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Hierarchies, Incentives and Collusion in a Model of Enforcement

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HIERARCHIES, INCENTIVES AND COLLUSION IN A MODEL OF ENFORCEMENT[1]

by

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ABSTRACT

This paper considers a model of enforcement with corruptible enforcers in a principal-supervisor-agent framework. We look at how different reward and penalty schemes lead to different outcomes (agent's compliance) by affecting the supervisor's choice of effort and honesty. It is shown that the organizational structure of the agency also influences the effort-honesty choice of the supervisors. A vertical hierarchical structure (with corrupt supervisors monitoring another corrupt supervisor) can be optimal in certain cases. Likewise, an arrangement where more than one supervisor monitor the agent, can also be optimal. The organizational issues assume importance when there are constraints on the size of rewards and penalties

Key Words: bribery,corruption, enforcement, hierarchy

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1 *This paper is based on an earlier essay titled Incentives for Law Enforcement,1992. Part of the research was done while the author was a visitor at the Centre for Development Economics, Delhi.

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I. INTRODUCTION

Many agency relationships like government- tax payer, regulator - firm rely on intermediate agents (supervisors)to seek agent related information (which is) essential to the implementation of the incentive scheme. The possibility that these supervisors can collude with the agents and distort or hide relevant information to further their own interest has a lot of significance for the design of optimal policies in these settings. Recently, this question has been addressed by a number of authors[2]. At a broad level, one can think of three approaches. One approach would be to get rid of the supervisors- that is to design incentive schemes such that agent's compliance is voluntary. But in all the examples mentioned above it is unlikely that such a policy works. The other end of the spectrum is privatisation or more appropriately transfer of "principal-ship" to the supervisor. In such a situation the supervisor is expected to carry out the necessary enforcement in his own interset. Examples are tax farming and private law enforcement. The middle ground is covered by the design of various incentive schemes in the form of rewards and punishments for both the agents and the supervisors. In this paper we shall be focussing on issues related to this only.

It would be relatively a simple matter if the principal could directly monitor the supervisor's effort and honesty while enforcing the contract. But in many cases even this might not be feasible. Moreover, given principal's information and other constraints he might not be able to design incentive compatible contracts for the supervisor so that

[2] Some of the recent papers include Tirole (85,92), Besley & Maclaren (92), Chander & Wilde (92), Basu et al.(92), Mookherjee & Png (95), Kaufman & Lawree (93), Lui (86) among others. Myrdal (), Rose-Ackerman (78) and Becker & Stigler (74) are some of the early contributions.

he is induced to supply required amount of effort and honesty. It is in this context that issues of hierarchy and organizational structure assume importance. One could appoint a higher level of supervisor to monitor the original supervisor. Or else one could have parallel supervision by more than one supervisor. The simple point that we wish to make in this paper is that the organizational structure and incentive system are related. In fact the optimality (or otherwise) of a particular organizational design depends on the kind of incentives that are feasible. However, we are not suggesting a theory of organizational structure as such[3]. In many cases a particular organizational structure might exist for reasons which have nothing to do with corruptibility of the supervisors. In that case one can do the opposite exercise of identifying the optimal incentive systems.

Section II introduces a simple model of enforcement. This can be adapted to various situations like tax evasion, pollution control etc. In section IIA we focus only on the corruption aspect. Section IIB introduces effort by the supervisor. This effort can be interpreted in various ways depending on how it affects the quality of information, likelihood of error, probabilty of detection etc. It is certainly a major component of the efficiency of the enforcement/regulating agency. Section III compares different organiztional structures. The comparative analysis is not quite complete as it not possible to characterise the entire set of outcomes under all the different structures. Section IV contains a brief discussion of other incentive schemes. The analysis in sections II-III can be viewed as input based incentive schemes. That is - supervisor's effort and honesty can be viewed as inputs to the final goal

[3] See Williamson (67), Radner (92), Sah & Stiglitz (86), Aoki (86) Mookherjee & Riechelstein (93) for different approaches to the question of organizational structure.

of agent's compliance. Section IV contains a brief discussion of what we call output based incentive schemes. Section V concludes the paper.

II. A SIMPLE MODEL OF ENFORCEMENT

II A: Corruption

Consider an individual Z contemplating an illegal activity worth B to him. If he is caught having committed the crime and reported to the court by the officer then he has to pay a penalty of $f(B) = fB$ $(f > 1)$. If p is the probability that he would be caught and punished then he would commit the crime if

$$B - p\,f\,B > 0$$

But the corrupt officer can take a bribe and let him off (do not report). Assuming bribes are determined by Nash bargaining solution[4], Z would have to pay a bribe of fB/2. So enforcement is diluted but not eliminated altogether. Even if bribes are determined by some other mechanisms so long as bribes are an increasing function of the penalty level same results would obtain. For a fixed p, if f can be rasied to 2/p then the individual would be dissuaded fron undertaking the illegal activity.

But suppose fines can not be raised to the desired level. Let $1/p < f < 2/p$. Then the only way to ensure compliance by Z is to ensure honest reporting by the officer. If the officer were to be given a reward for honest reporting $r(B) = rB$, then for sufficiently large

[4] The model and the bribe determination follows Basu et al (92). fB/2 is the solution to max (fB-B′)(B′). The details of the calculations have been left out.l

rewards (but feasible $r \leq f$) the officer will report truthfully. For given levels of f and p, this means Z won't commit the act. If we were to treat rewards as an outside option and not necessarily a disagreement payoff then the bribe that Z would pay in this setting continues to be fB / 2. So a reward rate $r \geq f / 2$ would mean the officer would always choose to be honest[5]. However, if for some budgetary or distributional reasons such large rewards are not possible then such a simple method of enforcemnt is not going to work.

