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TAX EVASION, CORRUPTION AND ADMINISTRATION:
MONITORING THE PEOPLE'S AGENTS UNDER SYMMETRIC DISHONESTY

by

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Abstract

Previous work on income tax evasion has assumed that taxpayers are dishonest, while tax collectors are honest. Such a clear "moral" asymmetry is seldom observed in developing countries. The present paper shows how corruption depends on the type of (corruption detection mechanisms in) society, and the incentives which can be designed to ensure honesty or increase net revenue. It also sheds light on the puzzle of why goverments ignore the implications of previous models to raise penalties on tax evaders. In some circumstances this can drastically reduce net revenues.

1. INTRODUCTION

There is by now a considerable literature on tax evasion, starting from the partial equilibrium models representing the evasion decision (Allingham and Sandmo, 1972, Srinivasan, 1973), to determining some of the allocation effects of evasion (Penceval,1979, Watson,1985). The paper of Sandmo (1981) goes a step further in attempting to derive normative implications in the framework of optimal tax theory. Though these papers differ from each other in some respects, there is one assumption common to them.

The assumption of asymmetric honesty between taxpayers and tax collectors, is implicit in previous work on tax evasion. In the USA this can be justified on the practical grounds that the IRS appears to be honest. [1/] Though this may historically be a reasonable assumption for the rich countries, it is highly questionable for the poor ones. [2/] A general model must encompass both possibilities, so that conditions under which the tax bureaucracy is honest can be investigated.

Most earlier models share the implicit conclusion that higher penalties decrease evasion by raising its cost, and are thus a virtually costless

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1. Application of the same reasoning to taxpayers would require a model which segmented taxpayers, as most of them also appear to be honest and should be treated as such.

2. As the recent publicity about the Philippines has brought home to most people. The increasing concern with tax evasion in rich countries, and reports of official corruptoin in government contracting and drug enforcement suggest a fresh look at this assumption even for these countries.

way of increasing net revenues (Cowell, 1985). [3/] This prescription does not seem to be taken seriously in many countries. On the contrary developing countries have offered public amnesty for declaring previously evaded taxes. [4/] If the bureaucracy is corrupt the price of evasion detected is not simply the penalty on evaded taxes, but also depends on the rewards and incentives for the tax collector. The role of evasion penalties can therefore be quite different from that in models with honest bureaucrats. The current paper shows how an increase in penalties on income tax evaders can reduce net revenue collections.

The most important results which emerge from the analysis relate to the design of an incentive system for tax collectors. The objective of incentive design is assumed to be the maximization of net revenues given the tax system and the societal institutions affecting corruption. In this context, the paper classifies societies into three types, Strong, Corruption Deterring and Weak, in terms of the coefficients related to corruption detection and punishment. [5/] A strong society is characterized by nonpositive expectations of marginal returns from corruption (taking bribes). In this case the tax bureaucracy is honest independent of the incentive system (the analysis of this case is relegated to the appendix).

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3. See papers by Kolm (1973), Fishburn (1979), Kemp and Ng (1979), Koskela (1983), Polinsky and Shavell (1979), Singh (1973), and Goode (1981).

4. I recall a recent (past year) report in the Washington Post that even the US IRS was discretely offering amnesty for specific offenses.

5. The cost to the government of detecting evasion have been addressed in earlier papers in the context of detection probabilites (Sandmo, 1981, Watson, 1985). These are assumed fixed in the present paper.

The paper focuses on the other two types of societies. In each case the incentive system for tax collectors can be classified into three ranges -- Honest range, Corrupt range and Degenerate range. If the incentive parameters lie in the degenerate range tax collectors act solely in thier own interests. Evasion is also higher than in the corrupt range. What distinguishes the Corruption Deterring Society (CDS for short) from the Weak society is that the corrupt range is characterised by Rent Transfer. Corruption has no effect on evasion, but its existence leads to a transfer of revenues from the government to the tax evaders and tax collectors.

The next section(2) discusses the view of corruption and evasion which underlies the tax evasion model. The presentation of the formal model is split up into two sections (3 and 5). Section 3 models the bargain between the taxpayer and tax collector, which determines the price of detected evasion, conditional on the evasion detected. As the conditions for honest bureaucracy depend solely on the bargaining solution of section 3, these are investigated in section 4. The remainder of the model, pertaining to the taxpayers evasion decision conditional on the price of evasion detected, is given in section 5.

The analysis of the Weak society with corruption detection probability independent of the amount of bribes taken by the agent is divided into two sections. Section 6 considers a linear incentive scheme (linear system), and section 7 a quadratic incentive scheme (exposure share system). The Corruption Deterring society, with expectations of marginal returns to the tax collector decreasing with bribes, is analysed in the next two sections. Section 8 considers the linear incentive scheme (bribe limit system), and section 9 very briefly considers the quadratic incentive scheme (bribe-exposure limit system.)

Section 10 concludes the paper with an overview of the results, and outlines some directions for future research.

2. MODEL OVERVIEW

With tax collectors potentially as dishonest as the tax payers the model must deal with two new issues. One concerns collusion between taxpayers and tax collectors in not exposing detected evasion in return for a side payment (bribe). [6/] The other is concerned with incentives for and monitoring of tax collectors, and is addresed in this paper using a principal-agent framework. [7/]

In simplest terms, we can think of the government as an organization which is collectively owned by the people, and one of whose objectives is to collect taxes. [8/] The tax bureaucrats in the government can therefore be viewed as the agents of the people (the principals). As in the shareholder-manager dichotomy in a corporation, the reality is more complex. The elected representatives or elected government usually forms an intermediate supervisory layer between the principal and the agents (Tirole 1985).

In the present paper hierarchical details are ignored. No distinction is made between the people and their representatives (the principal), or

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6. This is analyzed as a cooperative game between the two as in Virmani (1983).

7. The principal and agent are different from those in Reinganum and Wilke (1984).

8. The tax schedule will be assumed fixed prior to the tax collection operations considered here. The expenditure side of government is not considered at all in this paper.

between different layers of the government bureaucracy (the agent). 9/ The paper focuses on a single agent or tax collector, who can be seen as a representative of the tax bureaucracy. 10/

The tax collector is interested in his own returns subject to the incentive and monitoring system created by the principal. 11/ This system is assumed to have two components. One component is a general mechanism for detection and punishment of corrupt officials. In most societies this encompasses the police, special corruption detection departments, the judiciary, the elected representatives, the press and the public/consumer interest groups. 12/ The probability of detection will be assumed in general to depend on the total amount of bribe taken. If corruption is detected all bribes are forfeited plus a penalty is levied which is assumed measurable in monetary units.

For the present purpose we can define societies in terms of the corruption detection probability that characterizes it. The Strong society has a non-concave, the Corruption Deterring Society a convex, and the Weak

9. Issues connected with corruption of elected representatives will therefore not be addressed. Once the tax schedule is fixed the people are assumed to have identical objectives for the organization, i.e. maximize net revenue from the tax bureaucracy.

10. If there are N tax collectors/inspectors, each one can be assumed to cover 1/N of the entire sample of taxpayers. The paper therefore ignores any interaction between the inspectors.

11. Tax inspector is assumed to be risk neutral.

12. Though this element is probably most critical in determining cross country variations in official honesty/corruption, it will be taken as given for an individual country, the focus of the present paer. In some poor countries the elected government and other public agents may themselves be corrupt. Consideration of this issue is avoided in the present paper as it would make the analysis intractable.

society a non-convex, marginal expectation of returns from bribes. For expositional simplicity a linear function is assumed for both the strong and weak societies. 13/ The Strong Society is then defined by nonpositive expectation of marginal returns from bribes at the zero bribe level. The Corruption Deterring Society is defined as having positive but decreasing marginal expectation of return from bribes. Though such a function could arise from various combinations of detection probability and penalty levels, linear penalties and convex detection probabilities are assumed. The Weak Society is defined as having constant positive marginal expectation of returns from bribes.

