Revolutionary Party". Watergate, Whitewater, FCPA, campaign finance reform have been among the most intensively analyzed political issues in the U.S.A., and, on each "corruption" in some form has cast its shadow.

[3]The empirical literature, has also witnessed substantial growth with studies of individual countries as well as some cross-country data (two useful surveys are by Ades and Di Tella (1996) and Lambsdorff (1999)). Researchers have started confirming or challenging "plausible" hypotheses on the causes and consequences of corruption. In the context of our project, we would like to recall only a few interesting conclusions. Mauro's early empirical work [(1995), (1997)] focuses on the relationship between investment and corruption, and finds that corruption *lowers investment, thereby reducing growth*. Related to this theme are the studies involving a large sample of developing and transition economics [Morisset and Nesso (2002), Djankov et at (2001)] that reveal a correlation between corruption and the cost (in terms of time and official fees) of entry procedures.

[4]One of the first studies of corruption in India was the Santhanam Committee Report (1964): see Halayya (1985) for a detailed account of various cases of grand and petty corruptions and government responses to recommendations on appropriate actions to combat corruption. See, e.g., Bhagwati [(1973, pp. 6-7), 1993] Roy (2003) and the 2003 Report by Transparency International on the problem of "multiple verifications".

[5]Examples of typical anecdotes: the Financial Express, Wednesday, November 28, 2001: The Japanese envoy Mr. Hirabayashi compliments the intent of the industry minister Murasoli Maran. But he gets upset over India's much talked about "single window" for foreign direct investment. "The joke is that India has forty "single windows" for one investor. We (have) let our feelings and frustrations be known to Indian officers and captains of business. It is not easy to be working here. Also: Indian Express, Monday, January 28, 2002: "The US Ambassador to India said on Monday that Indian bureaucratic red tape was chocking economic ties between the world's two most populous democracies. US foreign direct investment into India tumbled to $366 million in 2000 from $431 million in 1999 and $737 million in 1997, a slide which the Ambassador blamed on "innumerable rolls of red tape stretching to the horizon".

[6]Estimates of efficiency-losses are also available for other countries; see the discussion of Mauro's bureaucratic efficiency index (1995), and its link with investment discussed in Ades and Di Tella (1996).

[7]It is important to point out that this specification of a qualification cost falls short of a realistic

description of the process of approval and implementation of investment projects in many contexts. An EP typically incurs some cost in preparing a proposal that is "qualified on paper", and submits an estimate of costs for upholding the regulatory standards. However, the more substantial part of the cost is incurred during the phase of actual construction, which is often subject to further on-site inspections. In the model we shorten this process by assuming that the EP will implement the exact proposal qualified on paper. On the other hand, an unqualified project approved through bribery will not result in any subsequent cost to the EP (fines/settlement of liability claims etc.). A more elaborate model would be needed to capture these intricacies, but we do not expect that our theoretical results would be significantly affected.

[8]In April 2005, one of us visited a town in Bulgaria on the behalf of the European Commission. The secretary of regional anti-corruption council described the situation as follows. What happens is that the entrepreneur is told by the bureaucrat who handles the application that his application got stuck in some agency and that 'efforts' must be made to get approval from that agency before proceeding further.

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