But one can hire another officer (2) who will monitor the behaviour of the first officer. Such hierarchies are quite common. Say with probability q, officer 2 can detect any bribe-taking by officer 1. Officer 2 can honestly report this. Officer 1 can be now penalized for having taken a bribe y. If 2 were not honest he could take a bribe for letting officer 1 off. Taking $f(y) = fy$ to be the penalty, officer 1 would have to a pay a bribe of fy/2. Given the linear nature of penalty functions, the bribe amount paid by Z to officer remains the same if we assume that Z does not have to bribe officer 2. It can be verified that the value of B′ that maximizes the Nash product $(fB - B')(B' - qfB'/2)$ is simply fB/2. Officer 1's expected gain from bribery now is [1-qf/2]fB/2. So even if r is less than f/2, honest behavoiur can be induced and crime can be prevented. What the additional layer of supervision does is to make bribe taking less attractive. Again, one can complicate the scenario by postulating different penalty for officer 1 and taking r as disagreement payoff but the essential logic of the situation remains the same.

[5] If rewards are taken to be diagreement payoff then bribe would be (r+f)B/2. So one would need a greater r in this case. Mishra (92) contains these variations and extensions.

One can add another layer horizontally. In many organizations this kind of overlapping jurisdictions is observed. For example a license or a permit might have to be cleared (scrutinised) by several bureaucrats in different ministries. In this setting both officers are supposed to detect illegal activity by Z. If one of them had caught Z and had reported truthfully then Z pays the penalty and the second officer's action would not matter anymore. However, if the first officer were to take a bribe and let Z off then officer 2 could also catch Z and demand a bribe or report. However, unlike the previous case, when officer 2 is honest and Z is penalised nothing happens to the first officer who has taken the bribe. The second officer does not monitor the first oficer. As in the previous case, we rule out collusion between these officers even though this might have some interesting implications.

Whoever is the second officer can get a bribe of fB/2 from Z if Z has not been reported by the first officer earlier. This means the first officer's bribe is going to be less. While negotiating with him Z knows that an agreement with the first officer does not guarantee complete letoff. If p is the probability that the second officer can catch Z, then bribe would be given by

$$\text{argmax } (fB-B'-p\, f\, B / 2)\,(B') = fB\,(2-p) / 4 < fB / 2 \text{ for } p > 0.$$

In fact, this bribe amount is going to be still less when officer 2 is expected to report truthfully. Like before, bribe taking is less attractive to the officer and a smaller reward can make him behave honestly.

It must be noted that we are dealing with the corruption aspect of different organizational structures. Other efficiency issues could be imortant as well. For example, in the overlapping jurisdictions case, if screening of the project requires specialised knowledge then such a structure might be optimal as it would reduce the number of undesirable projects. On the other hand there might be efficiency losses as it might lead to delays and un-coordinated actions. We abstract from these issues.

So far we have concentrated only on the honesty by the officer. But the effort decision also needs to be looked into. The probability of detection, among other things like state of the information technology and the size of the criminal-officer population, also depends on the effort exerted by the officer. The next section introduces effort into the model.

II B: Effort Choice

Let p_1 be the probability that officer (1) would catch Z having committed the crime. It depends on the amount of effort exerted by the officer as given by the simple function.

$$p_1 = e_1 / \bar{e} \text{ and } p_1 \in [0\ 1] \tag{A1}$$

where $\bar{e}$ is the maximal effort that the officer can exert. In addition to the penalty and reward functions (as specified before) the ultility functions are also linear. So the officer's payoff is

$$\Pi = \text{income} - e \tag{A2}$$

The officer can truthfully report the crime and collect a reward of r(B) = rB or take a bribe B_1 from Z and let him off. The bribe B_1 will depend on the penalty f(B) = fB that the individual faces for his crime. For convenience we consider the case where reward is like an outside option for the officer so that the bribe amount does not depend on R except that in equilibrium it has to be greater than R. We shall denote the choice of the officer by $h \in \{0,1\}$, where $h = 1$ refer to bribe taking and $h = 0$ refer to honest reporting. So the officer chooses e and h.

Likewise Z's decision to commit the crime would be denoted by $c \in \{0,1\}$. Where $c=0$ refers to no crime. Z might randomize between committing a crime and not committing. This randomization probability would also be denoted by c. At times we interpret this c as the extent of the criminal activity. We shall follow the same convention for the officer's strategies e & h also.

The expected payoffs to Z and officer 1 can be calculted as follows.

$$\Pi_z = B - p_1[h(fB)/2 + (1-h)fB] \tag{1}$$

where h is the probability that 1 will act dishonestly and take a bribe. Given all the assumptions and Nash bargaining, $(fB / 2)$ is the bribe Z pays to officer 1. If $\Pi_z > 0$ then clearly $c = 1$, and if $\Pi_z = 0$, $c \in [0\ 1]$

$$\Pi_1 = c.\max\left[\frac{fB}{2},\ rB\right]p_1 - p_1\bar{e} \tag{2}$$

If $\Pi_1 > 0$ then clearly $p_1 = 1$ or $e_1 = \bar{e}$ and like before $\Pi_1 = 0$ would mean $p_1 \in [0,1]$. $h \varepsilon \{0,1\}$ depends on whether bribe taking is more beneficial or not.