The second component of the system is specific to the tax bureaucracy, and central to the present analysis. The amount of income declared by any taxpayer is known to both the agent and the principal. The major role of the agent is to detect and expose evasion. The principal has no direct dealing with individual tax payers and therefore no direct information on evasion by any taxpayer or sub-set of taxpayers. The only information he receives regularly is the amount of detected evasion which is exposed by the agent. The simplest and most direct way to monitor the agent is through the amount of evasion exposed by him. 14/ The design of the exposure linked reward structure is important in determining how much, if any, of detected evasion will be exposed to the principal.

The taxpayers (N, say) are assumed to be divided into m sub-sets with n_j (j=1,...m) individuals having identical fixed income in each sub-set. It

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13. As bribes are always zero in the strong society, the assumption has absolutely no effect on the results for this case.

14. If the total taxable income in the economy was known, which is seldom the case, an alternative would be to judge declared plus detected income against this.

is assumed that checking is done on a random basis. [15] The same proportion of evaders from each sub-set are detected, and the distribution of those detected is identical to that of the evaders. Any evasion detected is specific to an individual (and to a given year or years), as detection has meaning only if the evader can be legally prosecuted. Any bribe for not exposing a certain amount of detected evasion must be negotiated by the evader and the tax inspector, and does not directly involve other evaders or the principal. Determination of the bribe and exposure level can be viewed as a bilateral bargain between the two, conditional on the amount of detection. [16] It will be represented as a Nash (1950) cooperative game between the evader and the detector (agent) against the principal (Virmani, 1983). [17] The starting basis for the deal is the non-cooperative solution with each acting independently. [18]

An assumption implicit in most models of income tax evasion is that evasion is merely misrepresentation by the taxpayer. Though this may be true for small amounts of labor income from the informal market, in general evasion

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15. In many countries each tax collector is assigned a certain number of taxpayers, and he deals on a personal basis with all taxpayers in his assigned area. He has to approve, after checking if necessary, every return filed by his set of taxpayers. Detailed checking may still be random, however.

16. Examination of collusive deals in developing countries suggests that they are more akin to a bilateral monopoly bargain than a tax inspector monopoly.

17. The role of the people as individual tax payers is, however, quite distinct from their role as collective "owners" of government. Just as the role of households as shareholders is quite distinct from their role as consumers or suppliers. It also has some similarity with the free-rider problem in public goods.

18. With agent detection effort and investigation probability fixed, threats have no meaning. A starting point given by a threat solution only becomes relevant if one of these is variable.

involves the concealment of income and information, and the introduction of false or misleading information. [19] Expenditures and labor costs incurred in evasion constitute a potentially important source of resource costs of evasion and corruption to the economy (Krueger, 1974, Bhagwati, 1982,). It is assumed that costs must be incurred in concealing income.

A parallel assumption in these papers is that of "all or none detection" on investigation. From the information perspective, it is unlikely that all types of concealment activity is of equal quality and equally easy to detect. More importantly detection is meaningful only if it can be proved in court (Greenberg (1984)). This will be represented in the present paper by making income tax evasion detected a convex function H of evasion X. [20] To simplify the exposition, the presentation will focus on two special cases. The 'linear tax' case in which marginal tax rates are constant, and the 'all-or-none detection' case in which tax rates can be non-linear but H(.) = X.

The formal model of bargaining is given in the next section. Section 4 considers the problem of honest bureaucracy in the context of the bargaining solution, before completing the model in section 5.

3. EVASION PRICE UNDER CORRUPTION

Though for simplicity of exposition, the model is framed as a single period one, it involves two stages. In the first stage, each risk neutral taxpayer decides on how much of received income (Z_i) to conceal (Xi). [21]

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19. For instance, the creation of false expense vouchers, sale of goods on the grey market and maintenance of illegal investment accounts in a foreign country.

20. An alternative assumption is to make the proportion of evasion detected a random variable, with different probabilities for detecting different proportions of income. These two approaches could also be combined. The latter was tried, but becomes too complicated in most cases.

This is based on the cost of concealment ($S(X_i)$), and his expectation of evasion cost for each level of evasion. At the second stage, the tax agent randomly selects a proportion (π) of taxpayers for investigation. An amount of concealed income $Y_i(\leq X_i)$ is detected for each of those investigated. Detection depends in general on both the total income and the amount of income concealed ($Y_i=H(X_i,Z_i)$). 22/ The actual price of evasion detected is determined at this stage.

In general a part of the evasion detected is revealed to the principal or formally exposed on official records ($W_i \leq Y_i$). The taxpayer has to pay a tax on the evaded income exposed ($wi=T(X_i+W_i)-T(X_i)$), plus a penalty, assumed to be proportional to the taxes evaded ($P_o w_i$). 23/ The taxpayer pays the tax inspector a bribe (b_i) for not exposing some or all of the detected evasion (Y_i-W_i), if this will reduce his total detection costs ($u_i=(1+P_o)w_i+b_i$). As noted earlier the bribe and exposure levels are assumed to be determined by a bilateral bargain between the taxpayer and the tax collector. The remaining tax and penalties are then assumed to be paid by the taxpayer to the government, and any rewards or incentive by the government to the tax collectors. Penalties are then levied on any corrupt tax officials detected.

In formally modeling the problem, I start with the second stage problem of determining the bribe and exposure levels for given detection. These determine the total cost and price per unit of detected evasion. The variable

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21. Risk neutrality is assumed to keep the collusion stage as simple and transparent as possible.

22. It will also depend on the effort expended by the inspector. The variable effort case is not considered in this paper.

23. T(.) is the tax function which is nonlinear in general, but is assumed to be linear in one of the two sub-cases considered.

Table 1: List of Variables

Z_i = Income received (fixed) by taxpayer i, i=1...N .

$z_i=T(Z_i)$ = Tax due on income Z_i. $T'>0$, $T''>0$. $T'=t_1$ (constant) if $T''=0$. Prime(s) represent 1st (2nd) differentials.

$D_i, d_i=T(D_i)$ = Income and income tax declared by i.

$X_i, x_i=T(Z_i)-T(D_i)$ = Income and income tax concealed by i.

$Y_i=H(X_i,Z_i)$ = Concealed income detected by tax inspector on investigation of i. $H_1,H_{11}>0$, $H_2,H_{12}<0$.

$y_i=T(Y_i+D_i)-T(D_i)$ = Extra tax due if detected evasion is fully exposed by inspector agent to prinicipal.

$W_i, w_i=T(W_i+D_i)-R(D_i)$ = Detected evasion exposed by agent and tax due on it (respectively)

$S(X_i)$ = Resource cost of evasion to taxpayer i. $S'>0$, $S''\geq 0$.

P_o = Penalty payable by taxpayer per unit of evaded tax.

π = Probability of being investigated by the tax inspector.

b_i = Bribe taken by tax inspector from taxpayer i.

$b=\sum_j b_j$ = Total bribes taken by tax inspector, $\underline{b}=\sum_{j\neq i} b_j$.

$u_i=b_i+(1+Po)w_i$ = Cost of evasion detetted.

$\underline{p}=\underline{p}_o+\underline{p}_1 b$ = Probability corruption/bribery being detected. $\underline{p}_1\geq 0$.

A_o = Penalty per unit of bribe on discovery of corruption.

$R=R_o+R_1 w+R_2 w^2$ = Reward for exposing tax evasion. $R_1>0$, $R_1+2R_2 w>0$ for all relevant w, $w=\sum_j w_j$, $\underline{w}=\sum_{j\neq i} w_j$.

$B=b(1-p_o-p_1 b)+R$ = Expectation of returns to agent($p=\underline{p}(1+A_o)$).

$C(X_i)=T(D_i)+S(X_i)+\pi u_i$ = Expectation of tax plus evasion costs to tax payer i.

