Controlling Collusion and Extortion: The Twin Faces of Corruption

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Abstract: *Corruption has two faces: collusion and extortion. The former refers to under-reporting of offenses by inspectors in exchange for bribes. The latter refers to bribes extracted against the threat of over-reporting. Both distort penalties that offenders expect to pay, relative to what they are supposed to pay, and can seriously reduce incentives to commit offenses. Existing theoretical literature on corruption control has recognized the tension between these two forms, while taking the structure of legally mandated fines for offenses as given. It has argued that extortion poses serious problems for high-powered incentive schemes for inspectors designed to combat problems of collusion. We argue that corruption control policies should be enlarged to include choice of fines, as these can help greatly in controlling both problems. We demonstrate a variety of contexts where problems of dilution of deterrence incentives owing to both collusion and extortion can be resolved by adjusting mandated fines, even though judicial systems may be weak and ineffective, and civil service norms may restrict use of high-powered bonus schemes for inspectors.*

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1 Introduction

The theoretical literature on law enforcement has identified extortion possibilities as a key obstacle to successful control of corruption (Banerjee 1994, Mookherjee 1997, Hindricks et al 1999, Polinsky and Shavell 2001, Khalil et al 2010). Providing auditors or inspectors with high powered incentives is necessary to curb collusive under-reporting of offenses they discover. Indeed, such under-reporting can be completely eliminated by privatization of inspections, where all fines paid by offenders are paid as bonus rewards to inspectors. However, a key drawback of privatized enforcement is that they give rise to a different problem, wherein inspectors are motivated to fabricate or over-report offenses in order to extort bribes. The historical experience with tax farming in medieval times is replete with problems of extortion where tax collectors harassed and extracted bribes from citizens against a threat of over-reporting their incomes and citing them falsely for tax evasion. With a weak judicial process, appeals made by citizens against over-reporting of crimes by inspectors cannot be satisfactorily addressed, either because appellate authorities lack the capacity to discover the truth, or to impose sanctions on inspectors for over-reporting. The anticipation of extortion can motivate citizens to under-report their incomes or commit large offenses, as better behavior is unlikely to be rewarded if they will be falsely implicated by extortionary inspectors. So the welfare consequences under privatization could be just as grevious, or even worse than collusive under-reporting generated by low powered incentive schemes for inspectors.

In this paper we address the twin problems of collusion and extortion in law enforcement. We show that it is possible to achieve second-best compliance levels, compliance levels which would be achieved in the absence of any form of corruption, by enlarging the set of policy instruments if revenue considerations are ignored.[1] Specifically we argue that adjusting fines for tax evasion or pollution can be an effective means of dealing with both collusion and extortion. This possibility has been ignored or overlooked by existing literature, which has taken the structure of fines as given. If choice of the fine structure can be coordinated with the design of incentives for inspectors, this allows two sets of policy instruments to deal with the twin problems of collusion and extortion. Specifically, under a wide variety of circumstances, appropriate choice of the fines for offenders (tax evaders or polluters) can effectively 'solve' both problems, even with very weak judicial appeals processes.

[1] Revenue problems can also be taken care of if there are no limited liability constraints for inspetors.

It is important to clarify what exactly we mean by 'solve', and the circumstances under which these results apply. By 'solve' we mean achieve consequences for utilitarian welfare that are the same as in a world where problems of collusion or extortion do not exist. In our 'solution' both collusive under-reporting and extortionary bribes will arise. But fines for offenses will be calibrated in such a way that the *expected marginal penalties* for offenses incurred by firms will end up exactly the same as in a world without corruption, so that the resulting levels of offenses will be the same. In some cases, consequences for net revenues will also be the same, provided expected bribes earned by corrupt inspectors can be mopped up through fixed fees, provided these do not violate inspectors' wealth constraints. We abstract from considerations of uncertainty and risk aversion of either inspectors or firms, though we do respect wealth constraints for firms that limit fines that can be imposed on them. We do not claim universality of this solution, but the main implication of our analysis is that legal fines for offenses ought to be an important tool in combating corruption.

We consider a setting of pollution where firms have heterogenous preferences for polluting and can choose how much to pollute (denoted by a). Suppose the government wishes to implement a given pattern of pollution behaviour, where appropriate deterrence is efficiently accomplished by some schedule of penalties $f^*(a)$ borne by firms as a function of the level of reported pollution. Under-reporting is sought to be prevented by the use of bonus schemes, with the bonus rate $r \leq 1$. An example of such high-powered incentive scheme is the case of privatization which eliminates under-reporting. Over-reporting is sought to be discouraged by an institutional setting where firms can appeal over-reporting by the inspector by incurring a cost, denoted by L. This cost is reimbursable in case of a successful appeal. Appeals succeed in discovering and then punishing over-reporting with some positive probability x. Parameter x captures the quality of the judicial system.[2] Privatization can be combined with lowering the actual pollution penalties below $f^*(a)$ uniformly by $\frac{L(1-x)}{x}$ for every level of pollution a. The game between inspectors and firms will result in inspectors extorting firms upto the point where the latter are indifferent between appealing and not. This implies that the sum of penalties and expected bribes paid by firms will exactly equal $f^*(a)$ following choice of pollution a. The reduction in penalties collected directly from the firms will be made up by lowering the salaries of inspectors uniformly by the same amount.

We then consider what happens when such high-powered incentive schemes cannot be used for whatever reasons, such as civil service norms or problems of equity and morale within bu-

[2] We allow for x to be as low as possible subject to the condition that inspectors would prefer not to over-report whenever they expect firms to appeal with certainty. See the discussion regarding Assumption A3 in Section 2.2.

reaucracies. In such contexts both collusion and extortion can potentially arise. Collusion is associated with under-reporting by inspectors, while extortion is associated with the opposite phenomenon of over-reporting. Both cannot of course happen at the same time. Collusion will typically arise on the equilibrium path owing to low-powered incentives for inspectors, while extortion will not. Nevertheless extortion threats increase the bargaining power of inspectors, which distort ex ante pollution incentives of firms. We show that under similar assumptions regarding the appeals process as in the case of high-powered incentives, both problems of collusion and extortion problem can be resolved costlessly through appropriate adjustments of pollution fines. Extortion raises the level of effective penalties incurred by firms, and lowering marginal penalties at high levels of pollution, thereby encouraging firms with high preferences for pollution to increase their levels of pollution. This can be addressed by lowering mandated fines suitably, so that the effective penalties end up just as they would be in a world without extortion. Conversely, collusion lowers both levels and marginal rates of penalties effectively borne by firms. This can be 'cured' by raising marginal fine rates and adjusting their level. Desired patterns of marginal deterrence can thus be achieved without violating limits on liabilities of firms.