We adopt the concept of a Nash equilibrium for this setting. One is interested in finding out how the socially desirable level of compliance can be achieved given that the officer is corruptible and effectively controls p. We consider cases where the effort cost $\bar{e}$ is not very high or $\bar{e} < \min [fB/2, rB]$. In that case we have the following set of outcomes (as given in Table 1) for different values of r and f.

Table 1

	$f < 2$	$f > 2$
$r < f/2$	$c = p_1 = h = 1$	$c = 2\bar{e}/fB$, $p_1 = 2/f$, $h = 1$
$r > f/2$	$c = \bar{e}/rB$, $p_1 = 1/f$, $h = 0$	$c = \bar{e}/rB$, $p_1 = 1/f$, $h = 0$

Notice that in no case $c = 0$. This is not surprising, since once no criminal activity is undertaken the officer is deprived of any reward or bribe income. Hence he has no incentive to put in any effort, but this can not be an equilibrium as Z will stand to benefit from committing the crime. At first sight this might seem to be consequence of our linearity assumptions. But this is true for any general specifications so long as officer's income depends on the equilibrium level of criminal activities. However, this has to be interpreted with some care as there could be lower bounds on p_1 due to sevaral factors. p_1 could be positive even for 0 effort, or with some probability 0 effort by the officer could be detected by the authorities and that could lead to punishment. Moreover, non-zero equilibrium criminal activity need not be so worrying as in many cases the first best level could be positive itself. But the general point remains that if bribery is sought to be discouraged this way then the incentive scheme might not be very effctive.

One last issue in the context of this model is the evaluation of social welfare. We take the stand in this paper that corruption *per se* does not affect social welfare. It is only the original criminal activity which affects social welfare. Hence bribes are only transfer between individuals and do not affect welfare. This does not mean that we are taking any normative stand regarding the ethical status of corruption in a society but we are simply adopting a convenient theoretical position. Punishments and rewards can be included in the welfare function as pecuniary punishments are revenue and rewards are costs to the government. For an exercise ostensibly seeking the detrmination of optimal r and f from the government's point of view this is probably necessary. But viewed from a larger social perspective rewards and punishments are also transfers and we exclude them from the welfare function. That leaves the cost of criminal activity and the effort of the officer. Denoting x as the net social cost of the criminal activity we have

$$W = -cx-e = -[cx+p_1\,\bar{e}]. \tag{3}$$

If r and f are unbounded then a social optimum does not exist, as one can keep raising r (and f since $r<f$) and welfare will improve. Both c and p will move in the same direction leading to higher W. This cprresponds to the standard Beckerian maximal fine hypothesis. Of course, this happens because the bribe amount is proportional to the fine and this is due to the Nash bargaining assumption in our model. Other bargaining schemes also would work so long as bribes are monotonic functions of the fine.

III. HIERARCHY

III A: Vertical Layers

Let us introduce a second officer who would monitor the first officer. We shall consider the purest form of such hierarchy where the second officer is not bothered about the initial crime and is interested in finding out whether the first officer has taken a bribe or not[6]. Let p_2 be

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[6] It is not reasonable to assume that the officer can detect bribe taking without detecting the crime to a later stage. See sec. IV later.

the probability that officer 1 is caught (bribe taking) by officer 2. Then officer 1 has to pay a penalty f (B) depending on the amount of bribe taken. The idea is that if the expected penalty from bribe taking is very high then the officer 1 would be honest. This means individual Z now expects to pay fB and can not get away by paying a bribe[7]. Intuitively if r can not be made arbitrarily large to induce honest behaviour than one can introduce another layer to make bribe taking not worthwhile. One of our proposition will confirm this intuition.

However, officer 2 is no different from officer 1. He can also take a bribe from officer 1 and ignore the bribery by officer 1. Moreover, p_2 should also depend on the effort exerted by the officer. We assume that p_2 is determined the same way as p_1 and officer 2 is corruptible. Let us assume for the time being that officer 2 always takes bribe[8]. In that case officer 2's payoff would be given by

$$\Pi_2 = p_1 ch f \left(\frac{fB}{2}\right) p_2 - p_2 \bar{e} \tag{4}$$

and

$$\Pi_1 = c \max\left[\frac{fB}{2}\left(1 - \frac{p_2 f}{2}\right),\ rB\right] p_1 - p_1 \bar{e} \tag{5}$$

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[7] Mishra (92) contains variuous extensions like different panalty functions. But the number of parameter increases and the model becomes quite complicated.

[8] It can be shown that whenever officer 2 is honest for certain values of r, officer 1 will also find it worthwhile to be honest. Hence we restrict attention to the case where 2 always takes a bribe.

Notice that, if $p_1 h = 0$ then the question of 2 getting a bribe from 1 does not arise at all and $\Pi_2 = 0$.

Since fB, rB and $\bar{e}$ are given from outside, the incentive to put in effort would depend on these. To keep the model simple we make the following assumption,

$$\bar{e} < \min [\, fB/2,\ f^2 B/4] \tag{A3}$$

This would mean that when 1 or 2 are getting the maximum possible bribes it must be worth on their part to have $e_i>0$. We donot need this assumption but it helps us reducethe number of alternative specifications to be considered.

Now, define r^*(value of r) such that $r^*B = \bar{e}$. So $r^*$is the minimum value of the reward rate so that an honest officer find it worthwhile to put in effort.

We would be interested in seeing how the government should optimally choose r and f. Although corruption does not affect welfare directly, it still might have to be curbed to reduce c and hence, the cost associated with crime. Social welfare will now be given by

$$W = - [cx + (p_1 + p_2)\bar{e}] \tag{6}$$

where, x is the net social cost of the criminal activity. We can now characterize the set of equilibria for different values of r and f. These details are given in the Appendix. Based on the anlysis of this vaertical layer model we can have the following proposition

Proposition 1 :(a) If f can be made arbitrarily large, it is always optimal to set $r > r^*$.