$G=\sum_j T(D_j)+\pi((1+P_o-R_1)w+R_2 w^2)-R_o$ = Expectation of net revenues to the principal.

definitions are listed in table 1. For those investigated, tax evasion of y_i detected. Detected taxpayer and agent jointly determine w_i and b_i. The noncooperative solution representing the bargaining base or threat point is given by,

$$\text{Taxpayer:}\quad \underset{b_i}{\text{Min}} = -u_i = -(1+Po)w_i-b_i, \tag{1}$$

The tax bureaucrat maximizes expectation of returns from bribes and reward from principal.

$$\text{Bureaucrat:}\quad \underset{w_i}{\text{Max}}\quad B=b(1-p_o-p_1b)+R_o+R_1w+R_2w^2, \tag{2}$$

The solution of (1) and (2) is easily shown to be $b_i=0$, $w_i=y_i$, which yields,

$$F=F_o=-(1+P_o)w_i,\; B=B_o=b(1-p_o-p_1b)+R_o+R_1(y_i+\underline{w})+R_2(\underline{w}+yi)^2 \tag{3}$$

The <u>Nash Co-operative Bargain</u> is therefore given by the joint maximization of L (eqn. 4) where F and B are the gains to the taxpayer and tax agent respectively,

$$\underset{w_i,b_i}{\text{Max}}\quad L=\underline{F}\ \underline{B}=(F-F_o)(B-B_o),\ \text{subject to}\ \underline{B}\geq 0,\ \underline{F}\geq 0,\ \text{where}$$

$$\underline{F}=(F-F_o)=(1+P_o)(y_i-w_i)-b_i, \tag{4}$$

$$\underline{B}=(B-B_o)=b_i(1-p_o-2p_1b+p_1b_i)-(R_1+2\underline{w}R_2)(y_i-w_i)-R_2(y_i^2-w_i^2) \tag{5}$$

The necessary conditions for a bargaining solution are,

$$L_b = dL/db_i = (1-p_o-2p_1b)\underline{F} - \underline{B} = 0\ . \tag{6}$$

$$L_w = dL/dw_i = ((R_1+2wR_2)\underline{F} - (1+P_o)\underline{B}) =$$

$$(\ R_1+2wR_2 - (1+P_o)(1-p_o-2p_1b))\underline{F} \leq 0 \tag{7}$$

The second line of (7) is obtained from the first by substitution of (6). L_b

> 0, $L_b < 0$ and $L_w > 0$, can be ruled out because they contradict conditions (4) and (5). If $\underline{F} = 0$, the taxpayer is indifferent between the bargaining and the honest solution a case which occurs for the linear system and is therefore ignored till section 6. Equations (4) to (7) determine the bribe b_i, the exposure w_i on which penalty has to be paid by the firm, and the cost per unit of evasion detected u_i. These are functions of y_i the detected evasion.

A graphical depiction of the solution can be obtained by considering the trade off between bribes and exposure for the bureaucrat relative to the trade-off for the taxpayer. Taking the total differential of (2) with B constant and of (1) with F constant, and comparing ~~the slopes of the trade-off~~ line, we have using the inequality sign in (7),

$$\left.\frac{db}{dw}\right|_{B=cons.} = -(R_1+2wR_2)/(1-p_o-2p_1b) \geq -(1+P_o) = \left.\frac{db}{dw}\right|_{F=cons.} \tag{8}$$

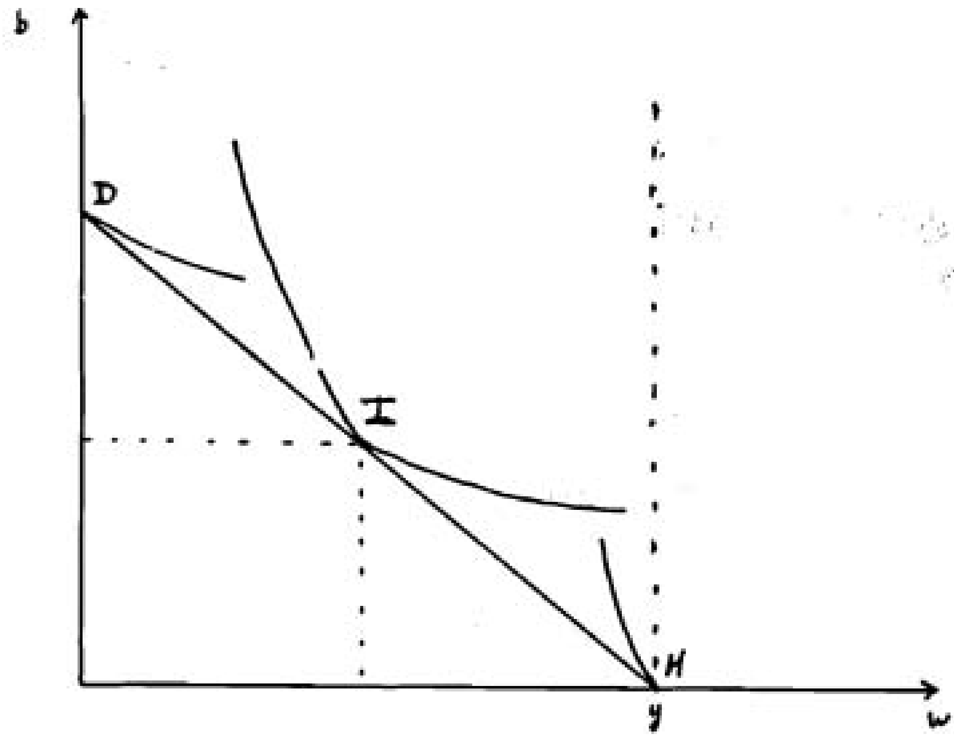
This is depicted in figure 1 as the solution points D (corner) and I (interior). H represents the no-bargain solution.

Before setting up and solving the first stage problem (section 5), I digress somewhat to consider the conditions for an honest bureaucracy.

4. HONEST BUREAUCRACY

In this paper, expectation of marginal returns to the agent from taking bribes $(1-p_o-2p_1b)$, and the marginal reward to him from exposure (to principal) of detected evasion (R_1+2wR_2), will both be assumed positive. When the former is negative at the zero bribe level honesty is ensured when the marginal reward is non-negative, as it is in the normal case in which bureaucrats get a fixed wage. This case is considered fully in appendix 1. The

Figure 1. Bargaining Solution



more interesting cases are ones in which evasion is not ruled out by very high detection probability for corrupt bureaucrats.

An honest bureaucracy will be defined as one in which there is no bargaining solution between it and the taxpayers. 24/ All detected evasion is exposed and incurs a penalty, and there are no side payments or bribes. The results hinge on the relationship between the marginal reward parameter R_1 and a critical value of this parameter which is termed R_c, defined as,

$$R_c = (1-p_o)(1+P_o).$$

The results are presented in the following propositions.

<u>Proposition 1. Honest Bureaucracy</u>

The bureaucracy is honest when reward parameter R_1 is greater than or equal to the critical value R_c, and the reward parameter R_2 is non-negative. 25/

Proof. Using (7) $L_w = R_1-R_c+2wR_2+2p_1(1+P_o)b > 0$ for $R_1>R_c$, which contradicts condition (7), so that there is no bargaining solution. 26/ If $R_1=R_c$, $L_w=2(wR_2+p_1(1+P_o)b)\geq 0$. The only possible solution is $L_w=0$, implying that either $w=0$(if $p_1=0$) or $b=0$(if $R_2=0$) or both are zero. If $p_1=0$ we must have from (6), $b_i = (1+P_o + (R_1+2R_2y_i)/(2(1-p_o)))y_i >$ $(1+P_o)y_i$ or $\underline{P}<0$, which cannot be a bargaining solution (contradicts condition on maximization). If $R_2=0$, we have using (4) to (6), $L_b=(R_c+R_1(y_i-w_i))$ $(y_i-$

24. The polar case in which none of the detected evasion is exposed will be termed the degenerate solution of the corrupt bureaucracy.

