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2007

Online at https://mpra.ub.uni-muenchen.de/38413/
MPRA Paper No. 38413, posted 28 Apr 2012 03:24 UTC

Information, Corruption, and Optimal Law Enforcement*

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January 2004

*We are grateful to Mitch Polinsky for helpful suggestions. The usual disclaimers apply.

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Abstract

We consider the role of asymmetric information on the emergence of collusion between criminals and enforcers, in the framework proposed by Bowles and Garoupa (1997) and Polinsky and Shavell (2001).

Our paper proposes that the optimal criminal sanction for the underlying offense is not necessarily maximal. We achieve this result by coupling the criminal sanction for the underlying offense with a criminal sanction for corruption, both imposed on offenders. A higher criminal sanction for the underlying offense implies that the government must spend more resources to detect and punish corruption (since the likelihood of collusion increases). Thus, the government could reduce this sanction, save on detection, and increase the criminal sanction for corruption (in order to offset the negative effect on deterrence).

JEL: K4.
Keywords: fine, probability of detection and punishment, corruption, information.

1 Introduction

Corruption has been an important issue in the economic literature of law enforcement. In their seminal article, Becker and Stigler (1974) argued that it might be advantageous to extend private enforcement to the criminal law and other areas where the law is now enforced publicly. Their principal argument was that public enforcement creates incentives to bribery which undermine deterrence. If law enforcement were privatized, however, competitive private enforcers could be rewarded with the fines offenders paid and enforcers would have no incentive to take bribes. In the last few years scholars have begun to pay more attention to corruption. Bowles and Garoupa (1997), Chang et al. (2000), and Polinsky and Shavell (2001) model corruption under a regime of public enforcement. Marjit and Shi (1998) and Garoupa and Klerman (2001) model corruption under a regime of private enforcement, and Garoupa and Klerman (2004) discuss non-monetary sanctions when there is collusion between offenders and enforcers.

A central conclusion of this literature is that corruption is usually socially undesirable, because it dilutes deterrence. As a consequence, it is usually optimal to expend resources to detect and penalize corruption.

The first point of our paper is to consider the role of asymmetric information on the emergence of collusion between criminals and enforcers, in the framework proposed by Bowles and Garoupa (1997) and Chang et al. (2000), and to same extent by Polinsky and Shavell (2001). Indeed, particularly in the case of casual corruption, the hypothesis of asymmetric information about private costs (opportunity costs) of enforcers engaging in collusion seems very plausible. The asymmetry of information leads the enforcers to overestimate this cost in order to increase their corruption rent. Therefore, asymmetric information might eventually deter corruption and deter bargaining between the two parties. We discuss the shortcomings of the solutions proposed by Bowles and Garoupa (1997) and Polinsky and Shavell (2001).

Our second point is to consider a collusion-proof solution as in the regulatory literature (Laffont and Tirole, 1993). We show that the optimal criminal sanction for the underlying offense is not necessarily maximal as in Bowles and Garoupa (1997) and Polinsky and Shavell (2001). We achieve this result by coupling the criminal sanction for the underlying offense with a criminal sanction for corruption, both imposed on offenders. A higher criminal sanction for the underlying offense implies that the government must spend more resources to detect and punish corruption (since the likelihood of collusion increases). Thus, the government could reduce this sanction, save on detection, and increase the criminal sanction for corruption (in order to offset the negative effect on deterrence).

We differ from Chang et al. (2000), because we do not incorporate social norms. They show that a less than maximal sanction could be optimal due to the 'snowballing' effect of social norms; raising fines could be counterproductive in deterring crime if collusion is widespread.

Our result instead could be seen as an application of the marginal deterrence principle. If detecting the underlying offense is more expensive than detecting corruption, deterring the underlying offense is relatively more important than deterring corruption. Thus, the optimal criminal sanction for the underlying offense is maximal. However, if detecting the underlying offense is less expensive than detecting corruption, deterring corruption is relatively more important than deterring the underlying offense. Thus, the optimal criminal sanction for the underlying offense is less than maximal, whereas the optimal sanction for corruption is higher than otherwise.