This approach can be extended in suitable ways even when appeal costs are not constant but differ with the extent of over-reporting, or when firms have heterogenous and privately known appeal costs. Finally we discuss the consequences of introducing problems arising from limits on liability of inspectors and financial costs incurred by the government. Then extortion problems cannot be resolved costlessly by the method of lowering pollution fines, since the loss of government revenues cannot be recovered by lowering inspector salaries. Indeed the 'solution' to the extortion problem that we are exploring in this paper may entail awarding subsidies for low levels of pollution, as a way of inducing firms to avoid large levels of pollution. Desired patterns of marginal deterrence can be achieved in the presence of extortion, but at a cost in terms of lower net government revenues. When government finances are scarce, revenue considerations will require the government to give up on securing deterrence of some range of pollution levels, e.g., by raising the minimum 'allowed' level of pollution. Nevertheless, the essential point remains that selecting the penalties for pollution remains a valuable tool for combating problems of corruption.

2 The Model

Our basic model follows Mookherjee and Png (1994) which focused on problems of securing marginal deterrence for pollution, where assets of firms limit penalties that can be imposed for pollution. That paper abstracted from problems of corruption. Call this the *second best* problem. We extend this to incorporate the possibility of both types of corruption: collusion and extortion. Our main focus is on showing circumstances where choosing pollution fines will fully resolve both problems in the sense that the second-best outcome can be implemented in the presence of collusion and extortion possibilities.

2.1 The Second-Best Problem: Benchmark with No Corruption

Firms choose pollution levels denoted by a where $a \geq 0$. Firms derive heterogenous benefits from pollution, represented by $t \in [0, T]$. Firm types are unobserved by inspectors, and are distributed according positive and continuous density $z(t)$. The benefit to type t from choosing pollution level a is $tB(a)$. The social cost associated with pollution level a is given by $h(a)$. Both benefits and costs are differentiable and strictly increasing, $B^{/}(a) > 0, h^{/}(a) > 0$. In addition, benefits are bounded above, $\lim_{a\to\infty} B(a) = \overline{B}$ and $\overline{B}$ is finite. Firms are inspected with probability μ and a firm detected with pollution level a pays penalty $f(a)$.

The probability μ of inspection is determined by the scale of the resources devoted by the government to enforcement. To a first approximation it is proportional to the ratio of inspectors to firms. Inspectors incur time costs but no unobservable effort costs in inspecting, as in Laffont-Tirole (1993), so as to abstract from the considerations emphasized by Mookherjee-Png (1995). Let c denote the marginal social cost of raising the monitoring probability μ and we assume this is exogenously given (determined by the costs of employing inspectors and providing them necessary resources for inspection). Later when we allow for corruption we shall be more explicit about the determination of these costs.

Also let λ denote the marginal social value of government revenues. This is essentially the marginal deadweight loss of tax revenues, and we shall take it to be a parameter. Net government revenues will equal the difference between fines collected and costs associated with inspections.

As in Mookherjee-Png (1994), the two major restrictions on enforcement here are that (i) fines that can be imposed are limited by the offender's wealth W, which is taken as given, and (ii) the inspection probability μ cannot be varied with the level of the offense. Hence marginal deterrence requires graduating fines to the severity of the offense. (ii) requires $f(a)$

to be an increasing function, while (i) requires it to be bounded above by W. We add to this model a concern for government revenues, which rules out the possibility of providing marginal deterrence costlessly by lowering the fine function sufficiently, without running into the limited liability constraint (i).[3]

With honest inspectors, the true pollution will be reported by the inspector, and a type t firm will choose $a(t)$ to maximize $tB(a) - \mu f(a)$.

The **second-best problem** is to select μ, $f(a)$ and $a(t)$ to maximize utilitarian welfare

$$SW = \int_0^T \{tB(a(t) - h(a(t))\}z(t)dt - \lambda[c\mu - \int_0^T f(a(t))z(t)dt] \tag{1}$$

subject to the constraints

$$0 \leq \mu \leq 1 \tag{2}$$

$$f(a) \leq W, \tag{3}$$

and the incentive constraint requiring firms to respond optimally by selecting offenses according to $a(t)$ which maximizes

$$tB(a) - \mu f(a) \tag{4}$$

Let $a^*(t)$ denote the second-best action schedule, and $f^*(a)$ the corresponding second-best fine function. Mookherjee-Png (1994) provide a detailed characterization of the second-best; here we note the following features.

(i) Every implementable action schedule $a(t)$ is non-decreasing in t, which follows from the incentive constraint (4).

(ii) The corresponding fine function $f(a)$ (which implements a non-decreasing $a(t)$) is non-decreasing in a. If it were decreasing over some range, firms would be incentivized to select actions at the upper end-point of this range rather than intermediate levels. The same outcomes would result by 'ironing' the fine function to make it flat over the entire range.

(iii) The second-best policy may involve an enforcement threshold level $a_0 \geq 0$ such that actions below this level are associated with rewards, i.e., negative fines. This will be the case if the limited liability constraint limits fines that can be imposed on large offenses, so deterrence of such offenses can be achieved only by graduating penalties sufficiently for lower levels of offenses. If the weight on government revenues is small enough relative to social harms from large offenses, and W is small enough, it will make sense to deter large offenses by rewarding small offenses.

[3]Mookherjee and Png (1994) instead imposed a nonnegativity constraint on the fine function.

In what follows we denote implementable action schedules by $a_t \equiv a(t)$ and second-best actions by a_t^*.

2.2 Collusion and Extortion

Now we allow for the possibility of corruption among inspectors. Inspectors may be inclined to under-report offenses they discover, motivated by bribes paid by firms to induce them to do so. This is the problem of *collusion* or *under-reporting*. Deterring under-reporting will require providing the inspector with carrots (in the form of bonuses for fines collected) and sticks (penalties imposed if such under-reporting is subsequently discovered). Inspectors can (or credibly threaten to) over-report offesnses motivated by higher bonuses or bribes paid by firms to prevent them from doing so. This is the problem of *extortion or over-reporting*. We discuss how this restricts the enforcement policy.

Inspectors compensation consists of two parts, a fixed wage w and bonuses or penalties associated with variable measures of inspector performance. Bonuses take the form of rewarding the inspector at a fixed rate r for every dollar of fines collected, $r \leq 1$. Penalties can also be imposed following discovery of corruption. This is explained further below.