25. The case in which both R_2 and p_1 are zero results in indifference between corruption and honesty, and is ignored here but considered in section 6.

26. $L_w>0$ implies $w_i=y_i$ and therefore $\underline{P}=-b_i\geq 0$, ie. $b_i=0$. This means $\underline{B}=0$ and $L_w=0$ a contradiction.

$w_i) > 0$, a contradiction. A similar contradiction results if both these parameters are non-zero. QED

The reason for this result is simply that the reward to the bureaucrat for exposing all evasion detected is too strong compared to the benefit (net of costs) of evasion. Under the assumptions of the theorem, $R_1 - R_c > -p_1(1+P_o)b-2wR_2$ for all w and b, contradicting equation (7) and (8). No bribes are therefore taken. This outcome can be depicted as point H in figure 1.

There is also one case in which an honest bureaucracy can result even if the marginal reward parameter R_1 is less than the critical value R_c. The condition of the R_2 parameter is still the same, but an extra condition must be imposed. The corruption detection probability must be independent of the amount of bribes taken by the tax agent (p_1=0). This is shown in the next proposition.

Proposition 2.

With R_1 less than R_c and R_2 non-negative, an honest bureaucracy can result if p_1=0.

Proof. Using (7) we have $R_1+2wR_2=R_c$. Substituting this in (4) to (6) and simplifying we have for bribe b_i and evasion cost u_i,

$b_i = (1+P_o + R_2(y_i-w_i))(y_i-w_i)$, and

$u_i = b_i+(1+P_o)w_i = (1+P_o)y_i + R_2(y_i-w_i)2 > (1+P_o)y_i$ as $R_2> 0$.

This means that $\underline{F} < 0$, and the taxpayer would suffer a loss in a bargaining solution. QED

An honest bureaucracy appears superficially to be much less likely when the marginal reward is declining with total exposure. This impression arises because so far we have focussed on the parameter R_1 instead of the equilibrium marginal reward. From (7) it is obvious that if marginal reward $(R_1+2wR_2) > R_c$, $L_w>0$ there cannot be a bargaining solution. The bureaucracy must be honest if the equilibrium marginal reward is equal to or exceeds the critical value (R_c). Define a marginal reward limit R_a as follows.

$R_a = R_c-2yR_2 \lesseqgtr R_c$ as $R_2 \gtrless 0$, where $y = \sum_i y_i$, if the total evasion detected. Then the following proposition follows.

<u>Proposition 3.</u>

In an incentive system with a quadratic marginal reward, the bureaucracy must be honest if R_1 is equal to or greater than the reward limit R_a, and R_2 is nonpositive.

Proof. Assume to the contrary that a bargaining solution exists (b>0) with $R_1>R_a$. Substituting this in (7) we have for $R_2\leq 0$,

$L_w=2p_1(1+P_o)b + R_1-R_c + 2wR_2 > 2p_1(1+P_o)b - 2R_2(y-w) > 0$,

as $y\geq w\geq 0$. This contradicts (7). QED.

The rest of the paper focuses on the corrupt bureaucracy. The honest bureaucracy cases do however enter into a consideration of the principal's optimization problem.

5. <u>THE EVASION DECISION AND NET REVENUES</u>

In this section I return to the first stage problem of the taxpayer. The taxpayer must determine how much to evade given the evasion price (function) conditional on evasion detected. The standard assumption of fixed income for each taxpayer is made. Formally his problem is to minimize the expected cost C(.) of income taxation and evasion, given the cost of evasion detected.

$$\underset{X_i}{\text{Min.}}\ C(X_i) = T(Z_i-X_i) + S(X_i) + \pi\,(b_i+(1+P_o)wi), \tag{9}$$
$$\text{subject to}\quad L_b=0,\quad L_w\leq 0\ \text{(eqns. (4) to (6))}$$

Forming and minimizing the Lagrangian and simplifying the necessary conditions for an interior solution, we have for the 'linear tax' and 'all-or-none detection' cases,

$$S'(X_i) = \begin{cases} t_1\,\left(1-\pi\ MC_d\ H_1(X_i,Z_i)\right) & \text{for } T'=t_1, \\ T'(D_i)\,\left(1-\pi\ MC_d\right) & \text{for } H(.)=X_i \end{cases} \tag{10}$$

The marginal cost of evasion detected is denoted MC_d and given by equations (11) or (12) in the interior and corner solution cases respectively.

$$MC_d = L_{by}\ ((1+P_o)^2\ p_1 - R_2)/(2V),\ \text{if } L_w=0, \tag{11}$$
$$L_{by}=2((R_1+2wR_2)+R_2(y_i-w_i)),\ V=((p_1(1+P_o)^2-R_2)(1-p_o-2p_1b)-p_1R_2\underline{F}),$$
$$MC_d = (\ (1+P_o)(1-p_o-2p_1b) + (R_1+2R_2y_i)\ )/U,\ \text{if } L_w < 0,$$
$$U=2(1-p_o-2p_1b+p_1b_i+p_1(1+P_o)y_i) \tag{12}$$

U and V are related to the sufficient conditions for a bargaining equilibrium and must both be non-negative if (6) and (7) represent a maxima.

Equation (10) shows that the margipal resource cost of evasion must equal the expectation of tax saving from marginal evasion. What distinguishes this condition from the usual analysis of asymmetric dishonesty (with proportional penalty) is that the marginal cost of evasion detected is not constant in general. It will be assumed that the second order conditions for a minima are satisfied. This means that either S" or H_{11} (2nd differential of H with rspect to X) or T'' must be positive, and any decline in marginal cost of detected evasion must not be too large. [27] Given this assumption the effect of an increase in the price of evasion is to decrease evasion.

Equations (6), (7) and (10) represent a solution of the evasion problem for an individual taxpayer. As this solution depends in general on the total bribes taken and the total exposure by the tax agent, it represents a "partial solution". The "complete equilibrium" must be determined by solving the entire set of equations simultaneously. In principle this involves solving $2N'(N'=N/\pi)$ equations for the evasion price, and N equations for evasion levels. The chief problem that simultaneity creates is that in general there may be multiple solutions. Though this possibility is noted where relevant, the formal analysis will focus on situations in which a unique equilibrium exists.

There are, however, only N'+1 independent equations for determining the 2N' variables in the N' evasion prices, as (7) is identical for all taxpayers. With equation (7) common to all bargains, N-1 variables can, within certain bounds, be set arbitrarily. The reason for this outcome is that the tax collector cares only about the total bribes he receives and the total exposure that he makes to the principal. He is indifferent to the precise distribution of the bribes recieved and exposure levels of the taxpayers whose evasion he detects.

In the general case with all parameters non-zero, equation (7) acts as a bribe-exposure limit to the bargaining solution. With R_2 positive, it

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27. That is $S''+t_1\ MC_d+t_1\ dMC_d/dy_i>0$ for the linear tax case, and $S''+(1-MC_d)T''+T'\ dMC_d/dy_i>0$ for all or nothing detection.

also represents the agents trade-off between bribes and exposure. As shown in subsequent sections (7) reduces to a bribe limit or exposure limit in special cases.

The principal's problem can now be formally stated. The Principal's objective is to maximize expectation of returns from tax and penalty payments on tax payer net of cost of payments to agent. [28/]

$$\max_{R_2, R_2} G = T(D_i) + \pi\,(\,(1+P_o-R_1-R_2w)w\,) - R_o \tag{13}$$

This problem is difficult to solve for the ~~general case,~~ and the paper focuses on the special cases mentioned in the introduction.

6. THE LINEAR SYSTEM

I start the analysis of the weak society, defined by a linear probability of corruption detection (p_1=0), by considering a linear incentive system (R_2=0). The necessary conditions determining the 2nd stage bribe exposure solution (equations 6 and 7) reduce to,

$$(1-p_o)\underline{F} - \underline{B} = (R_1+R_c)(y_i-w_i) - (1-p_o)b_i = 0, \tag{6'}$$

$$R_1 - R_c \leq 0 \;,\; R_c = (1-p_o)(1+P_o) \tag{7'}$$

The sign of the second equation determines the corner solutions for exposure w_i.