(b) A zero corruption ($h = 0$) need not be optimal when r is bounded above[9].

Proof: Part (a) claims that for every policy with $r<r^*$, there exists another policy $r>r^*$ which dominates it. To prove this claim we look at the possible outcomes when $r<r^*$. Notice that when $r<r^*$, officer 1 is never honest in the equilibrium (whenever there is positive enforcement $p_1 > 0$). So part (a) of our proposition say that it is always optimal to aim for some honesty, even though honesty in itself does not affect welfare directly.

Consider a policy with $r<r^*$. We can have three cases (see the appendix for details) depending on the value of f. If f is also low compared to $\bar{e}$ so that assumption A3 is not valid, or $fB/2 < \bar{e}$ then in equilibrium we have $c = 1$, $p_1= 0$. Depending on the value of f we have either $p_1 = p_2 = 1$, or $p_1 + p_2 = 2/f$. But $c=1$ and $h =1$ in all the cases. So the best one can do is to have no enforcement at all or $c = 1$. But there exists a policy with $r>r^*$, and f large enough so that social welfare is higher under the latter scheme.If r is bounded so that r can not be made large then we can have $r<f/2$ and $c = \bar{e}/rB$ and $p_1+p_2= (3f-2r)/f^2$. So welfare is given by

$$W(r>r)= -[(\bar{e}/rB)x + \bar{e}(3f-2r)/f^2] \text{ and } W(r\leq r) = -x \qquad (7)$$

$$W(r>r) > W(r<r) \text{ iff } \bar{e}(3f-2r)/f^2< x(1-\bar{e}/rB).$$

Clearly one can find a f such that this inequality is true. In this equilibrium there will be some amount of corruption. If r can also be raised so that $r>f/2$, then one can even do better.

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[9] technically speaking large and finite f or r are also bounded. What the statement here implies is that these upper bounds are small as explained in the proof. The exact bounds are not given to avoid extra notations.

The possibility of designing a large penalty is quite important. To see this, consider the first case when $\bar{e}$ is so high that $\bar{e} > fB/2$. Then $r \leq r^*$ would mean $c = 1$ and $p_1 = 0$ in equilibrium, but $r > r^*$ (it is possible with $f>r$) would lead to $c = \bar{e}/rB$, $p_1 = 1/f$ and $p_2 = 0$ (as $h = 0$). In that case if x is small we can have

$$(\bar{e}/rB)x + (1/f)\bar{e} > x \tag{8}$$

or, $W(r \leq r^*) > W(r > r^*)$.

(b) Part (b) of the Proposition considers the case when $r>r^*$ but but r can not be raised sufficiently. In such a situation it is possible that a no-corruption equilibrium is not optimal. To see this consider the following example.

Let $r \leq 1$. One can set $r = 1$ and $f=2$, so that in equilibrium $c = \bar{e}/rB$, $p_1 = 1/2$ and $h = p_2 = 0$. On the other hand by raising f one can do better. As f is raised beyond 2, we have $r<f/2$ and hence in equilibrium $c = \bar{e}/rB$, $p_1+p_2 = (3f-2r)/f^2$. It is clear that if $f>6$, the second scheme (with $h>0$) dominates the former scheme ($h=0$) in welfare terms. Hence it might not be desirable to insist on absence of corruption always.॥

Our work is closely related to that of Mookherjee and Png (95). They concentrate on the incentive aspects of the problem in a situation where the second officer is honest and can commit to certain p_2. In their model it is always better to have no bribe equilibrium. Part (a) of Proposition 1 in our model is quite similar to their result. However, as part (b) shows if r is constrained to be below certain level then some amount of corruption might be optimal.

We want to see whether the presence of the second layer is beneficial from society's point of view. Denoting by $W^1(W^2)$ the welfare when one (two) layers are there, the following claim can be made.

Proposition 2: It is optimal to have a second layer of policing only when both r and f are bounded and x is large.

Proof: When r is bounded above and $\bar{e}$ is so high that r is less than r^*, it is clearly the case that $W^1 \geq W^2$. Using the arguments in proposition 1 (and the details given in the appendix) in the two-layer case it is seen that $c = 1$ and $p_1 + p_2 \geq 2/f$, where as in the single layer case $c \leq 1$ and p_1 is either 1 or $1/f$. In fact in this case the optimal policy is to have no enforcement at all.

Now take $\bar{e}$ to be low so that enforcement is desirable. If r is bounded but f is not then $W^1 > W^2$. As discussed in Proposition 1 when f can be raised indefinitely it is optimal to have large f even though this implies $h > 0$. Hence in the two-layer case $c = \bar{e}/rB$, $p_1 + p_2 = (3f-2r)/f$. Comparing this with the single layer case(with $r<f/2$),the second term is greater than $2/f$ and the value of c in the single stage case is also lower. If f is chosen so as to make $r \geq f/2$, then both the cases are same, but we know that one can improve on it by choosing a large enough f.