The sequence of events is as follows. The regulator announces the enforcement policy μ, f in addition to inspector compensation policy. Firms choose pollution levels $a(t)$. Each firm is inspected with probability μ. The true pollution level is detected costlessly by the inspector. However, the inspector is corruptible and its reported action $a^{/}$ can be different from the true action. We describe the interaction between the inspector and the firm later. Let $e(a \mid f)$ be the effective payment/penalty associated with action a; given regulator's stipulated penalty $f(a)$. Note that with a non-corrupt inspector $e(a \mid f) = f(a)$. Firm's maximization problem is slightly different now. Type t firm will choose a_t which is the solution to

$$\underset{a}{Max}\ tB(a) - \mu e(a) \tag{5}$$

Comparing this with Eqn(4), it is clear that second-best actions a_t^* can be implemented by any fine function g if $\partial e(a \mid g)/\partial a = \partial f^*(a)/\partial a$. The inspector has an exogenously given outside option payoff if he were to not work for the government. The *enforcement problem* now involves selection of an inspector compensation policy which consists of a fixed payment w and a bonus rate r, subject to incentives of inspector to report discovered offenses, and the incentives of the firms to commit offenses, besides the constraints in the second-best problem, and the constraint that ensures that inspectors are willing to work in the government.

The Game Form: The interaction between the inspector (I) and the firm (F) is captured by a game form with two components. This is quite similar to game forms used in Hindriks et al (1999) and Polinsky and Shavell (2000).

The first stage of the game is the co-operative phase where the inspector and the firm bargain over the report $a^{/}$ and payment b from the firm to the inspector. We assume that both the inspector and the firm are risk neutral and bribe determination follows the symmetric Nash bargaining solution. If they agree, inspector reports $a^{/}$ and receives a transfer b from the firm. If they fail to agree, both I and F choose their strategies noncooperatively with their disagreement payoffs being determined by the following non-cooperative game N.

In the non-cooperative game, first I reports $a^{//} > a$. Then F decides whether to accept it or appeal at cost L. If accepted, the game ends and F pays $f(a^{//})$ as penalty and I receives $rf(a^{//})$. For the firm there is a fixed cost associated with filing an appeal. This cost denoted by L is constant and same for everyone, irrespective of the type and action of the firm.[4] The inspector knows the exact value of L. If the firm appeals the true action is discovered with probability $x > 0$, the legal cost L is reimbursed, as are the excess fines paid, so the firm ends up paying the correct fine $f(a)$. The inspector on the other hand, refunds the excess rewards and over that pays a penalty $m(a, a^{//})$; where $m(a, a^{//}) = 0$ if $a = a^{//}$, and $m(a, a^{//}) > 0$ if $a < a^{//}$. With probability $(1 - x)$, the true action is not discovered and F loses the appeal, so F pays $f(a^{//})$ and I receives $rf(a^{//})$.[5]

The final stage of the game is a possible media leak which forces the government to take punitive action against exposed collusion. In the absence of a media leak, the inspector receives a bonus of $rf(a^{/})$, as the collusion goes undetected. Let q be an exogenous probability of the media leak. Following the leak, the firm pays $k(a, a^{/}) \geq f(a)$, i.e., an amount that exceeds the fine that it would have paid in the absence of under-reporting. The inspector receives commission $rf(a)$ whenever $a = a^{/}$and pays a fine $j(a, a^{/})$ otherwise.[6] We shall assume that $k(a, a^{/}) = f(a)$, $j(a, a^{/}) = 0$ if $a = a^{/}$, and $k(a, a^{/}) > f(a)$, $j(a, a^{/}) > 0$ for all $a > a^{/}$. For simplicity we assume that b is recovered from the inspector following a leak. We shall assume that these penalties for collusion are exogenously given.

Penalties and Limited Libaility: While inspectors are not subject to any limited liability constraint, we nevertheless assume that inspector's fines cannot exceed some arbitrarily given

[4]We relax this assumption later and discuss various cases where L is a variable cost.

[5]Note that the appeal system is therefore assumed to be effective in the following sense. Upon discovery of over-reporting, it is is able to recover the reward and reinstate the true penalties. Hence the inspector will never pay the firm to make an over-report and collect a high reward, which the firm can avoid by appealing. With an ineffective legal system, over-reporting can be a form of collusion too.

[6]We also assume that the entire bribe amount can be recovered from the inspector, following a leak.

limit J. This rules out the possibility of controlling collusion via arbitrarily large penalties following exposure in a media leak.

$$k(a, a^{/}) \leq W, \text{ and } m(a, a^{/}), \quad j(a, a^{/}) \leq J \tag{A1}$$

As mentioned above, we specialize to the case where collusion penalties following a media leak $k(a, a^{/})$, and $j(a, a^{/})$ depend linearly on the extent of under-report provided the former does not violate the firm's limited liability constraint, otherwise it is set equal to W.

$$k(a, a^{/}) = \min\{k[f(a) - f(a^{/})], W\} \text{ and } j(a, a^{/}) = j[f(a) - f(a^{/})], \ \forall \ a^{/} < a, k, j > 1 \tag{A2}$$

Our third assumpetion ensures that while over-reporting I will not wish to induce an appeal. Consider the disagreement game where I reports $a^{//}$. Following an appeal, I gets $(1-x)rf(a^{//})+ x(-m(a, a^{//}))$. An effective court system means that x is bounded away from zero and the following condition is always satisfied.[7]

$$(1 - x)rf(a^{//}) + x(-m(a, a^{//})) < rf(a), \forall \ a, a^{//} > a \tag{A3}$$

Payoffs: Let d_I, d_F denote the disagreement payoffs to the inspector and the firm, π_I, π_F denote the corresponding payoffs from agreement. Using (A3), it is possible to solve for d_I and d_F. The inspector will over-report the firm to fullest extent possible; that is the firm will be indifferent between appealing and not appealing. In case of agreement, given our assumption that media leak is possible with reports $a^{/} < a$, we can have two cases. Suppose $a^{/} \geq a$.The joint payoffs from agreement will be given by $\pi_F + \pi_I = (r-1) \ f(a^{/})$. Since $r \leq 1$, this is maximized at $a^{/} = a$. It is clear that from the view point of the inspector and the firm, over-reporting clearly involves a deadweight loss for any $r < 1$. So over-reporting will not occur as part of any agreement. In fact, over-reporting will not occur on the equilibrium path because the joint payoff from reporting the true action a will always exceed the joint payoff from the disagreement game for $r \leq 1$. Now consider $a^{/} < a$. This means that under-reporting is jointly profitable. In such an event, the linearity of penalty functions imply that under-reporting is maximal. The following Lemma confirms this.