---

28. Both the costs and benefits of the general corruption detection system are taken as given, and not considered explicitly in this paper.

From equation (7') and section 4, it is apparent that there are three sub cases, depending on value of the marginal reward relative to the critical value R_c.

1a. Honest Bureaucracy

$R_1 > R_c = (1-p_o)(1+P_o)$, $w_i = y_i$, $b_i = 0$, $u_i=(1+P_o)y_i$.

This is the case which was considered in proposition 1.

1b. Transitional Bureaucracy (exposure indeterminate)

$R_1=R_c=(1-p_o)(1+P_o)$, $b_i=(1+P_o)(y_i-w_i)$, $u_i=(1+P_o)y_i$.

In this case the appropriate bribe can be determined for each level of exposure, but the precise level is indeterminate. In effect both the evader and the agent are indifferent between different bribe exposure combinations.

1c. Degenerate Bureaucracy (no exposure)

$R_1 < R_c$, $b_i = (R_1+(1-p_o)(1+P_o))y_i/(2(1-p_o))$, $w_i=0$, $u_i=b_i$.

In this case the probability of corruption detection is low, and the savings from nonexposure of detected evasion high relative to the rewards of exposure. No exposure therefore occurs, and the agent acts solely in his own interests.

In case 1a the solution of the taxpayer's first stage problem of how much to evade is exactly identical to the honest bureaucracy case (appendix 1). The important thing to note in the present context is that the amount of evasion by the taxpayer is independent of the reward to the agent. An increase in the marginal reward therefore merely increases the reward costs of the principle unless the fixed part is simultaneously adjusted downward.

In case 1c the taxpayer's evasion costs are all in the form of a bribe, which is still linearly related to detected evasion. It now also depends on the marginal reward and corruption detection system affecting the agent (p_o). Evasion is therefore negatively related to marginal reward R_1, penalty for agent corruption A_o and its probability of detection p_o. Increasing the marginal reward has a positive effect on tax payments, but costs nothing since exposure of detected evasion remains zero.

Putting the three cases together the principal's maximization problem (13) can be represented graphically as in figure 2. The optimal incentive scheme is represented by the maxima at $R_1 = R_c = (1+P_o)(1-p_o)$, and the jump in expectation of returns at R_c is equal to $\pi\,(1+P_o)p_o y_i$.

This simple case illustrates most starkly how penalties on tax payers interact with the reward, the penalties and the detection probabilities for agents, to determine exposure and bribes. In particular an increase in penalties on tax evasion can lead to a sharp deterioration in the government's returns as shown in figure 3. This is because higher penalties make it more profitable for the tax evader and agent to collude, tipping the balance of the system from honesty to corruption. [29] The effect of a deterioration of the social environment which reduces the probability of corruption detection or penaltier on it is similar. [30] This can bring about a sudden sharp increase in corruption and deterioration in returns to the principal (figure 4).

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29. This provides some justification for schemes which allow past evasion to be declared to the government for a temporary reduction in penalties.

30. For instance, if tax agents begin to feel that jail is not inevitable if corruption is detected.

Figure 2. Principal's Net Revenue

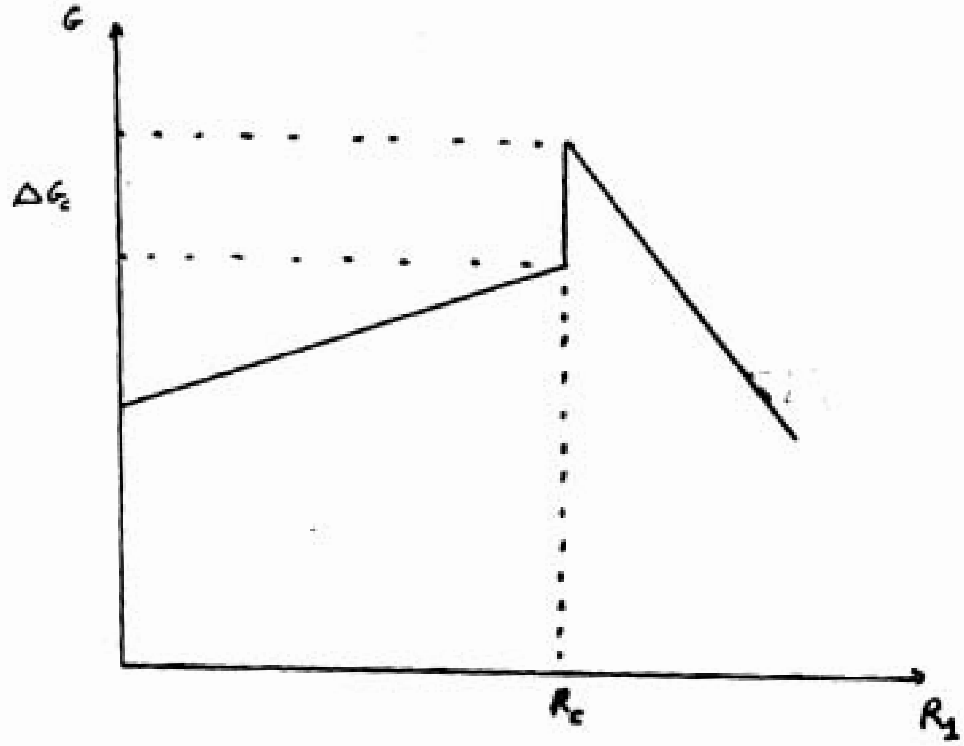


Figure 3. Effect of Penalties on Taxpayers

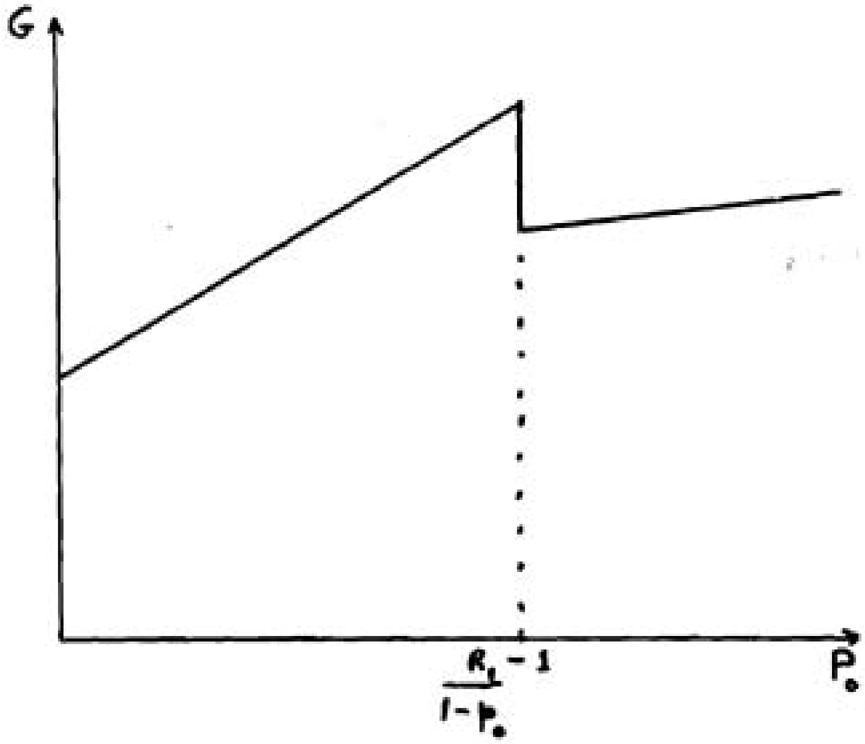
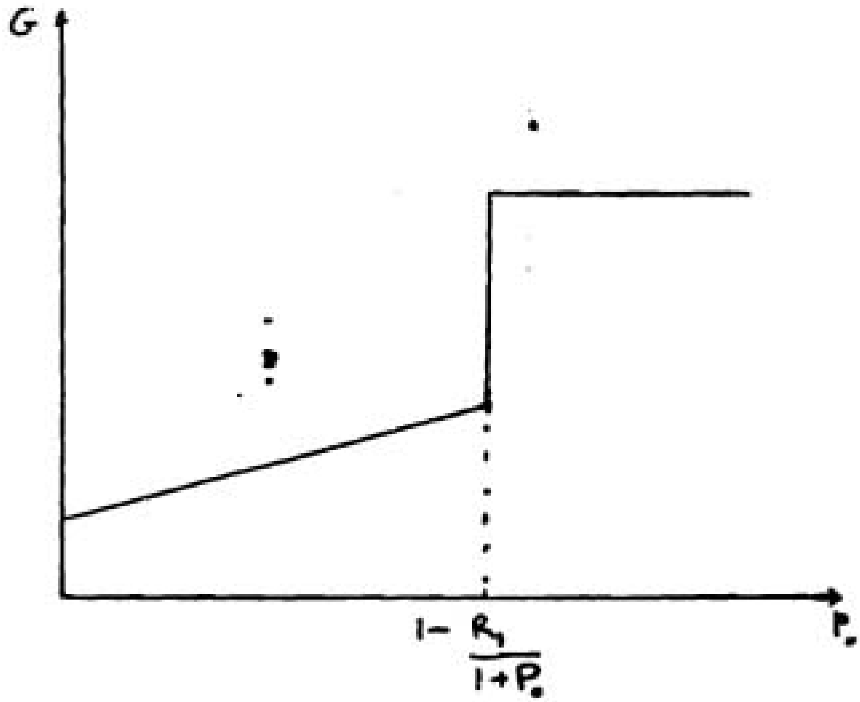