Now consider $r < 1$ and $f < 2$ such that honest reporting is not possible. Of course, honest reporting can be achieved in a trivial sense by lowering f sufficiently (below 1), but then it is optimal not to have any monitoring. Hence with $r < f/2$, in the single layer case $c = 1$, $p_1=$

1. The best one can do is to have no enforcement, or $W^1 = -x$. On the other hand in the two layer case one can deter crime to some extent. In equilibrium $c = \bar{e}/rB$. The social welfare will be given by $W^2 = -x(\bar{e}/rB) - \bar{e}\,[(3f-2r)/f^2]$. If x is sufficiently high then W^2 can exceed W^1. ||

This result is to be interpreted carefully, since given our assumption it is always possible to achieve honest reporting in the single layer case by giving a reward $r \geq f/2$. Secondly the presence of a corrupt second officer means in equilibrium there is some amount of bribing going on and this defeats the purpose of having a second layer to make the first layer report honestly. Gangopadhyaya *et al* (91) have shown the desirability of hierarchical structure in a different context without looking into the effort incentive aspect.

III B: Overlapping Jurisdictions or Horizontal Layers

As our earlier discussion in section II shows it clearly matters as to who is the first one to detect Z's crime. In many organizations this sequence might be given from outside. We simplify our analysis by assuming that both the officers have equal probability of being the first one to catch Z, irrespective of their efforts. Since we shall focus on the symmetric case, this is not such a limiting assumption. In the symmetric case, where both officers put in same effort ($p\bar{e}$) let p be the probability of either detecting Z. The penalty and reward functions are the same but the payoffs would turn out to be different.

A complete characterization of all posible outcomes is difficult but certain sub cases can be analysed. If $r>f/2$, then both are honest and $h_1=h_2=0$. This means that an officer would expect a payoff of

$$\Pi_i = [cp(rB)/2] - p\bar{e}. \quad i = 1,2 \tag{9}$$

This is so because, when an officer is not the first one and Z has already been penalized, the officer does not get anything.

$$\Pi_z = B - p(fB) \tag{10}$$

It can be checked that in equilibrium $c = 2\bar{e}/rB$ and $p = 1/f$. Comparing with the vertical model it is clear that welfare is less in this case as c is higher and effort is also higher.

Let $r < f/2$ but $r \geq (2-1/f)f/4$. Recall that the right hand side in the second inequality is the bribe that the first officer gets when the second officer is also bribe taker. Since $r<f/2$, the second officer always take a bribe. So if the above inequality holds, then the first officer would be better off reporting honestly and taking the reward. This is an interesting case, because now the officer's strategy depends on whether he is the first one or the second one. The officer's optimal response is to take a bribe if he is second and report truthfully if he is first. But this implies that in equilibrium Z is always reported truthfully and penalized. In fact the equilibrium is same as the previous case with $c = 2\bar{e}/rB$ and $p = 1/f$.

When $r<f/2$, complete honesty on the part of the officer is never the case in earlier models (the single layer or the vertical). In this case however, even with smaller reward honest reporting can be induced. How does it compare to the vertical layer case? For this parameter range the horizontal case induces more honesty but social welfare depends on the net social cost x and effort $\bar{e}$. In the vertical case, $c = \bar{e}/rB$ and

$p_1+p_2 = (3f-2r)/f^2$. Welfare in these two cases is given by (W(V) for vertical and W(H) for horizontal case)

$$W(V) = (\bar{e}/rB)x + \bar{e}(3f-2r)/f^2 \tag{11}$$

$$\text{and } W(H) = (2\bar{e}/rB)x + 2\bar{e}/f \tag{12}$$

W(H) > W(V) whenever x is not very large and f also can not be raised too much so as to make the difference in effort cost small. It shows that the horizontal case can do better than the vertical case in some situations.

Likewise, it can be compared with the single layer case. Unlike the vertical case which can be superior to the the single layer case some time, the horizontal case is always dominated in welfare terms for any f>2. It is not surprising because in the horizontal case there is always duplication of effort. But if we put some weight on corruption itself in the social welfare function then the horizontal case can certainly dominate others. Secondly, as pointed out in the next section some organizations might combine features of both these extreme cases.

IV: OTHER INCENTIVES

Notice that in the vertical hierarchy model, officer 2 is simply supposed to monitor the behaviour of officer 1. This is unsatisfactory on two accounts. First, it asumes that there is a simple and direct way to detect bribery. Second, since elimination of bribery *per se* is not the main aim why should the second officer be restricted to monitor the bribery aspect only? A natural way out is to consider the case where the second officer also detects the illegal act by Z with probability p_2. Then not only is Z penalised but officer 1 also has to face the penalty. Detection by 2 could be because Z's crime was earlier undetected or it was detected and 1 took a bribe. By clubbing these together 1's incentive to put in higher effort is being strengthened[10]. This structure in fact has features of both the vertical and the horizontal cases. However, we must add that in cases where the auditing technology is not perfect-that i s by putting in maximum possible effort it is not possible to get high p- it would introduce certain disincentive for officer 1.

A logical extension of this argument would be to compensate the officer solely in terms of the final outcome (the extent of criminal activity). This would also take care of the problem (and perhalps an unpleasant feature of all the models) that reward income to the officer vanishes if there is no illegal activity. But such an approach begs the following obvious question. If the planner could observe c and condition payments on c then where is the need for the officer? One can proceed in two ways. To fix ideas let us consider a concrete example of pollution by firms. So Z is the firm, the officer is the pollution inspector and the planner or the principal is the regulator.

The regulator does not observe the level of pollution c and relies on the report by the inspector. Now the interpretation of p (or effort) also changes a bit. It is the probability with which the inspector observes the true level of pollution. This introduces another problem in the sense that when the officer does not observe the true c, what it would report. The officer gets a reward $s(c)= (1-c)S$ or say more extrme reward of S if c=0 and

[10] Mookherjee and Png (95) consider this case in their model and report that effort by the agent is always higher.