Lemma 1 *Consider the bribe game described above. Suppose assumptions A1-A3 hold. In-*

[7]Suppose we set $m(a, a^{//}) = J$ for any $a^{//} > a$. Then a sufficient condition is $(1 - x)rW < xJ$.

spector's reported action $a^{/}$ will be given by the following

$$a^{/} = \left\{ \begin{array}{ll} 0\ if & 1-r > q(k+j) \\ a & otherwise \end{array} \right\}$$

Proof. Consider the non-cooperative game N first . Firm will never appeal if $a^{//} \leq a$. Since $r \geq 0$, we can consider only $a^{//} > a$.[8] Using (A1) and (A3) it can be seen that I chooses $a^{//}$ such that $a^{//} = f^{-1}(\min\{f(a) + L(1-x)/x, W\})$. The disagrement payoffs are given by

$$d_I = rf(a^{//}) \text{ and } d_F = W - rf(a^{//}), where\ f(a^{//}) = \max\{f(a) + \frac{1-x}{x}L, W\} \quad (6)$$

Suppose $a^{/} \geq a$. Then payoffs to both F and I from agreement $(b, a^{/})$will be $\pi_F = W - f(a^{/}) - b$ and $\pi_I = r\ f(a^{/}) + b$. Joint payoffs from agreement exceed the sum of disgreement payoffs iff

$$W + (r-1)f(a^{/}) \geq W + (r-1)f(a^{//}) \quad (7)$$

This inequality always holds for any $r \leq 1$ and $a^{/} < a^{//}$. Surplus from agreement is given by

$$(\pi_I + \pi_F) - (d_I + d_F) = (r-1)[f(a^{/}) - f(a^{//})]$$

Since $a^{/} \geq a$,the above expression is maximized at $a^{/} = a$.

Now consider $a^{/} < a$. Since this case involves possible leak with probability q and subsequent fines for bribery, limited libaility coniderations come in to play. Using (A2), payoffs to F and I will be given by

$$\begin{aligned} \pi_I &= rf(a^{/}) + b - q\{j[f(a) - f(a^{/}) + b\} \quad (8) \\ \pi_F &= W - f(a^{/}) - b - q\min\{k.[f(a) - f(a^{/})], W - f(a^{/})\} \end{aligned}$$

The joint payoff from agreement is simply $W - (1-r)f(a^{/}) - q\{\min\{k.[f(a) - f(a^{/})], W - f(a^{/})\} + j[f(a) - f(a^{/})\}$.To see when the joint payoff from agreement is maximized, consider first the case where limited liability constraint is not binding. Clearly, maximizing $\pi_I + \pi_F$ is equivalent to minimizing $\{(1-r) - q(k+j)\}f(a^{/})$ for a suitable choice of $a^{/}$. If $1-r > q(k+j)$, the joint payoff is maximized at $a^{/} = 0$.

The optimality of maximal under-reporting holds when the limited liability condition is binding. Consider an action a and a report $\widetilde{a}$ such that the limited liability constraint is

[8] Additionally, we can also allow for diagreement games where I asks for a bribe by proposing a bribe and an action. An earlier version considered this but overall qualitative results are not affected.

binding. Since $k > 0$, the constraint is likely to bind for bigger under-reports rather than for smaller unde- reports. Clearly, if the optimal under report is $a^{/} \leq \widetilde{a}$, then $a^{/} = 0$. If under reporting is profitable with a higher total penalty $(k + j)$, it will of course be profitable with $(1 + j)$.

When $1 - r \geq q(k + j)$, under-reporting is not optimal and joint payoff is increasing in $a^{/}$. But for $a^{/} \geq a$, joint payoff is maximized at $a^{/} = a$. ■

In what follows we shall be discussing these two cases.

2.3 Extortion Only: $1 - r \leq q(k + j)$

Since under-reporting is subject to external monitoring such as media leaks or other forms of audits, collusive under-reporting will not be profitable for higher values of $r, q, k,$ and j. Whenever $1 - r \leq q(k + j)$, only extortion can take place. Note that this case includes the privatized enforcement case where $r = 1$. It is well-known from Laffont-Tirole (1993) and others that if no lower bound is imposed on the fixed payment w to inspectors, the second-best can be achieved, in the absence of extortion, by a high-powered incentive scheme involving $r = 1$ which removes all incentives for inspectors to under-report, and then selecting w low enough so as to meet the inspector's participation constraint with equality. Rents earned by inspectors are thereby taxed away upfront, if necessary with fixed payments w that are negative, representing bids posted by inspectors for the right to collect.[9] We argue that second-best action schedule can be implemented even when extortion possibilities are present.

As shown above, over-reporting typically involves deadweight losses, with costs incurred by firms exceeding the benefits that inspectors obtain from over-reporting. Hence it will not actually arise on the equilibrium path, as firms will be willing to pay bribes to induce the inspector to not over-report. Extortion will simply serve to increase the bargaining power of inspectors and enable them to extract more bribes. These extortion-induced bribes can distort incentives of firms to commit offenses in the first place. To see how the enforcement problem is affected, consider the second best action schedule and fine $f^*(a)$. We examine whether f^* can implement the same eaction schedule in the presence of extortion.

Recall that in this case $a^{/} = a$. From the Lemma it is clear that effective penalties will go up only to the extent extortion affects the disagreement payoffs. If effective penalties go up uniformly by the same amount so that marginal pollution costs are unchanged for all actions we can implement $a^*(t)$ even with extortion and the same fine function f^*. However, this is not

[9] If there was a positive lower bound to w, such high-powered incentives would represent high revenue losses for the government, as fines paid by the firms will be used to pay bonuses.

possible if wealth constraint is hit and some firms cannot be over-reported to the same extent (by $\frac{L(1-x)}{x}$). In such a case, for small values of t and corresponding low levels of a_t, incentives will be unaffected but beyond a certain threshold firms with $t > t^*$, marginal incentives will fall and firms will choose higher pollution levels. The following Proposition confirms this.

Proposition 1 *Suppose appeals processes are weak enough in the sense that* $\frac{L(1-x)}{x} > W - f^*(a_T)$, *second-best outcome cannot be implemented by second-best fine function* f^* *even when under-reporting is deterred completely,* $1 - r \leq q(k + j)$.

Proof. Joint payoff from agreement is $W - (1-r)f(a)$ and joint payoff from disagreement is $W - (1-r)f(a^{//})$ where $f(a^{//}) = \min\{f(a) + \frac{1-x}{x}L, W\}$. Using Nash Bargaining it is easy to verify that bribe $b = \frac{1+r}{2}\frac{1-x}{x}L$, if $f(a) + \frac{1-x}{x}L < W$ and $b = \frac{1+r}{2}(W - f(a))$ otherwise. The expected pollution costs anticipated by the firm (sum of fines and bribes) associated with pollution a is now $e(a) = \min\{f(a) + \frac{1+r}{2}\frac{L(1-x)}{x}, f(a) + \frac{1+r}{2}(W - f(a))\}$.