We also discuss the compensation of enforcers in a context of corruption. Harris and Ravin (1978) have proposed that enforcers should get a share of the gains obtained by the government from enforcing the law. They show that there is an optimal incentive contract for enforcers. In a more recent work, however, Mookherjee and Png (1995) show that owing to the strategic interaction between offender and enforcer, raising the penalty for corruption may cause crime to increase (because it reduces the incentive to monitor). Besley and McLaren (1993) consider problems of both moral hazard, which arises because taking bribes cannot be observed without costly monitoring, and adverse selection, since not all enforcers can be identified as being honest or dishonest.

In our paper, enforcers have lower salaries when there is bribing because the government takes into account the expected bribes that officers may receive from criminals. This for example might explain why wages of officials in less developed countries are so low. They take into account the possibility of corruption. More severe anti-corruption policies generate the need for higher salaries. The gain from eliminating corruption must be balanced against higher enforcement costs.

The paper goes as follows: In section two, we introduce the basic model from Bowles and Garoupa (1997) and Polinsky and Shavell (2001). In section three, we analyze the bribing game under asymmetric information; in section four, we consider law enforcement costs; in section five, we discuss optimal deterrence in the context of a corruption proof solution. Final remarks are addressed in section six. Proofs of results are in appendix at the end of the paper.

2 Basic Model

We follow Bowles and Garoupa (1997) and Chang et al. (2000), and to a certain extent Polinsky and Shavell (2001) models which we briefly review in this section. Each risk neutral individual decides whether or not to become an offender. Once he acts as a criminal, he may be detected or not (the probability of detection and punishment of an offender is p). If detected, he starts a bargaining process over the bribe with the police officer. If such process is successful (it will be with probability $1 - r$, where r is the rate of honesty across enforcers), he pays a bribe R to the corrupted police officer. After the bribery has occurred, the corrupted police officer may be detected (the probability of detection and punishment of an enforcer is q), and if so, both enforcer and offender are punished.

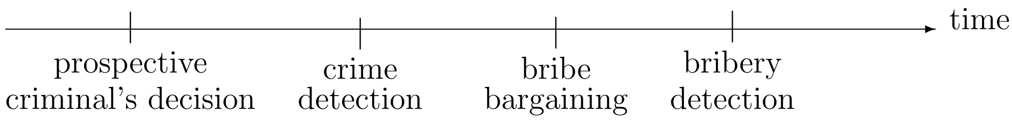
Notation

The variables in the model are denoted as follows:

- p = probability of detection of a criminal;
- q = probability of detection of corrupted police officer;

- F = fine imposed on convicted criminal;
- S = fine imposed on corrupt police officer;
- T = extra fine imposed on convicted criminal who bribed an officer;
- b = prospective gain from crime;
- h = social harm caused by crime;
- R = bribe;
- r = rate of honesty across enforcers;
- ψ = cost of being corrupted;
- w = salary of a police officer;
- $g(b)$ = distribution of gains from crime;
- $l(\psi)$ = distribution of ψ;

The arrow of time for this model follows:



The expected utility of each potential offender who commits the act is given by:

$$\begin{aligned} \mathcal{U} &= (1-p)b + p\{r(b-F) + (1-r)q(b-\mathcal{R}-F-T) + (1-r)(1-q)(b-\mathcal{R})\} \\ &= b - p[r+(1-r)q]F - p(1-r)qT - p(1-r)\mathcal{R} \qquad (1) \end{aligned}$$

where $\mathcal{R}$ is expected bribe given type of enforcers as explained later. There are four possible states of nature: (a) an offender is not detected, (b) an offender is detected and does not collude with the enforcer (he pays the sanction for the underlying offense), (c) an offender is detected and colludes with the enforcer; they are detected by the government, (d) an offender is detected and colludes with the enforcer; they are not detected by the government.

The expected utility of an enforcer who accepts the bribe is:

$$\begin{aligned} \mathcal{V} &= (1-q)(R+w) + q(R+w-S-\psi) \\ &= R+w-q(S+\psi) \end{aligned} \tag{2}$$

where ψ includes, for example, psychological costs and opportunity costs borne by a police officer when she is bribed. The police officer's rent $\mathcal{V}_c$ generated by bribing is given by $\mathcal{V} - w$ or $R - q(S+\psi)$.