0 if c>0. This policy would lead us nowhere unless with some probability the regulator can find out the true level of c, so that the inspector could be penalised in the event of a false report. Otherwise one can add another reward r for the inspector for truthful reporting like before. Notice that once the firm has chosen to pollute, it is in the inspector's interest that he should report no pollution. Hence the bribe amount that he would receive is likely to be quite less. Say the firm has chosen c = 1. Then once the firm is caught by the inspector, the bribe would be (f-s)/2, if the inspector were to report c = 0. So the gain to the inspector from reporting falsely is (f+s)/2. Hence if he is assured of getting r>(f+s)/2 then he is going to report the polluting firm to the regulator. But this means r has to be quite large as s has to be bounded below so that the inspector finds it worthwhile to put in effort. Of course now in equilibrium the inspector is getting a positive amount from the regulator and there might be a social cost attached to raisng that fund.

Another scenario where it makes sense is when there are more than one firm and the regulator can observe the aggregate. Let us assume that regulator can not regulate individual firm's behaviour based on the aggregate, hence the inspector. Suppose there are two identical firms. Then the inspector would report truthfully when both firms have chosen c=1 or c=0. But suppose one firm (1) has chosen c=0 and the other (2), c=1. Since the inspector's report can not be verified (except the sum) possibities of bribey arise. Inspector can take a bribe of f/2, from firm 2 and report that it is firm 1 which has polluted. In such an eventuality firm 1 would also be willing to bribe to avoid being misreoprted. But the inspector can not take bribe from both. We are diallowing the possibility that the inspector can report 1/2 , 1/2. Since penalty function is linear the inspector would end up with the same bribe. In fact the inspector can report the true levels (0,1) and take bribe from firm 1.

It seems this kind of harrassment is the major problem here. However, if we allow the possibilty that the firm can take all its information (hard information) before the regulator and he can then verify the inspector's report. For false reporting the inspector can be punished. This would mean the inspector can not overstate anyone's level of c, and hence would always report the truth. This would lead to the choice of (0,0) by the firms.

It is instructive to compare the informational situation with that of the previous model. In the input based models the inspector has to provide hard information (that can be verified) to earn the reward for honest reporting. In the event of bribery, the inspector furnishes no information at all. In fact effort could be directly linked with collection of hard information. But in the present scheme, the inspector need only furnish soft information. Only in cases of harassment the firm presents hard information regarding its pollution level. To make his report the inspector needs to know the pollution levels, but does not have to prove it. Hence in situations where information can be obtained but difficult to verify, this model would apply.

But what about the effort of the inspector? If firms are going to choose c=0 in equilibrium and the inspector does not have to provide hard information, why should the inspector spend any effort? There are different possible explainations, but we present the following one as it has nice implications for the earlier models.

Once we depart from a static model and consider a multi period situation there would be strong reasons for the inspector to put in effort. Loosely speaking, if firms are going to form beliefs about the inspector on past behaviour, then at any point the inspector would have an incentive to put in effort to affect his future payoffs. In fact if inspectors are heterogenous in terms of efficiency (high effort, low effort), inspectors have an incentive to build a reputation as high effort one so that firms choose 0 pollution. In the models of section II-III, however, the opposite tendency would be observed. Here the inspector would like the firm to belive that it is going to put in low effort, so that the firm would be induced to choose high c and hence he would get high reward next period. It would be interesting to see what the equilibrium would look like in these two cases.

Reputation has another important dimension also. Since bribery is an informal contract, the officer can renege after taking a bribe and collect the reward also[11]. Such behaviour would give a wrong reputaion for the inspector and adversely affect the future bribe income. Again in these two kinds of models the inspectors motive for reputation building would be different.

Hierarchies might be observed in these cases also. As the number of firms increase there would be need for more than one inspectors. Again if a collective reward scheme is not possible, the regulator would not be able to implement the scheme. But the regulator can hire another higher level inspector who would be responsibe for the total pollution and who has better information than the regulator. If each inspector is assigned m number of firms (out of n), then the higher inspector would need to know the total pollution in all these subgroups (n/m) of firms. There also might be cases where the higher level inspector is paid according to the output scheme but the lower officers are compensated by input scheme. This resembles quite a few real life cases. The head of an organization or a minister is not rewarded if he

[11]This would affect the the optimal length of the contract and tarnsfer policy. These issues are under study. See also Tirole (92) for a discussion.

reports truthfully and complains about the corrupt or inefficient behaviour of his organization. Rather he is rewarded on the basis of his overall performence.

V. CONCLUSIONS

We have shown that organizational design as well as the optimal policy towards corruption matter most when there are constraints on the rewards and penalties. As an example it was seen that `employing a thief to catch another thief' can be a useful policy in certain circumstances. Similarly, the no-corruption outcome need not be the main objective all the time and rewards. The model presented here is highly simplistic, but intuition suggests that similar results would hold for more general models. In fact a model with non linear payoff functions can make things easier in the single layer case by guaranteeing an interior solution (as in Mookherjee and Png (95)). But the introduction of a second officer in the model makes it very copmlex. Since we want to relate the problem to organizational design, we have kept the model simple and tractable. Moreover, the constraints on r and f are taken as exogenous to the model. Endogenising them would give a more complete picture.

The effort choice of the officer has been one of the main focusses of our anlysis. Effort of the officer is one of the main componenets of the efficiency of the enforcement process. We have studied only one consequence of effort choice-namely the probability of detection. But similar variables like investment in human capital, learning on the part of the officer are also crucial. Jointly, these determine the efficiency of the officer. Greater efficiency in this sense would minimize the two types of errors common to enforcement problem. Less number of criminals would go undetected and unpunished and on the other hand fewer innocents would get wrongly apprehendedand made to bear avoiadable costs. The fact that innocents incur some (expected) cost is important not only because it is ethically undesirable, but also because it distorts the incentive of the individuals and induces more and more individuals to take up the illegal act[12].