Pollution costs are raised uniformly by $\frac{1+r}{2}\frac{L(1-x)}{x}$, until the wealth constraint is hit. Since $\lim_{a\to\infty} f^*(a) = W$ in the second-best, there exists an action $\bar{a} < \infty$ such that $f^*(\bar{a}) = W - \frac{L(1-x)}{x}$. So fines for all offenses below $\bar{a}$ will rise uniformly by a constant amount $\frac{L(1-x)}{x}$, and will equal W for all offenses $a \geq \bar{a}$. *Marginal pollution costs are unchanged until* $\bar{a}$, *but fall to* $\frac{1-r}{2}f^{/}(a)$ *thereafter, thus destroying marginal deterrence for high levels of pollution.* If the judicial system is weak ($\frac{L(1-x)}{x}$ is large enough), $\bar{a}$ will be smaller than a_T, the largest pollution level in the second-best. The second-best action schedule a_t^* can then no longer be implemented.

In the privatization case with $r = 1$, marginal pollution costs fall to zero for all firms with $t > t^*$. Hence these firms will jump to maximal levels of pollution, since there are no incentives to control the level of pollution above $\bar{a}$. ■

This result underlies the argument of Banerjee (1994), Mookherjee (1997) and Hindricks et al (1999) that extortion poses a drawback to the use of high-powered incentive schemes for inspectors, a particular manifestation of multi-task problems associated with use of incentive schemes highlighted by Holmstrom and Milgrom (1990). They argue accordingly that low-powered incentives ought to be used to address the problem of extortion. But this will in turn create problems of collusive under-reporting. Collusion therefore has to be tolerated in order to avoid excessive extortion. In a related context Khalil et al (2010) argue that it might be optimal to tolerate some collusion but extortion has to be prevented. Polinsky and Shavell (2000) arrive at somewhat opposite conclusion, in a different setting, where it is optimal to tolerate limited extortion. We argue in this paper that this trade-off need not be so hopeless.

With two problems that need to be controlled, additional instruments need to be utilized. One such instrument is the fine function for pollution.

The problem with extortion is that it raises the expected penalties associated with pollution. Hence one way to address this problem is to lower the mandated fine function in such a way that the resulting schedule of expected penalties generate same marginal deterrence as in the second-best situation. In the situation depicted above, the government can choose a fine function

$$g(a) = f^*(a) - \frac{L(1-x)}{x} \tag{9}$$

which is uniformly lower by the extent of the excess fine due to over-reporting for every $a \leq a_T$. Above a_T the fine function g will be constructed so that it is strictly increasing and tending to W as $a \to \infty$.

[Figure 1]

It is evident that upon replacing the second-best fine function with g, inspectors will extort $\frac{1+r}{2}\frac{L(1-x)}{x}$ from every firm with $a \leq a_T$, since for any pollution level at or below a_T there exists some higher pollution level where the fine is at least $\frac{L(1-x)}{x}$ higher, and which the firm has the ability to pay. This implies that the expected penalty following any $a \leq a_T$ will be $e(a \mid g) = g(a) + \frac{1+r}{2}\frac{L(1-x)}{x}$. Since $\partial e(a \mid g)/\partial a = \partial f^*(a)/\partial a$ for any $a \leq a_T$ marginal deterrence is preserved for all types and actions. Hence the second best action schedule can be implemented by g.

Proposition 2 *Suppose* $1 - r \leq q(k + j)$. *There exists a fine function which together with high-powered incentives enables implementation of the second-best action schedule* a^*. *outcome (*

Proof. From the construction of the fine function g (eqn 10) it is clear that first order

conditions to the two incentive constraints (4) and (5) are identical. ■

The lowering of the fines paid by firms results in a loss of government revenues by $\frac{L(1-x)}{x}$ per firm. Note that reward payments also fall by $r\frac{L(1-x)}{x}$, but reward payments are adjusted against the salaries and hence cannot be counted as savings. However, the inspector receives extortion bribes to the tune of $\frac{1+r}{2}\frac{L(1-x)}{x}$. Hence salaries can be reduced by $\frac{1+r}{2}\frac{L(1-x)}{x}$ without violating the inspector's participation constraint. So net loss in revenues will be given by $\frac{1-r}{2}\frac{L(1-x)}{x}$ per firm. In the special case of privatization, $r = 1$, government revenues are unaffected. When collusion is sought to be resolved via high-powered incentives $r \geq 1 - q(k+j)$, the revenue loss from addressing extortion (by lowering fines) is higher for lower values of r. If the government were to choose r such that $r \geq 1 - q(k + j)$, then it should choose $r = 1$ to minimize revenue loss. With privatization extortion does not disappear — indeed it is rampant — but it has no consequences for deterrence of pollution. Neither does it have consequences for rents illegally appropriated by inspectors, as these are extracted upfront in the form of lower salaries.

Corollary 2 *In the case of privatized enforecement, $r = 1$, the second-best deterrence level can be implemented with no revenue implications provided wealth constraints for inspectors do not bind, and appeal costs L are constant for all firms and known to all.*

3 Collusion & Extortion: $1 - r > q(k + j)$

Now consider the case where collusive under-reporting arises becasue of low-powered inspector incentives and weak oversight by the media or other watchdog agencies. There are several reasons, such as civil service norms and equity concerns, which makes high-powered incentive schemes difficult to employ. Hence we are more likely to see the co-existence of both collusion and extortion. Collusion can happen in equilibrium, while over-reporting will not (but the threat of over-reporting will affect bribes, allowing inspectors to extract more than in a situation where over-reporting is not possible).

As shown earlier (Eq 9), if $1 - r > q(k + j)$, under-reporting will take place and it will be maximal $a^{/} = 0$. Denoting $f(0) = f_0$, we can rewrite the joint payoff from agreement as

$$W - (1 - r)f_0 - q\{\min\{k.[f(a) - f_0], W - f_0\} + j[f(a) - f_0\} \tag{10}$$

Joint payoff from disagreement will be $W - (1 - r)f(a^{//})$ where $f(a^{//}) = \min\{f(a) + \frac{1-x}{x}L, W\}$. Note that these joint payoffs reflect two types of limited liability constraints. In one case, extortion is limited because $f(a^{//})$ cannot exceed W. In the other case, the ability to impose fine following collusive under-reporting and its subsequent discovery is limited because $k.[f(a) - f_0]$ can not exeed $W - f_0$. To see how bribes are determined (by Nash bargaining) and are affected by extortion possibilities, let us ignore the limited liability constraint in the disagreement game for the time being, $f(a^{//}) < W$ for all $a \leq a_T$. This is without any loss of generality because, as seen in the construction of the fine $g(a)$ in Proposition 2, we shall construct a fine function where this constraint will never bind.