3 Bribing Game under Asymmetric Information

In Bowles and Garoupa (1997), the costs represented by ψ are public information in the moment of the bargaining. In our model, ψ is private information to enforcers. We relax the assumption that ψ is observable by criminals and suppose that it is known only to the officer when the bargaining takes place. Indeed, particularly in the case of casual corruption, the hypothesis of asymmetric information about private costs (opportunity costs) of enforcers engaging in collusion seems very plausible.

The asymmetry of information of course leads the enforcers to overestimate this cost in order to increase their corruption rent. Therefore, asymmetric information might eventually deter corruption and break bargaining between the two parties. The purpose of this section is to analyze the extent asymmetric information affects corruption.

The private cost ψ is a continuous parameter that belongs to the closed interval $I = [\underline{\psi}, \bar{\psi}]$, where $\bar{\psi} > \underline{\psi}$. Hereafter ψ denotes a realization of a random variable with cumulative distribution $L(\psi)$ and the corresponding positive probability density function $l(\psi)$. We make the following (usual) assumption about $L(.)$:

Assumption 1 *The distribution $L(.)$ satisfies the monotone hazard rate property:*

$$\frac{\partial}{\partial\psi}\left(\frac{L(\psi)}{l(\psi)}\right) \geq 0$$

In this setting, an offender designs a compensation (bribe) structure that maximizes his expected utility while guaranteeing the enforcer at least her reservation utility. From the incentive contract theory and the revelation principle (see Laffont and Tirole, 1993), it is well known that, without loss of generality, one can restrict the search to the class of mechanisms that induces a truthful revelation of the enforcer's cost parameter ψ. In our context, it is easy to see that any optimal mechanism M that induces a truthful reporting can be represented as the following $M = \langle\sigma(\psi), R(\psi)\rangle_I$, where $\sigma(\psi)$ is the probability of offering a bribe of amount $R(\psi)$ for the corrupted enforcer of type $\psi \in I$.

Given a mechanism M, let the level of utility achieved by the officer of type ψ if she reports type $\tilde{\psi}$ be:

$$\mathcal{V}(\psi, \tilde{\psi}) = \sigma(\tilde{\psi})[R(\tilde{\psi}) - q(S + \psi)] \tag{3}$$

where $\mathcal{V}(\psi) = \mathcal{V}(\psi, \psi)$ denotes truthful reporting of costs.

The *incentive compatibility constraint* (IC) to guarantee truthful reporting is given by:

$$\mathcal{V}(\psi, \psi) \geq \mathcal{V}(\psi, \tilde{\psi})$$

for all $\psi, \tilde{\psi} \in I$.

The *individual rationality constraint* (IR) is

$$\mathcal{V}(\psi) \geq 0$$

for all $\psi \in I$.

In this context the problem for the offender is to maximize his expected utility subject to (IC) and (IR). Once detected by an officer, the expected utility of a criminal is:

$$\begin{aligned}\mathcal{U}^c &= \sigma(b - R - qF - qT) + (1-\sigma)(b-F) \\ &= b - F - \sigma(R + qT - (1-q)F) \end{aligned} \tag{4}$$

where the bribe is accepted with probability σ.

The criminal solves the following program:

$$\max_{(\sigma,R)}\{\int_I [b - F - \sigma(\psi)(R(\psi) + qT - (1-q)F)]dL(\psi)\}$$

subject to (IC) and (IR).

We are now able to solve the problem of side payments (bribing) with asymmetric information. To find the optimal solution, we begin by characterizing the class of bribing contracts that satisfies the incentive constraint in order to implement M in a dominant strategy.

Lemma 1 *The bribe contract satisfies the incentive constraint if and only if*

(i) $\mathcal{V}_c(\psi) = q\int_{\psi}^{\bar{\psi}} \sigma(x)dx$

and

(ii) $\sigma'(\psi) \leq 0$ *for all* $\psi \in I$.

The rent from corruption $\mathcal{V}_c(\psi)$ is the informational rent left to an officer of type ψ by the criminal. Indeed because of asymmetric information about private costs of enforcer, the criminal is forced to give up a costly rent to the officer. The informational rent is used to discipline the enforcer into revealing her true private cost of being bribed. From the first lemma, we can remark that the informational rent is decreasing in ψ. Hence to be willing to reveal her cost, a lower ψ type must be rewarded with a more substantial rent than a higher ψ type. Furthermore, from the monotonicity assumption such that $\sigma'(\psi) \leq 0$, an officer with low private cost is characterized by an increased probability of being offered a side contract (i.e., a bribe). Note also that the informational rent increases with $\sigma(.)$.