Figure 4. Effect of Changes in Corruption Detection



7. EXPOSURE SHARE SYSTEM

This section considers the quadratic incentive system, in the context of a weak society ($p_1=0$). With the marginal reward parameter R_2 positive the system is honest as shown in propositions 1 and 2. It will therefore be assumed negative in this section. he marginal reward parameter R_1 is less than(or equal to) the critical reward level R_c, the left hand side of equation (7) (reproduced as (15)) is negative (zero). There is no exposure of detected evasion, and we have the degenerate sub-case, with the cost of evasion equal to the bribe (equation (14)).

$$u_i = b_i = (1+P_o)y_i/2 + y_i(R_1+R_2y_i)/(2(1-p_o)) \quad , \tag{14}$$

$$R_1-R_c +2wR_2 < 0 \text{ for } w \geq 0 \tag{15}$$

The marginal cost of evasion detected is therefore,

$$MC_d = (1+P_o)/2 + (R_1+2R_2y_i)/(2(1-p_o)) \tag{16}$$

By differentiating (16), and recalling that evasion is negatively related to the marginal cost of evasion, we see that evasion is negatively related to both incentive parameters. As the principal's net revenue depends only on declared taxes, this will rise as R_1 is raised to R_c, and R_2 is raised towards zero. Net revenues will also rise with penalties on tax evasion.

If the marginal reward parameter R_1 is greater than the critical reward level R_c, a corruption solution is obtained with positive but partial exposure of detected evasion. Equations (6) and (7) reduce, on simplification and substitution to equations (17) and (18), giving the <u>Exposure Share sub-case</u>. [31]

$$R_1 + 2wR_2 - R_c = 0 \tag{17}$$

$$b_i = (1+P_o + R_2(y_i-w_i)/(2(1-p_o)))(y_i-w_i) \tag{18}$$

In contrast to the linear incentive scheme, complete honesty does not result from a marginal reward parameter R_1 greater than the critical level R_c. There is no contradiction, however, as the marginal reward in this case is not R_1, but R_1+2R_2w, and this is equal to R_c (equation (17)). This case should be compared to the linear one in which the taxpayer and tax agent were indifferent between the honest and degenerate solution. Thus replacement of a linear by a declining marginal reward moves the system towards corruption.

The formal analysis of the exposure share sub-case is somewhat more complicated. For an individual tax payer equation (17) determines the amount of detected evasion exposed (w_i) given the exposure of all other evasion detected ($\underline{w}(i)$). While bargaining with the tax collector, and in determining his evasion, the taxpayer treats the latter as given (i.e. $w_i=w_m-\underline{w}(i)$). [32] In ("complete") equilibrium, equations (17) and (18) must be solved simultaneously for all taxpayers detected. As equation (17) is identical for all tax payers, N'-1 variables can be arbitrarily set without affecting the bargaining solution (as noted in section 5).

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31. In the exposure share system total exposure is implicitly limited to w_m (i.e. $w \leq w_m$) where w_m is obtained by solving (17').

32. In a formal rational expectation context, this can be thought of as the myopic assumption.

Table 2. Corruption Outcomes in the Weak Society ($p_1 = 0$)

	HONEST SYSTEM $R_2 > 0$	LINEAR SYSTEM $R_2 = 0$	EXPOSURE SHARE SYSTEM $R_2 < 0$
$R_1 < R_c$	HONEST	DEGENERATE	DEGENERATE
$R_1 = R_c$	HONEST	INDIFFERENT/ HONEST	DEGENERATE
$R_1 < R_c$	HONEST	HONEST	CORRUPT

One simple plausible rule for setting w_i, which ensures consistency with (17) in equilibrium, is as follows. 33/

$$w_i = a_i\, w_m/y\ ,\ a_i \geq 0 \text{ as } y_i \geq 0,\ \sum_i a_i = \sum_i y_i = y, \tag{19}$$

$$w_m = -(R_1-R_c)/(2R_2) \tag{17'}$$

The cost and marginal cost of evasion detected are therefore,

$$u_i = b_i+(1+P_o)w_i = (1+P_o)y_i + R_2(y_i-a_i w_m/y)^2/((2(1-p_o))$$

$$MC_d = 1+P_o + R_2\ (y_i-a_i w_m/y)/(1-p_o) \tag{20}$$

Differentiation of (20) and (17') shows that the price of evasion detected, and consequently income declared, must be positively related to the reward parameters R_1 and R_2.

Proposition 4.

In the exposure limited sub-case, the principal can maximize net revenues by putting, R_1 equal to the tax payer's penalty factor $(1+P_o)$, and R_2 equal to a negative value R_b.

Proof. Increasing R_1 and R_2 will increase declared income and associated tax revenues as shown above. Consider the change in net revenues from penalties and rewards $(1+P_o-R_1-wR_2)w$ with R_1 and R_2. On differentiation and simplification these reduce respectively to,

$$(1+P_o-R_1)/(-2R_2) \gtrless 0 \text{ as } R_1 \lesseqgtr 1+P_o.$$

$$w_m(1+P_o-R_1)/(-R_2) \gtrless 0 \text{ as } R_1 \lesseqgtr 1+P_o\ . \tag{21}$$

Thus an increase in R_1 or R_2 leads to an increase in total net revenue as long as R_1 does not exceed $1+P_o$ and R_2 is less than zero (and system is corrupt).

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33. Again, $a_i=y_i$ fulfills these conditions.

Define a reward limit R_b as follows,

$$R_b = -p_o(1+P_o)/(2y)$$

By putting $R_2=R_b$ and $R_1 = (1+P_o)$ into equation (6) (the source of (17)), it is seen that,

$L_w = p_o(1+P_o)(1-w/y) \geq 0$ as $w \leq y$ so that (23) holds only if $w=y$. Complete honesty is ensured if $R_1=1+P_o$, and $R_2 \geq R_b$. As R_1 and R_2 have no effect on evasion under an honest system, and revenues from exposure net of rewards decline, net revenues are maximized at $R_1=1+P_0$, $R_2=R_b$. QED.