Given the static nature of the model some interesting issues can not be raised. In section IV we have raised some of them like reputation building, optimal length of agent-supervisor relationship but a satisfactory treatment awaits further research.

[12] In a related paper (Mishra (95)) we show how this leads to multiple equilibria. Efficient officer and small criminal population on one hand and inefficient officer and large criminal population on the other, arise as equilibria in a model with same paprameter values.

APPENDIX (A)

Proposition: Given assumptions A1 - A3, and $r > r^*$, we have,

(a) $c^* = 0$ is not an equilibrium

(b) When $f < 2$, the equilibria are as shown in the table. In this case c^* takes one of these three values $c^* = 1$ or $\bar{e}/rB$ or $2\bar{e}/(f-1)fB$

(c) When $f > 2$, there is only one equlibrium possible with $r < f/2$ where $c^* = \bar{e}/rB$

	$r<f(2-f)/4$	$f(f-1)/2>r>f(2-f)/4$	$f/2>r>f(f-1)/2$	$r>f/2$
$f<2$	$c = 1$; $h = 1$, $p_1 = 1$ and $p_2=1$.	$c=\bar{e}/rB$, $h=4r/(f+2r)$ $p_1=(f+2r)/f^2$ and $p_2=2(f-2r)/f^2$.	$c=2\bar{e}/[(f-1)fB]$ $p_1=1$, $h=2(f-1)/f$ $p_2=2(f-2r)/f^2$.	$c=\bar{e}/rB$ $p_1=1/f$, $h=0=p_2$.
$f>2$	same as above (the second column)			same as above

Proof:

(a) It is easy to see that if $c^* = 0$, then 1 would set $p_1 = 0$, but that would imply $c^* = 1$.

(b) Again, given the restrictions on r, it is easy to verify that the corresponding values listed in the table constitute an equilibrium. However in addition these are unique for the parametric specifications given. Most of the analysis below is to check this uniqueness.

(i) In the first case, notice that honest reporting by 1 can not occur, as it pays to take a bribe even if he is certain to get caught by 2. Since $h = 1$ and $f < 2$ then given that $p_1 \leq 1$, $c = 1$ in equilibrium. Since $(f^2 B/4) > \bar{e}$, it clearly implies that p_2 is also equal to 1. Without this restrictions of course p_2 can take other values without affecting c, h and p_1 in equlibrium.

(ii) In the second case,since $f(f-1)/2 > r > f(2-f)/4$, clearly p_2 has to lie between 0 and 1.

If $p_2 = 0$, then 1 prefers to take a bribe, while if $p_2 = 1$, he reports truthfully and both situations cannot be equlibrium ones. Hence, in equilibrium $p_2 \neq 1$. This would imply, using (4)

$$cp_1hf^2B/4 = \bar{e} \tag{13}$$

Now, it can be shown that we can not have both $h = 1$ and $p_1=1$. If we have $h = p_1 = 1$, then by (13) and (A3) $c = 4\bar{e}/(f^2B) < 1$. This would contradict the fact that given $f<2$ and $h = 1$, by (1) $\Pi_Z > 0$ and $c = 1$.

Let us consider the case, $h = 1$ and $p_1 < 1$. Since $h = 1$, by (2) expected bribe income $\geq$ the reward income. Notice that if $h = 1$, then $c = 1$. This would mean $p_1 = 4\bar{e}/f^2B$. But, we already have

$$crB \geq cfB(2-p_2f)/4 = \bar{e} \tag{14}$$

Using the fact that $r > r$, $c=1$, (14) and (2) would imply $\Pi_1>0$ leading to a contradiction.

If we take $p_1 = 1$ and $h < 1$, then (2) would imply

$$cfB(2-p_2f)/4 = crB \geq \bar{e} \tag{15}$$

Using (15) and (13), this means $r > f^2h/4$. On the other hand, by (1), $\Pi_Z \geq 0$, since $c \neq 0$.

$$\Pi_z \geq 0 \Rightarrow h \geq 2(f-1)/f \tag{16}$$

Combining (15) and (16) $r \geq f(f-1)/f$, which is not possible given the restrictions on r.

Hence, the only case left is that of $p_1<1$ and $h<1$. But $p_1h<1$ would mean $crB = \bar{e}$. Since $rB > \bar{e}$, it must be the case that in equilibrium $c < 1$. The equilibrium outcome given in the Table is, therefore, the unique one.

(iii) Consider the third case. Like the second case we can not have $p_2= 1$. Similar arguments can be used to eliminate the possibilities of $h = 1$ and $p_1 \leq 1$. But, since $r > f(f-1)/2$ it is possible to have $p_1= 1$ and $h<1$ in equilibrium. But can one have both p_1 and h less than 1, like the previous case? The answer is no. Since $h<1$, $c = 1$ would imply $p_1=1$ (by 2 and 14). Hence, $c < 1$, or by (1)

$$1 - [fh/2 + (1-h)f] = 0,$$

$$\text{or,}\quad h = 2(f-1)/f \tag{17}$$

from (13) and (17), it can be seen that

$$c = 2\bar{e}/(f-1)fB \tag{18}$$

But using the value of c, it is easy to check that

$$\{2\bar{e}/f(f-1)B\}.rB = \bar{e}B/\{f(f-1)/2\} > \bar{e}.$$

This implies that $p_1= 1$. Hence, $p_1= 1$ and $h<1$ and $c < 1$ is only configuration possible with $p_2 = 1$.