In order to find the components of the optimal bribing contract M, we must determine the expected utility of the criminal. From the definition of $\mathcal{V}_c(\psi)$ we have:

$$\sigma(\psi)R(\psi) = q(\psi + S)\sigma(\psi) + \mathcal{V}_c(\psi) \tag{5}$$

where the left-hand-side is the expected bribe, and the right-hand-side is the sum of the expected cost of being bribed plus the informational rent.

The expected utility of an offender is:

$$\begin{aligned}\mathcal{U} &= \int_I [b - F - \sigma(\psi)(R(\psi) + qT - (1-q)F)]dL(\psi) \\ &= \int_I [b - F + \sigma(\psi)(1-q)F - \sigma(\psi)q(\psi + S + T) - \mathcal{V}_c(\psi)]dL(\psi)\end{aligned}$$

with

$$\mathcal{V}_c(\psi) = q\int_{\psi}^{\bar{\psi}} \sigma(x)dx$$

as showed in lemma one.

Then, after integrating by parts, we derive:

$$\mathcal{U} = \int_I [b - F + \sigma(\psi)(1-q)F - \sigma(\psi)q(\psi + S + T) - \sigma(\psi)qL(\psi)/l(\psi)]dL(\psi)$$

The following proposition can now be proved:

Proposition 1 *Corruption occurs with the following probability $\sigma^*(\psi)$: one if $\psi \leq \psi_0$, and zero if $\psi > \psi_0$, where:*

$$(1-q)F = q(S + T + \psi_0 + L(\psi_0)/l(\psi_0))$$

The critical level of private costs is such that the expected gain of bribing an officer (the left-hand-side in proposition one) equals the expected cost plus the expected informational rent (the right-hand-side in proposition one).

Corollary 1 *The endogenous number of corrupted officers is given by* $1-r = prob(\psi \leq \psi_0) = L(\psi_0)$*, where* $\psi_0 = \psi_0(F, S, T, q)$*. The number of corrupted officers is increasing in the fine* F*, and decreasing in* S, T*, and* q*.*

Contrary to Bowles and Garoupa (1997) and Polinsky and Shavell (2001), we have an endogenous likelihood of corruption under asymmetric information. A higher fine seems to reduce the rate of honesty since criminals are willing to pay higher bribes, making officers more willing to accept a bribe. Punishment of corruption deters bribing by increasing the rate of honesty across offenders, either in the form of more severe punishment for corrupted officers and corrupter offenders, or in the form of higher likelihood of punishment.

Corollary 2 *The informational rent is given by* $\mathcal{V}_c(\psi) = q(\psi_0 - \psi)$*, for all* $\psi \leq \psi_0$*.*

The informational rent for an enforcer type $\psi \leq \psi_0$ is a proportion of the difference between her own private costs and the critical level for bribing.

Corollary 3 *The optimal bribe under asymmetric information is given by* $R^*(\psi) = q(S + \psi_0(F, S, T, q))$*, for all* $\psi \leq \psi_0$*.*

This is an important corollary because it implies that the amount offered as bribe does not depend on the type of enforcers $\psi \in I$. The bribe is determined at the marginal level (type ψ_0).

Corollary 4 *The bribe is increasing in* F *and* S*, and decreasing in* T*. It is increasing in* q *if* $q \geq \tilde{q}$*, and decreasing in* q *if* $q < \tilde{q}$*, where*

$$\tilde{q}(S + \psi_0) = F/[1 + \frac{d}{d\psi_0}(\frac{L(.)}{l(.)})]$$

A higher fine for the underlying offense makes criminals more willing to pay a higher bribe, and a higher sanction for corruption makes criminals less willing to pay a higher bribe. A higher fine for corruption imposed on corrupted enforcers means that they must be offered a higher bribe to collude. A higher likelihood of detection of corruption implies more risks for the two parties. A higher q means that offenders want to pay less, and officers want to be paid more. Thus, depending on which effect dominates, the result follows.[1]