Let y* be the total evasion detected under an honest system, then $R_b = -p_o(1+P_o)/(2y^*)$, where the right hand side is independent of the incentive parameters as long the bureaucracy is honest. Therefore we must also have,

<u>Corrolary 4.1</u> The incentive system remains optimal despite changes in its concavity, as long as the marginal reward parameters satisfy the constraint, $R_1+2R_2y^* = R_c$, $R_1 \leq 1+P_o$.

Thus, in a weak society, with its linear corruption detection system, the simplest incentive system maximising net revenues is also linear. The marginal reward must be set equal to the critical rate R_c. The broad pattern can be summarized as in table 2.

5. <u>BRIBE LIMIT SYSTEM</u>

I turn now to the <u>Corruption Deterring Society</u>, defined by a convex corruption detection probability ($p_1>0$). This section considers the linear incentive scheme ($R_2=0$). With marginal reward greater than or equal to the critical value, the essential features of the solution are the same as in the

Linear system. With the marginal reward R_1 less than the critical value R_c, the bargaining solution given by equations (6) and (7) reduces to,

$$b_i\ (2(1-po-2p_1b) + p_1b_i) = (R_1 + (1+P_o)(1-p_o-2p_1b))(y_i-w_i) \qquad (6'')$$

$$R_1-(1+P_o)(1-p_o-2p_1b) = R_1-R_c+2p_1(1+P_o)b < 0 \qquad (7'')$$

As in the exposure share system both an interior (corruption) and a degenerate solution are possible, with the former arising when (7") is zero, and the latter when it is negative. The conditions under which each will prevail are more complicated and interesting. In general equation (7) represents the "bribe-exposure" limit. With R_2 zero, it reduces to a <u>bribe limit</u> b_m, where b_m is obtained by setting (7") to zero and solving for b.

$$b_m = (R_c-R_1)/(2p_1(1+P_o)) \qquad (22)$$

Equation (7") then shows that the total bribes taken by the bureaucrat will be less than or equal to this limit. When the system is not bribe limited, it degenerates into a completely corrupt one. Only when the system is <u>bribe limited</u>, will the agent expose to the principal, a part of the evasion that he detects.

Whether or not the system will be bribe limited depends on the total bribes received in the degenerate case, b_o (say) relative to b_m (eqn. (22)). Putting w_i=0 in equation (6") and solving for the bribe, we have,

$$b_i \overset{-}{=} b_i(\overset{+}{R_1}, \overset{+}{P_o}, \overset{+/-}{p_o}, \overset{+/-}{p_1}; \overset{+}{y_i}, \overset{+/-}{\underline{b}(i)}), \text{ where } \underline{b}(i) = \sum_{j\neq i} b_j \qquad (23)$$

for each taxpayer whose evasion is detected. The signs of the partials given above the equation are obtained by totally differentiating equation

(6"). 35/ The possibility of a negative effect of $\underline{b}(i)$ on b_i suggests that there may be multiple equilibria. 36/ Assuming that there is a unique equilibrium, the N' simultaneous equations for the N' evaders detected by the agent, can be solved as functions of the exogenous parameters. Summing these functions gives the total bribe b_o in the degenerate case. The degenerate solution will therefore prevail if this total bribe, $b_o = b(R_1, \ldots)$, is less than the bribe limit. From (22) it is apparent that the bribe limit declines linearly with the marginal reward (R_1) offered by the principal to the agent. A degenerate solution can be ruled out for $R_1 = R_c$ because this implies (from 6"), $w=0$, $b=0$ a contradiction. Therefore, b_o must either cross Θ_m at least once or lie entirely above it. The two possible cases are shown in figures 5a and 5b respectively. 37/

Figure 5a identifies a second important marginal reward level R_m, which represents the minimum marginal reward necessary for ensuring that the tax bureaucracy is not totally corrupt. When the marginal reward is less than R_m, the (fixed) marginal return from exposure is less than from total bribes. Nothing is exposed and we have a degenerate solution. If the reward is greater than R_m the marginal return from bribes above b_m is less than that from exposure. It becomes profitable for the agent to limit his total bribes and expose all detected evasion above the level required to ensure this bribe. If the marginal reward lies between R_m and R_c the previously identified critical level, we have a corrupt system with partial exposure.

35. $db_i/d\underline{b}(i) \gtrless 0$ as $y_i \lesseqgtr y^* = 4R_1/p_1(1+P_o)^2)$, as shown in appendix 2.

36. The total effect of a change in the marginal reward may also not be positive.

37. There can also be multiple points of intersection. In this case bribe limited and corrupt solutions will alternate.

Figure 5a. Bribe-Limit Case

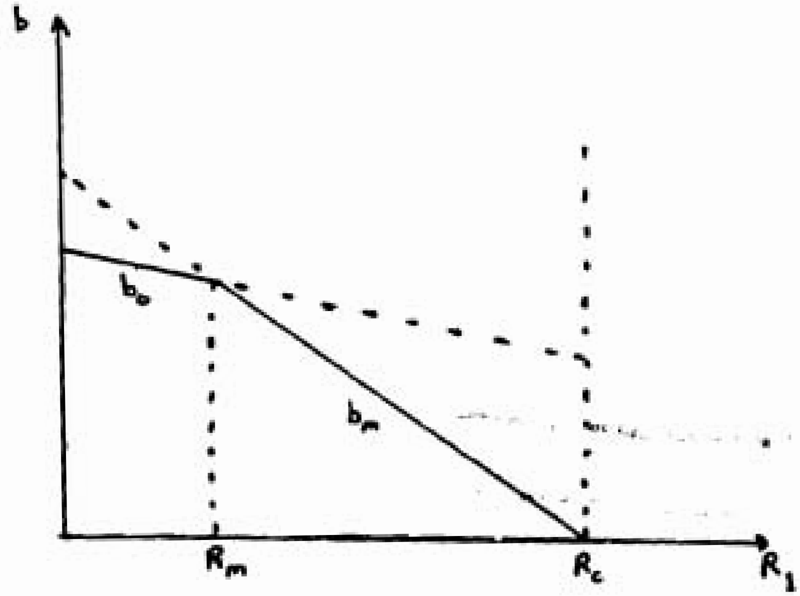
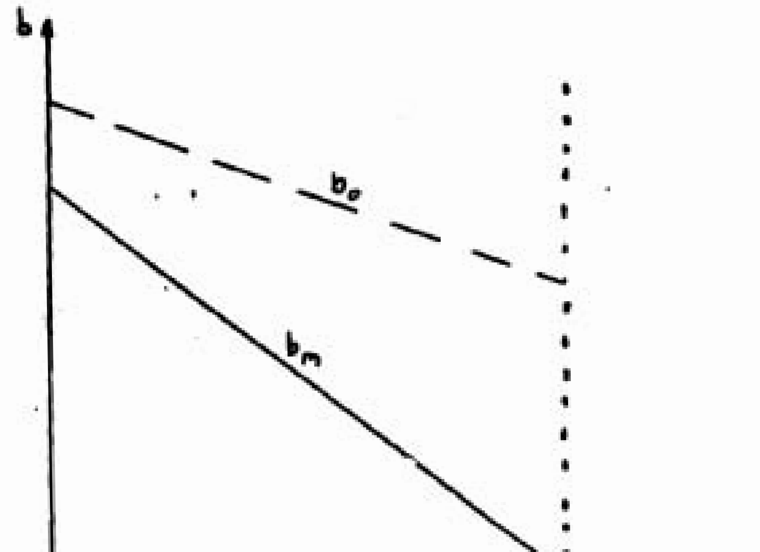