Note: If $r > f(f-1)/2$, then the equilibrium value of p_1 as given in the second case, would be greater then 1. This inconsistency arises due to the fact, for 1 and 2 to choose $p_i < 1$, it means both the bribe income/reward income would be equal to the same $\bar{e}$. Since 1 is indifferent between taking a bribe and truthful reporting, expected income is c r B. For 2, bribe income would be $cp_1h\,f^2B/4$. In equlibrium we need to have

$$c\,p_1h\,f^2\,B/4 = c\,r\,B = \bar{e}$$

$$\text{or,}\quad p_1h = 4r/f^2 \tag{19}$$

In addition since $c < 1$, we have

$$1 - p_1\left[h\frac{f}{2} + (1-h)f\right] = 0$$

$$\text{or}\quad 1 - p_1f + (4r/f^2).(f/2) = 0$$

$$\text{or } p_1 = \frac{1}{f} + 2r/f^2 > 1 \tag{20}$$

Here it must be the case that in equlibrium 1's bribe income is greater than $\bar{e}$ (can not hold for 2). Taking $p_1 = 1$ and value of p_2 such that 1 is indifferent between $h = 0$ and $h = 1$, we can find out c.

(iv) The last case is obvious. In equilibrium truthful reporting always takes place.

(c) Consider first , $r < f/2$. We begin by noting the following two facts.

(i) In equlibrium $p_1 \neq 1$, $p_2 \neq 1$. This is because given $f > 2$, $p_1 = 1$ would imply that

$$1 - [h.f/2 + (1-h)f] < 0 \text{ for any value of h.}$$

Similarly if $p_2 = 1$, 1 would prefer to be honest even with a reward of $r = 0$.

(ii) If $p_1, p_2 > 0$ then $h \neq 1$. To see this notice that in equilibrium we must have (using

$$cp_1 \frac{f^2}{4} B = c\left(1 - \frac{p_2 f}{2}\right) \frac{fB}{2}, \text{ as } h = 1.$$

$$\text{or } p_1 = \frac{2}{f} - p_2 \text{ or } p_1 < \frac{2}{f} \tag{21}$$

Putting this in Z's utility function,

$$B - p_1\left[\frac{fB}{2}\right] > 0 \text{ or } c = 1$$

Similarly $h = 1$ would imply

$$\left(1 - \frac{p_2 f}{2}\right) \frac{fB}{2} \geq rB \tag{22}$$

Combining this with (2… have, $p_1 > 4r/f^2$ or 2's total expected income should exceed rB. If $r > r^*$ then clearly $rB > \bar{e}$ and hence $p_1 \frac{f^2}{4} B > \bar{e}$, so $p_2 < 1$ is not possible.

Combining (i) and (ii) it is easy to see that $c = \bar{e}/rB$, $h = 4r/(f+2r)$ would be the unique equilibrium for values of p_1, p_2 as given in the table.॥

Note: Clearly the restriction $\bar{e}_1 = \bar{e}_2$ has eliminated many other possible equilibria. for example in the case of $f > 2$ and $r < f/2$, if we consider $\bar{e}_1 < \bar{e}_2$, then two other equilibrium configurations are possible. Let $\alpha = \bar{e}_1/\bar{e}_2$

(1) If $r < f/2\ (\alpha)$ then $c = 2\bar{e}_2/fB$, $h = 1$

$$p_2 = \frac{2}{f}(1-\alpha)p_1 = \frac{2}{f}$$

(2) if $r > \frac{f}{2}(\alpha)$ then $c = 1$, $h = 1$, $p_1 = \frac{4\bar{e}_2}{f^2 B}$

and $p_2 = \left(1 - \frac{2\bar{e}_1}{fB}\right)\frac{2}{f}$

In the second case however α has to be very small, so that r can be also small, as we need $rB \leq \bar{e}_1$ in equlibrium.

APPENDIX B:

When rewards are quite small relative to $\bar{e}$, we have the following. *Proposition* If $r < r^*$, then in equilibrium it is always the case that $c = 1$ and $h = 1$.

Proof: Before we proceed, notice that since $r < r^*$, we can not have $r > f^2B$ because of (A3). Let us consider the case $f < 2$. When $r < f(2-f)/4$, the analysis is same as the one in the previous proposition. Following the same arguments, $p_2 < 1$. In addition $h < 1$ would imply

$$cfB(2-P_2f)/4 = c$$

$$rB < rB = \bar{e}, \tag{23}$$

$$\text{or,} \quad p_1 = 0.$$

But, given our assumptions (A3) this can not be an equilibrium. Hence, in equilibrium $h = 1$. Since $f < 2$, $h = 1 \Rightarrow c = 1$. This means to have $p_2 < 1$, we need using (13)

$$p_1 = (4\bar{e}\ /f^2B) < 1. \tag{24}$$

It can be easily checked that $p_2 = (2/f) - (4\bar{e}/f^2B)$.

When $f > 2$, by (1) and (2) p_1 and p_2 must be less than 1. In addition by (23), $h = 1$. These two together imply

$$cp_1f^2B/4 = cfB(2-p_2f)/4,$$

$$\text{or,} \quad p_1 + p_2 = 2/f.$$

Since $p_2 > 0$ (by 2, 4,A3, and the fact that $f^2B/4 > fB/2 > \bar{e}$) $p_1 < 2/f$ or $c = 1$. We can proceed to find values of p_1,p_2 as given in (24).∎

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