Having determined the optimal bribe contract in presence of corrupted officers and asymmetric information, we analyze the incentive individuals have to commit the underlying offense. We rewrite (1) as:

$$\begin{aligned}\mathcal{U} &= b - p[r + (1-r)q]F - p(1-r)qT - p(1-r)\mathcal{R} \\ &= b - pF + pL(\psi_0)[(1-q)F - qT - R^*] \\ &= b - pF + pL(\psi_0)q(L(\psi_0)/l(\psi_0) - T) \\ &= b - p[F - qL^2(\psi_0)/l(\psi_0) + qL(\psi_0)T] \qquad (6)\end{aligned}$$

making use of $1 - r = L(\psi_0)$, $R^* = q(S + \psi_0)$, and $(1-q)F = q(S + \psi_0) + qL(\psi_0)/l(\psi_0)$.

Hence crime occurs if and only if the gain obtained by the offender more than compensates him for the expected loss:

$$b \geq p[F + qL(\psi_0)T - qL^2(\psi_0)/l(\psi_0)] = z(p, q, F, S, T)$$

As in the usual models, we will assume that the illegal gain an individual obtains from committing an offense is not known to the government, but the density $g(b)$ of gains among the population of potential offenders is known, where $g(b) > 0$ and $b \in [0, \infty)$.

4 Law Enforcement

Here we depart from previous literature by analyzing determinants of enforcement costs. Our analysis differs from the usual literature which leaves

[1]Suppose $\psi \in [0, 1]$ according to a uniform distribution. It can be shown that the sign of the derivative depends on S being more (positive) or less (negative) than $F + T$. The bribe must compensate the partner who is more sanctioned by the government if collusion is detected.

as a black box the enforcement costs. We start by assuming that the top tier of enforcers is incorruptible.[2] Let the utility of an 'elite' agent who spends observable effort e_1 in order to detect corruption (monitoring effort) be:

$$\mathcal{V}_1 = \tilde{w} - e_1 \tag{7}$$

An elite agent accepts this job if the utility of the job is more than her reservation wage $\bar{w}_1$. Hence the optimal wage from the viewpoint of the government is:

$$\tilde{w} = e_1 + \bar{w}_1 \tag{8}$$

The expected utility of an officer who spends observable effort e_0 in order to detect offenses is:

$$\mathcal{V}_0 = w - e_0 + p(1-r)[R^* - q(S + E[\psi|\psi \leq \psi^0])] \tag{9}$$

where $E[\psi|\psi \leq \psi^0]$ is the expected psychological cost given $\psi \leq \psi^0$ (i.e., an offender accepted a bribe) since neither the state nor the enforcer know type ψ before bribing actually takes place.[3] Then $E[.|.]$ is the conditional expectation of ψ, since only type $\psi \leq \psi_0$ accept an offered bribe R^*.

Replacing for $R^* = q(S + \psi_0)$ and $1 - r = L(\psi_0)$, we have:

$$\mathcal{V}_0 = w - e_0 + pL(\psi_0)q(\psi_0 - E[\psi|\psi \leq \psi^0]) \tag{10}$$

An officer accepts this job if expected utility of the job is more than her reservation wage $\bar{w}$. Since salaries are costly for the government, the optimal wage is:

$$w = e_0 + \bar{w}_0 - pL(\psi_0)q(\psi_0 - E[\psi|\psi \leq \psi^0]) \tag{11}$$

In presence of corruption, the government takes into account the expected bribes that officers may receive from criminals and pays a lower salary w than otherwise. This might explain why wages of officials in less developed

[2]See Basu et al. (1992) for discussion.

[3]We assume that police officers accept labor contracts in the veil of ignorance of their own private costs. This seems a plausible assumption since most psychological costs can only be assessed in the actual context where the bribing takes place.

countries are so low. They are set by governments taking into consideration the possibility of bribing. This observation offers an explanation for why enforcers and officials have lower wages, and why enforcers and officials are willing to accept lower wages.

Finally, we assume that relationships between efforts and enforcement is given by $p = e_0/c_0$ and $q = e_1/c_1$, where $c = (c_0, c_1)$ are parameters of enforcement technology, with $c_0 > 0$ and $c_1 > 0$.