Using symmetric Nash bargaining solution, we can work out the bribe b and the effective penalty function e for any given fine function f. The details are given in the Appendix. To see how collusion and extortion determine the effective penalty, let us first consider the case where $k.[f(a)-f_0] \leq W-f_0$. As shown in the Appendix, the effective fine for action a, given mandated fine function f, will be given by

$$e(a \mid f) = \frac{1}{2}(1+r+qk+qj)f(a) + f_0 - \frac{1}{2}(1+r+qk+qj)f_0 + \frac{1-x}{2x}L(1+r) \tag{11}$$

Since gain from collusion is positive, $1-r > q(k+j)$, it can be seen that $1+r+q(k+j) < 2$. This implies that collusion results in a dilution of marginal penalties, $\partial e(a \mid f)/\partial a < \partial f(a)/\partial a$. Dilution can be both in levels and the rate at which penalties increase with the level of pollution. In the absence of extortion (say $x=1$ or $L=0$), it can be shown that $e(a \mid f) < f(a)$. Hence firms pay less both in absolute as well as marginal terms for ech level of pollution. However, since extortion possibilities raise the bribe paid by the firm, overall effective penalty can be higher.

Irrespective of whether actual penalties go up or not, what matters for firm pollution incentives is the marginal penalties associated with an increase in pollution levels. If the second-best fine function f^* is mandated, collusion implies marginal expected penalties are less than what they were in the second-best context. Consequently pollution levels will rise if the same fine function in the second-best were to be used.

It can be shown that these observations hold even in the case where $k.[f(a)-f_0] > W-f_0$. The exact nature of the effective penalty function changes but the dilution of marginal penalties is similar. The effective penalty in this case is given by

$$e(a \mid f) = \frac{1}{2}(1+r+qj)f(a) + f_0 + \frac{1}{2}q[W-f_0] - \frac{1}{2}(1+r+qj)f_0 + \frac{1-x}{2x}L(1+r) \tag{12}$$

To remedy this dilution, marginal fine rates need to be adjusted *upwards* for every level upto pollution levels of a_T so that same level of deterrence can be achieved. This adjustment can be achieved by increasing the *slope* of second-best fine function. But this will affect the limited liability constraints and we need to ensure that these constraints are respected. Let $n(a)$ denote this new scaled-up fine function. First, we need to ensure that each action is extorted in the same manner, that is $a^{//}(a)$ exists for all a, where $n(a^{//}) = n(a) + \frac{1-x}{x}L$. Otherwise, as we saw in the discussion preceding Proposition 1, marginal fine rate will drop to zero for some firms and second best pollution levels can not be implemented. Second, since $f(a) \leq W$, we need to ensure that the new function also satisfies $n(a) \leq W$. We achieve both these by adjusting *downwards* the *intercept* of the new fine function.

Third, not all firms can be penalized to the full extent (after a leak) because of the limited liability condition discussed earlier. Define a_1 as the pollution level such that limited liability constraint will be binding for firms choosing a higher level of pollution. Assuming maximal under-reporting with the new fine function $n(a)$, the limited liability constraints for firms choosing $a \geq a_1$ will be binding where $k.n(a_1) - k.n(0) = W - n(0)$.[10] Since the effecive penalty functions for these two segments are different, the scaling-up of the slope will also be different. The details of this construction is given below. Define

$$\alpha = \frac{2}{(1+r+qj+qk)}, \alpha^{/} = \frac{2}{(1+r+qj)}, \qquad 1 < \alpha, \alpha^{/} < 2 \tag{13}$$

Fine function $n(a)$ is given by the following,

$$\begin{aligned} n(a) &= \alpha f^*(a) + W(1-\alpha^{/}) - \frac{1-x}{x}L + (\alpha^{/} - \alpha) f^*(a_1), \forall a \leq a_1 \\ n(a) &= \alpha^{/} f^*(a) + W(1-\alpha^{/}) - \frac{1-x}{x}L, \forall a > a_1 \\ a_1 &= f^{*-1}\left[\frac{(k-1)\alpha f_0 + \alpha^{/} W}{\alpha(k-1)+\alpha^{/}}\right] \end{aligned} \tag{14}$$

The collusion feasibility condition (eqn 10) is satisfied leading to maximal underreporting (with the new fine function). By construction, this fine function satisfies the limited liability constraint $n(a) \leq W - \frac{1-x}{x}L$. Note that $f^*(a) \leq W$ implies $n(a) = \alpha^{/} f^*(a) + W(1-\alpha^{/}) - \frac{1-x}{x}L = W - \frac{1-x}{x}L - \alpha^{/}(W - f^*(a)) \leq W - \frac{1-x}{x}L$. [11] Moreover, marginal expected (effective) penalties resulting from $e(a \mid n)$ will be the same as in the second-best, at every action level $\partial e(a \mid n)/\partial a = \partial f(a)/\partial a$. Given the absence of wealth constraints, this will implement the second-best actions.

We continue to assume absence of wealth constraints for inspectors, so financial costs incurred by the government in lowering pollution fines in order to solve extortion problems do not arise as these can be recouped from inspectors upfront in the form of lower salaries. In this situation, of course, collusion does occur and inspectors earn bribes. Again, their fixed salaries can be adjusted to ensure that rents to the inspectors are minimized.

Proposition 3 *Let $q(k+j) < 1-r$ so collusion cannot be prevented, and extortion can also happen, with all firms having the same appeals cost $L > 0$. Then the second-best action schedule can be implemented, upon using the fine function (14).*

Of course financial cost considerations represent one rationale for unwillingness of govern-

[10] Given (A1-A2) and $1-r < q(k+j)$,it canbe shown that this will always be true even for the new function $n(a)$.

[11] It can also be verified that it is true for the other segment as well.

ments to select high-powered incentive schemes for inspectors or lower fines for firms. Our purpose in this section is to establish the key result that *the second-best can still be implemented with judicious choice of fines, which overcome both collusion and extortion problems, under the conditions described in this and previous sections.* We obtain these results for the case where collusion penalties following exposure after a media leak are proportional to the fines underpaid (and hence linear in the bribes). Extension to more general set of collusion penalties will have to be considered in future work

4 Extensions

In what follows we consider various weakenings of the pristine conditions assumed earlier. In particular, we assumed that legals costs (L) are constant and known to the inspector as well as the planner.

4.1 Variable Legal Costs

Above we assumed that the legal cost L is same irrespective of what a and $a^{//}$ are. This may be unrealistic in some situations. Appeal costs might depend on the level of a and the extent of extortion.

Consider the case where appeal costs L depend on the extent of excess fine imposed on the firm $f(a^{//}) - f(a) = S$ which it claims to recover from appellate authorities. Let $L = L(f(a^{//}) - f(a))$. The firm will appeal iff

$$\frac{1-x}{x} L(f(a^{//}) - f(a)) < f(a^{//}) - f(a) \tag{15}$$

A priori, it is not clear whether the legal cost of appeal should be increasing or decreasing in the extra fines resulting from exortion. In either case, it is reasonable to assume that $L(0) > 0$ and $\frac{1-x}{x} L^{/} < 1$. If the rate of increase of L is bounded away from one, there is a unique fixed point S^{*} of the function f. Then the firm with true pollution a will appeal if and only if $f(a^{//}) - f(a) > S^{*}$.