Rewriting salaries we have:

$$\tilde{w} = c_1 q + \bar{w}_1 \tag{12}$$

$$w = c_0 p + \bar{w}_0 - pL(\psi_0)q(\psi_0 - E[\psi|\psi \leq \psi^0]) \tag{13}$$

Suppose each enforcer is paid the same wage that she could earn elsewhere, i.e. her reservation wage, the first wage regime described by Besley and McLaren (1993). In our model, every potential enforcer would like to become an enforcer (because of bribes), and the government bears a higher enforcement cost. The wage regime we analyze is one where the government pays a wage below the reservation wage. Unlike Besley and McLaren (1993), it is not a capitulation wage (only the dishonest became enforcers), because we have assumed that enforcers accept their job in the veil of ignorance of their opportunity cost of accepting bribes.[4]

In order to simplify the analysis, we suppose the density $l(\psi)$ is a uniform probability density function with support $I = [0, 1]$, and $q \in [F/(F + S + T + 2), F/(F + S + T)]$. The critical level of psychological cost is:

$$\psi_0 = [(1 - q)F - qS - qT]/(2q)$$

The conditional expectation is $\psi_0/2$ and we can rewrite the salary of an enforcer as:

$$\begin{aligned} w &= c_0 p + \bar{w}_0 - pq\psi_0^2/2 \\ &= c_0 p + \bar{w}_0 - pq[(1 - q)F - qS - qT]^2/(8q^2) \end{aligned}$$

where we assume $\bar{w}_0$ is sufficiently large to generate a positive salary.

[4]It would be a capitulation wage in Bowles and Garoupa (1997) and Polinsky and Shavell (2001).

Lemma 2 *The salary of an enforcer is increasing in* S, T, *and* q, *and is decreasing in* F. *It is increasing in* p *if* $c_0 > q\psi_0^2/2$, *and decreasing in* p *if* $c_0 < q\psi_0^2/2$.

Higher fine means a higher bribe so the government can reduce the salary of an officer. Thus, bribing saves on enforcement costs by lowering the wage to paid to enforcers.

More severity and higher likelihood of punishing officers involved in corruption means that the salary must be higher to satisfy the rationality constraint. When corrupter offenders bear a higher sanction, the bribe is lower and the salary paid to an officer will have to be higher, by the participation constraint.

The probability of detection of an underlying offender has an ambiguous effect. It increases effort costs and it increases the likelihood of bribing (since an officer will meet an offender more often). The first effect implies a higher salary, the second effect implies a lower salary.

5 Corruption Proof Solution

In this paper we follow the usual approach of the regulation literature by studying a corruption proof solution, that is, the optimal policy when the government seeks to completely eliminate corruption. A possible justification is that corruption is socially very harmful or generates important distortions with a high deadweight loss.[5]

The social welfare function is the sum of illegal gains plus social damage minus enforcement costs as in Polinsky and Shavell (2000). Note that bribes, salaries, and sanctions are assumed to be costless transfers:

$$W = \int_z^\infty (b-h)g(b)db - c_1 q - c_0 p - \bar{w}_0 - \bar{w}_1 \tag{14}$$

[5]In Bowles and Garoupa (1997) and Polinsky and Shavell (2001), the harmfulness of corruption and optimal policies when corruption is not harmful are discussed.

The government maximizes social welfare in $\langle p, q, F, S, T \rangle$ subject to maximal fines $\langle \bar{F}, \bar{S} \rangle$ interpreted as total (exogenous) wealth of offenders and enforcers. Notice that by construction the bribe paid by the offender is always less than total wealth.

Corruption is deterred by setting the likelihood of detecting and punishing corruption $\tilde{q}(F) = F/(F + S + T)$ so that $\psi_0 = 0$.

In a corruption proof solution, the planner maximizes the following Lagrangean in F, S, T, and p:

$$\begin{aligned} \mathcal{L} &= \int_{pF}^{\infty} (b - h) g(b) db - c_1 F/(F + S + T) - c_0 p - \bar{w}_0 - \bar{w}_1 \\ &\quad + \lambda_0(\bar{F} - F - T) + \lambda_1(\bar{S} - S) \end{aligned} \tag{15}$$

where $\langle \lambda_0, \lambda_1 \rangle$ are the associated multipliers.

Proposition 2 *Corruption-proof law enforcement is characterized by:*

(i) $F(h - pF)g(pF) = c_0$,

(ii) $S = \bar{S}$,

(iii) $F = \bar{F}$ *and* $T = 0$ *if* $c_0 p \geq c_1 \tilde{q}(\bar{F})$,

(iv) $F = c_0 p \bar{F}/(c_1 \tilde{q}(\bar{F}))$ *and* $T = \bar{F} - F$ *if* $c_0 p < c_1 \tilde{q}(\bar{F})$.

The collusion proof solution implies that it is optimal to impose a maximal fine on officers while the optimal fine on criminals may be lower than maximal. This results contrasts with Polinsky and Shavell (2001) who have shown that all fines should be maximal when controlling corruption.

The opposite result is obtained when enforcement costs are higher for corruption than for the underlying offense. The fine imposed on criminals should be less than maximal because a higher sanction makes bribes more likely and thus more costly to deter. However, note that the fine should not be zero since then no one would be punished and everyone would commit the underlying offense. The sanction for corruption imposed on criminals is positive and determined by the wealth constraint.

When enforcement costs are higher for the underlying offense than for corruption, the fine imposed on criminals should be maximal and, by the wealth constraint, the fine for corruption imposed on offenders is zero. It is more important to deter crime than corruption because crime detection is more expensive than corruption detection.

6 Conclusion

This paper presents a simple model to evaluate the alternative enforcement policies in presence of corruption. We have shown that the optimal criminal sanction for the underlying offense is not necessarily maximal in a corruption-proof solution.

Our results are presented in the framework proposed by Bowles and Garoupa (1997) and Polinsky and Shavell (2001). In this context, the fact that bribes allow the government to pay lower wages is socially neutral. In a more general setup, it could be that this effect is socially valuable. Consequently, some corruption could be socially valuable, because it reduces enforcement costs. Of course that this effect must be balanced against the fact that corruption dilutes deterrence of the underlying offense.

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Proofs

Proof of Lemma 1

From the definition of $\mathcal{V}_c(\psi)$ such that:

$$\mathcal{V}_c(\psi) = \max_{\tilde{\psi} \in I}\{\sigma(\tilde{\psi})[R(\tilde{\psi}) - q(\psi + S)]\}$$

Then $\mathcal{V}_c(\psi)$ is an upper envelope of a linear function in ψ, it is convex and we have almost everywhere (using the envelope theorem):

$$\mathcal{V}_c'(\psi) = -q\sigma(\psi)$$

$$\mathcal{V}_c''(\psi) = -q\sigma'(\psi) \geq 0$$

only if $\sigma'(\psi) \leq 0$ for all $\psi \in I$.

By integration of $\mathcal{V}_c'(\psi)$ such that $\mathcal{V}_c(\bar{\psi}) = 0$, we obtain

$$\mathcal{V}_c(\psi) = q\int_{\psi}^{\bar{\psi}} \sigma(x)dx$$

And the lemma follows. $\square$

Proof of Proposition 1

The optimal $\sigma^*(\psi)$ is determined by the first-order condition:

$$\partial\mathcal{U}/\partial\sigma(\psi) = (1-q)F - q(S + T + \psi + L(\psi)/l(\psi))$$

Then $\sigma^* = 1$ if $(1-q)F > q(S + T + \psi + L(\psi)/l(\psi))$. And $\sigma^* = 0$ if $(1-q)F < q(S + T + \psi + L(\psi)/l(\psi))$. Let ψ_0 be given by:

$$(1-q)F = q(S + T + \psi_0) + qL(\psi_0)/l(\psi_0)$$

Therefore, from assumption one (on monotone hazard rate of $L(.)$), it follows that $\sigma^*(\psi) = 1$ holds only if $\psi \leq \psi_0$ given that $\sigma'(\psi) \leq 0$. Conversely $\sigma^*(\psi) = 0$ when $\psi > \psi_0$.$\square$