[Figure 2 here]

Consequently the inspector will be able to over-report the offense upto the point where $f(a^{//}) = f(a) + S^{*}$ without inciting the firm to appeal. Hence the extortion bribe will be equal to $L(S^*)$, irrespective of the level of pollution. This reduces to the case of a constant appeal cost, with $L = L(S^*)$. Hence previous analysis continues to apply in this case.[12]

4.2 Some Honest Inspectors

Similar issues arise when a fraction β of inspectors and honest and do not extort. This does not distort patterns of marginal deterrence either, under the other conditions assumed so far. With penalties chosen according to $g(a)$ which lower the second-best penalties uniformly by the equilibrium extortion bribe b charged by corrupt inspectors, which is a constant and independent of a, second-best marginal deterrence is again ensured for all firms, irrespective of what kind of inspector they are assigned to. Firms with honest inspectors will pay $g(a) = f(a) - b$ and those with corrupt inspectors will pay $g(a) + b = f(a)$. So those with honest inspector will pay less but by a constant amount b.

The problem this might give rise to, is with regard to the determination of inspector salaries since the government will not know which inspectors are honest. These are familiar issues from the work of Besley and McLaren (1993). If it offers a salary which makes the corrupt inspectors indifferent between working or not for the goverment, the honest inspectors will not work for the government. But this has no welfare consequences. In other words, the government may as well pay such a low salary that induces only the corrupt inspectors to work for the government, and still achieve the second-best.[13]

4.3 Privately Known Legal Costs

Firms may vary with regard to the legal costs they will incur to file an appeal, owing to underlying differences in legal expertise and connections. In the bargaining over extortionary bribes, this will hamper the ability of inspectors to extract bribes.

In what follows we assume that the government and the inspector have the same information about the legal costs incurred by any given firm. Clearly if this were not true in the cases considered above where all firms have the same legal cost L, which is known by the inspector but not the government, the latter would not know exactly by how much to lower the pollution fines to deal with the extortion problem.

[12] Matters are more complicated if legal costs depend on the actual pollution levels themselves, rather than just the size of the fines involved. Suppose L depends on $a^{//} - a$, the extent to which pollution was over-reported. Now firm will appeal iff $\frac{1-x}{x} L(a^{/} - a) < f(a^{//}) - f(a)$. In this case, extortion ribe will typically depend on a. Whether second-best actions can be implemented requires further investigations.

[13] An ancillary problem arises if inspectors vary in their level of honestness, a problem stressed by Besley and McLaren (1993): auctioning the right to inspect would result in appointment of corrupt inspectors as the more corrupt would want to bid more.

Suppose each firm faces a fixed legal cost L which can be different from the cost of other firms. Suppose it is distributed according some distribution function $\theta(L)$. Assume that θ is independent of t, i.e., legal costs are independent of preferences for pollution. The firm knows the realization of L, but the inspector does not.

The inspector will now be limited in its ability to discriminate between firms of varying legal costs. Upon discovering a firm which has polluted a, it can threaten to over-report the pollution to $f(a') = f(a) + b$ and not do so if the firm pays a bribe b. Whereupon the firm will appeal if L is smaller than b (with probability $\theta(b)$) and not otherwise. In the former case the appeals process will impose a fine $m(f(a') - f(a)) = m(b)$ on the inspector with probability x, which the inspector will trade off against the benefit of the bribe if either the firm does not appeal, or the appeal does not succeed. The key point to note that the optimal bribe b^* for the inspector which will depend on the distribution θ, and the effectiveness and sanctions of the appeals process (x and $m(.)$), *will be independent of the actual pollution level* a.

Therefore the second-best actions can still be implemented as above, lowering the fine function upto a_T uniformly by the equilibrium extortion bribe b^*. Those that do not appeal will face an expected penalty equal to $g(a) + b^* = f(a)$, those that do will incur an expected penalty of $(1-x)[f(a)+b^*+L]+xf(a) = f(a)+(1-x)(b^*+L)$.[14] Hence the pattern of marginal deterrence is unaffected. Given the assumed absence of wealth effects, the second-best actions a_t will continue to be chosen.

Of course in this situation some deadweight losses may arise owing to extortion — associated with appeals that happen in equilibrium. So it is possible that the level of welfare is lower as a result, depending on the deadweight resource costs of appeals that are filed. But the primary impacts of extortion on levels of pollution or expected penalties paid by firms can be avoided. Of course, this depends partly on the assumption that legal costs and preferences for pollution are independently distributed, which ensures that the equilibrium bribe is independent of the pollution level. However, it is not clear whether we have any compelling reasons to believe that legal costs and pollution preferences should be correlated. This issue needs further exploration.

4.4 Revenue Considerations

Most corruption controlling mechanisms have serious revenue implications. It is well known that high-powered incentives can control corruption in the absence of extortion. But a key problem with providing high-powered incentives for inspectors is that it can end up transferring

[14] Note that for firms that appeal it will be the case that $f(a) + b^* + L < W$, since they must have the resources needed to file an appeal. So the wealth constraint cannot bite for such firms.

too much rents to inspectors, if their wealth or liability is limited. In the absence of wealth constraints or limited liability, inspectors could bid for the right to inspect. This would enable the government to recover upfront the surpluses that inspectors will subsequently earn from bribes, in which case the inspectors could be driven down to their outside option payoffs. But with limits on liability, e.g., if the government has to pay a minimum fixed salary to collectors which could be supplemented with bonuses or bribes, privatization or high-powered incentives would get too expensive for the government.

In our model, the proposal to adjust fines, will have further implications. Suppose fines are used to finance rewards and compensations to the inspector. Lowering fines will imply revenue loss for the government. We can implement second best action schedule but the corresponding welfare will be lower. Optimal policy in such a setting requires further investigation and is left for future research.

5 Concluding Comments

All of the preceding arguments have utilized the lack of any wealth constraint of inspectors. Clearly this is unrealistic. The key argument is that inspectors may earn bribes owing to collusion or extortion, but judicious choice of the fine function imposed on firms ensures that bribes depend on pollution in a way that firms end up with the right marginal disincentives for pollution. To avoid losses of net revenues for the government, controlling extortion requires the fixed salaries of inspectors be adjusted downward by the expected bribes, divided by the probability of an effective audit. These salaries could well end up being negative: inspectors will have to bid for the right to inspect. There may well be limits to how much inspectors can bid, owing to wealth constraints. Alternatively, there may norms or regulations concerning minimum salaries. In that case controlling extortion by lowering pollution fines will result in revenue losses for the government. The same reason may restrict the use of high-powered incentives for collectors.