Proof of Corollary 1

Denote $1 + \frac{d}{d\psi_0}(\frac{L(.)}{l(.)})$ by τ. The following derivatives are useful:

$$\frac{\partial\psi_0}{\partial F} = (1-q)/(q\tau) > 0$$

$$\frac{\partial\psi_0}{\partial S} = -1/\tau < 0$$

$$\frac{\partial\psi_0}{\partial T} = -1/\tau < 0$$

$$\frac{\partial\psi_0}{\partial q} = -F/(q^2\tau) < 0$$

We can check that:

$$\frac{\partial}{\partial F}(1-r) = l(\psi_0)\frac{\partial\psi_0}{\partial F} > 0$$

$$\frac{\partial}{\partial S}(1-r) = l(\psi_0)\frac{\partial\psi_0}{\partial S} < 0$$

$$\frac{\partial}{\partial T}(1-r) = l(\psi_0)\frac{\partial\psi_0}{\partial T} < 0$$

$$\frac{\partial}{\partial q}(1-r) = l(\psi_0)\frac{\partial\psi_0}{\partial q} < 0$$

and the corollary follows.□

Proof of Corollary 2

From lemma one we have:

$$\mathcal{V}_c(\psi) \;=\; q\int_{\psi}^{\psi_0}\sigma^*(x)dx + q\int_{\psi_0}^{\bar{\psi}}\sigma^*(x)dx = q(\psi_0-\psi)$$

by proposition one.□

Proof of Corollary 3

By construction, we have:

$$R(\psi) = q(S+\psi) + \mathcal{V}_c(\psi)$$

where the bribe (when occurs with probability one) equals expected cost plus informational rent. Then, for $\psi \leq \psi_0$,

$$R^*(\psi) = q(S+\psi) + q(\psi_0 - \psi) = q(S+\psi_0)$$

and the corollary follows.□

Proof of Corollary 4

We have the following comparative statics:

$$\frac{\partial R^*}{\partial F} = q\frac{\partial \psi_0}{\partial F} > 0$$

$$\begin{aligned}\frac{\partial R^*}{\partial S} &= q(1+\frac{\partial \psi_0}{\partial S}) \\ &= q(\tau-1)/\tau > 0\end{aligned}$$

$$\frac{\partial R^*}{\partial T} = q\frac{\partial \psi_0}{\partial T} < 0$$

$$\begin{aligned}\frac{\partial R^*}{\partial q} &= S+\psi_0(F,S,T,q) + q\frac{\partial \psi_0}{\partial q} \\ &= S+\psi_0(F,S,T,q) - F/(q\tau)\end{aligned}$$

The sign of the last derivative depends on q being higher (positive) or lower (negative) than $\tilde{q}$.□

Proof of Lemma 2

The following comparative statics are important:

$$\frac{\partial w}{\partial F} = -pq\psi_0 \frac{\partial \psi_0}{\partial F} < 0$$

$$\frac{\partial w}{\partial S} = -pq\psi_0 \frac{\partial \psi_0}{\partial S} > 0$$

$$\frac{\partial w}{\partial q} = -pq\psi_0 \frac{\partial \psi_0}{\partial q} - p\psi_0^2 > 0$$

$$\frac{\partial w}{\partial T} = -pq\psi_0 \frac{\partial \psi_0}{\partial T} > 0$$

$$\frac{\partial w}{\partial p} = c_0 - q\psi_0^2/2$$

and the claim follows.□

Proof of Proposition 2

The first-order conditions are:

$$\mathcal{L}_p = F(h - pF)g(pF) - c_0 = 0$$

$$\mathcal{L}_S = c_1 F/(F + S + T)^2 - \lambda_1 = 0$$

$$\mathcal{L}_F = p(h - pF)g(pF) - c_1(S + T)/(F + S + T)^2 - \lambda_0 = 0$$

$$\mathcal{L}_T = c_1 F/(F + S + T)^2 - \lambda_0 = 0$$

Second-order conditions are assumed to be satisfied. From the first-order condition with respect to S, we have $\lambda_1 > 0$ and $S = \bar{S}$.

From the first-order condition with respect to p, we can write:

$$(h - pF)g(pF) = c_0/F$$

From the first-order condition with respect to T, we can write:

$$\lambda_0 = c_1 F/(\bar{F} + \bar{S})^2$$

We can rearrange the remaining first-order condition as:

$$\mathcal{L}_F = pc_0/F - c_1/(\bar{F} + \bar{S}) = 0$$

The optimal solution depends on the following situations:

(a) $c_0 p \geq c_1 \tilde{q}(\bar{F})$.

We should have $F = \bar{F}$ and $T = 0$.

(b) $c_0 p < c_1 \tilde{q}(\bar{F})$.

We should have $F = pc_0\bar{F}/(c_1\tilde{q}(\bar{F}))$ and $T = \bar{F} - F$.