If these wealth constraints are binding, the government will no longer be able to implement second-best actions without incurring revenue losses. The preceding arguments show that it can implement second-best actions, at a financial cost. When extortion alone is the problem, these costs will amount to roughly the appeals cost of firms, divided by the probability of an effective audit. This revenue loss has to be weighed off against the welfare costs of lowering pollution incentives. We suspect this is the key problem underlying problems of corruption, which deserves more attention in future research.

The other assumption which played a role in the analysis is risk-neutrality of firms, which enabled us to abstract from wealth effects (apart from limited liability constraints on choice of fines).

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6 Appendix

Bribe Determination: $1 - r > q(k + j)$

Note that NBS is given by b which maximizes the Nash product $(\pi_I(b) - d_I)(\pi_F(b) - d_F)$

Conisder the case where limited liability condition is not binding.

$\pi_F - d_F = \{W - f_0 - (1-q)b - qk[f(a) - f_0]\} - \{W - f(a) - \frac{1-x}{x}L\} = (1-qk)[f(a) - f_0] - (1-q)b + \frac{1-x}{x}L$

$\pi_I - d_I = \{rf_0 + (1-q)b - qj[f(a) - f_0]\} - r\{f(a) + \frac{1-x}{x}L\} = (1-q)b - r\frac{1-x}{x}L - (r+qj)[f(a) - f_0]$

Bribe b is given by the solution to $(1-qk)[f(a) - f_0] - (1-q)b + \frac{1-x}{x}L = (1-q)b - r\frac{1-x}{x}L - (r+qj)[f(a) - f_0]$

$$b = \frac{1}{2(1-q)}\{(1 - qk + r + qj)[f(a) - f_0] + \frac{1-x}{x}L(1+r)\}$$

Since expected penalty is given by $e(a) = f_0 + (1-q)b + qk[f(a) - f_0]$, plugging the value of b we get

$$e(a \mid f) = \frac{1}{2}(1 + r + qk + qj)f(a) + f_0 - \frac{1}{2}(1 + r + qk + qj)f_0 + \frac{1-x}{2x}L(1+r)$$

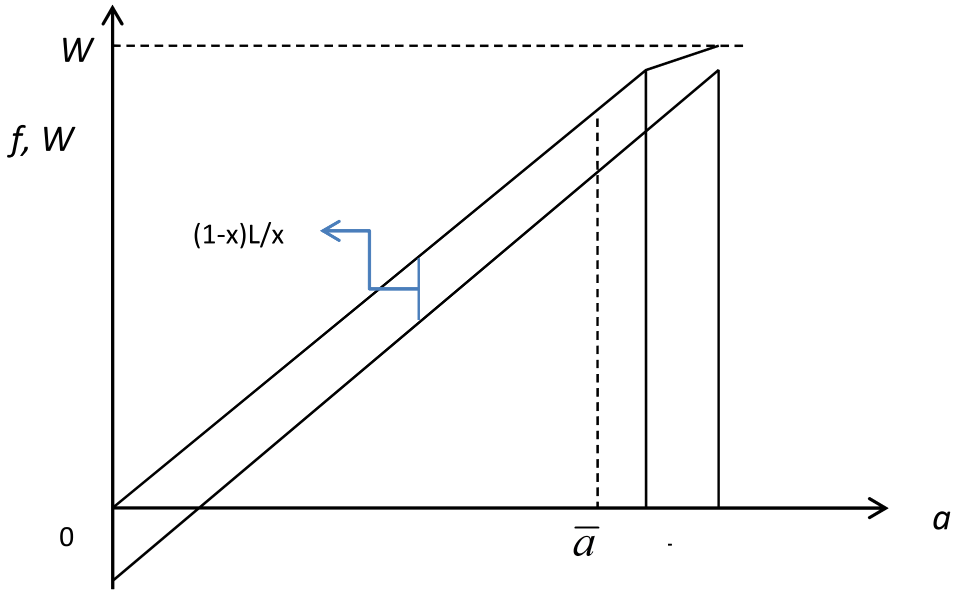
Likewise, we can solve for the bribe b and exected penalty e when the limited liability condition is binding.

$\pi_F - d_F = \{W - f_0 - (1-q)b - q[W - f_0]\} - \{W - f(a) - \frac{1-x}{x}L\} = f(a) + \frac{1-x}{x}L - f_0 - (1-q)b - q[W - f_0]$

$\pi_I - d_I = (1-q)b - r\frac{1-x}{x}L - (r+qj)[f(a) - f_0]$

We can solve for b and expected penalty will be given by

$$e(a \mid f) = \frac{1}{2}(1 + r + qj)f(a) + f_0 + \frac{1}{2}q[W - f_0] - \frac{1}{2}(1 + r + qj)f_0 + \frac{1-x}{2x}L(1+r)$$


W
f, W
(1-x)L/x
0
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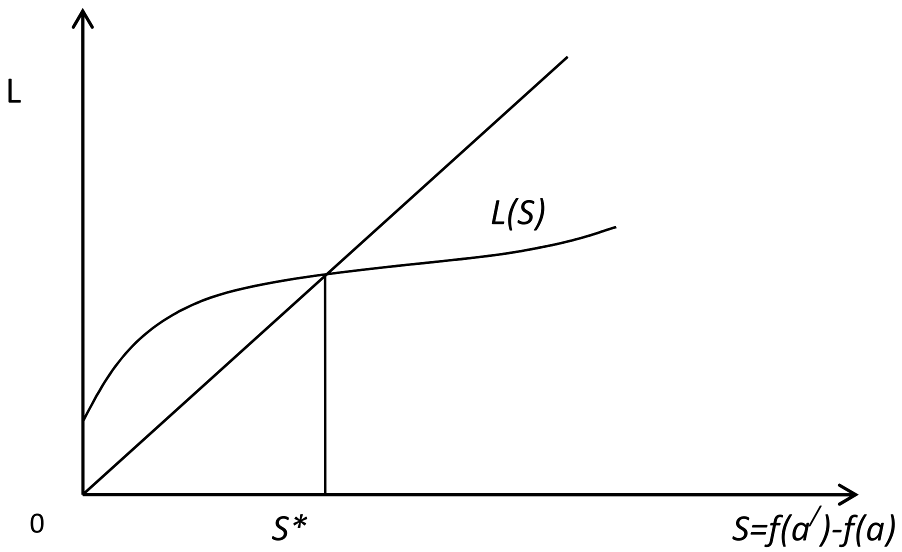
L
L(S)
0
S*
S=f(a′)-f(a)