Figure 5b. Bribe-Limit Case



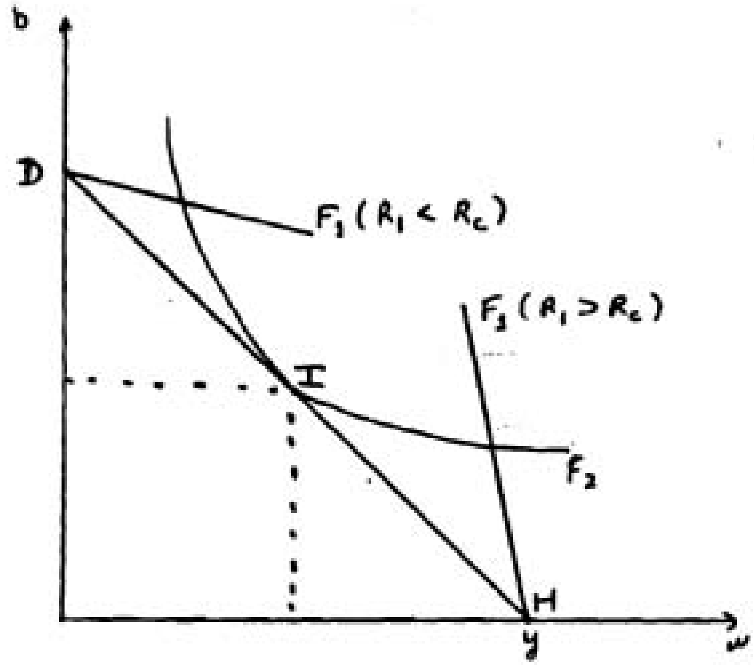
Above R_c the incentive system ensures that the agent is completely honest. In the context of this section the weak economy with linear incentives, has a minimum reward level R_m equal to the critical value R_c. The presence of declining marginal returns from bribes opens up an intermediate region by effectively reducing R_m below R_c. In the case of figure 5b this region expands to fill the whole solution space, with R_m effectively equal to zero.

The differences between the bribe limit and linear cases, can be seen in terms of equation (8) and the corresponding figure 1 (reproduced here as figure 6). As shown in figure 6, the taxpayers trade-off function between bribes and exposure is linear (slope=$-(1+P_o)$) in both cases. In the linear case, the agents trade-off function (F1) between bribes and exposure is linear with slope $-R_1/(1-p_o)$. It intersects the taxpayers trade-off line at a corner point H (point D) when R_1 is more (less) than R_c. In the bribe limit case the agent's trade-off function (F2) has slope $-R_1/(1-p_o-2p_1b)$, so that as R_1 falls below R_c there is a range of values for which the solution is at an interior point such as I.

It has sometimes been speculated that corruption is purely a transfer of rents from the government to its agents and the taxpayer. In the degenerate sub-case this is clearly not so as the price of evasion detected is a non-linear function of the evasion detected and various parameters (equation 23).[38] The bribe-limited sub-case seems to support this speculation. The existence of corruption effectively results in an infra-marginal transfer from the principal to the agent and the taxpayers. The marginal cost of evasion is identical to the case of the honest bureaucracy. That is,

38. The effect of changes in penalties P_o on the marginal price of evasion detection can be negative in the degenerate case. This reinforces the result obtained in the linear system.

Figure 6. Bribe-Limited Solution



Proposition 5. Corruption as Transfers

The bribe limited sub-case results in an infra-marginal fall in the cost of evasion. As the marginal cost of evasion is identical to that under the honest bureaucracy, so is the amount of evasion.

Proof. As in the exposure share sub-case, equation (7") is identical for all taxpayers, and N'-1 variables can be set arbitrarily. A simple rule for setting b_i, which ensures consistency with (22) in equilibrium, is,

$$b_i = a_i b_m/y \ , \ a_i > 0 \text{ as } y_i > 0, \ \sum_i a_i = y = \sum_i y_i, \tag{24}$$

with a_i constrained so that (6") yield a non-negative exposure value less than evasion detected (y_i). [39] The amount of exposure is then obtained by substituting (24) in (6"). That is,

$$w_i = y_i - \left(1/(1+P_o) + p_1 b_m a_i/(2R_1 y) \right) (b_m a_i/y) \tag{25}$$

The cost of detected evasion is in this case,

$$u_i = b_i + (1+P_o)w_i = (1+P_o)y_i - (R_c - R_1)2a_i^2/(8R_1 p_1(1+P_o)y^2) \tag{26}$$

$$MC_d = 1+P_o \tag{26'}$$

QED.

The marginal cost of evasion detected is $1+P_o$ (eqn. 26') which is the same as in the case of an honest bureaucracy. The second term on the right of (26) is independent of detected evasion y_i. [40] It represents the infra-marginal subsidy recieved by all evaders as a consequence of corruption. Though taxpayers benefit from the existence of corruption, the amount of evasion is unaffected by the existence of corruption.

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39. One solution which satisfies these constraints is $a_i = y_i$.

40. In equilibrium a_i must satisfy (17) so that it will tend to be monotonically related to y_i.

In the final part of this section I consider the principal's problem of maximizing net revenues G (equation (13)). In the bribe limited sub-case, changes in R_1 and other parameters affecting the tax agent have no effect on the evasion decision. The principle's net revenue therefore depends on total exposure w which can be obtained by summing (25) over all evaders detected. Differentiating G (eqn.13) with respect to R_1, substituting and simplifying we find that the slope of G can have either sign, but must be negative at $R_1=R_c$ (appendix 2).

In the degenerate sub-case the opposite situation prevails. Parameter changes affect only the evasion cost, but have no effect on exposure and consequently on the principal's reward costs. The "partial equilibrium" effect (i.e. all other bribes held fixed) of R_1 on evasion (bribe price) is negative (positive) in this case (appendix 2). Assuming that the total effect is negative, as it is likely to be if a unique "complete equilibrium" exists, the solution of the principal's problem can be shown as in figure 7. The optimal marginal reward (R_1*) will then lie between the two critical reward levels identified above ($R_m<R_1^*<R_c$).

9. THE BRIBE-EXPOSURE LIMIT SYSTEM

In this section I briefly consider the quadratic incentive scheme in the context of a corruption deterring society. Somewhat surprisingly, replacement of a linear with a quadratic incentive scheme has no effect on the degenerate solution and the conditions for its existence. This is because the new parameter R_2, drops out of equation (7) when there is no exposure. The bribe-exposure limit reduces effectively to a bribe limit b_m, which is still given by equation (22). The bribe solution for the degenerate sub-case will now depend on the new parameter, and is given by (6) with $w_i=0$ for all

Figure 7. Principal's Net Returns in the Bribe Limit Case

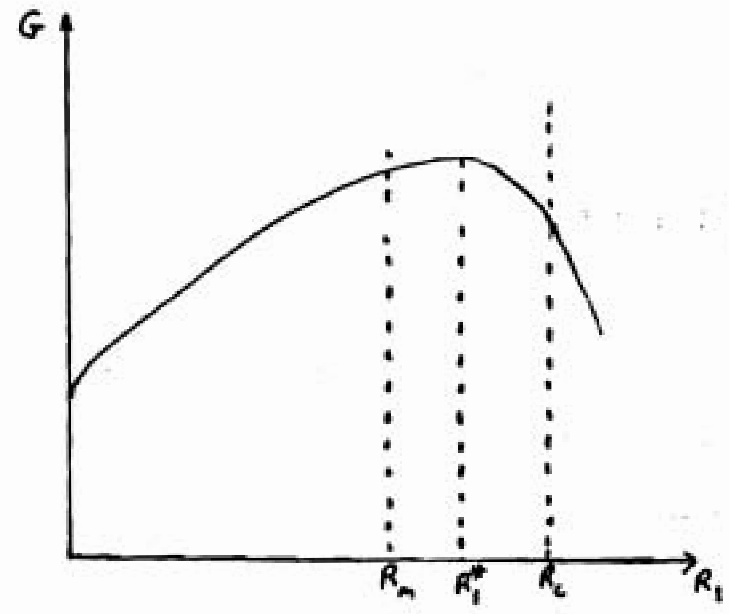
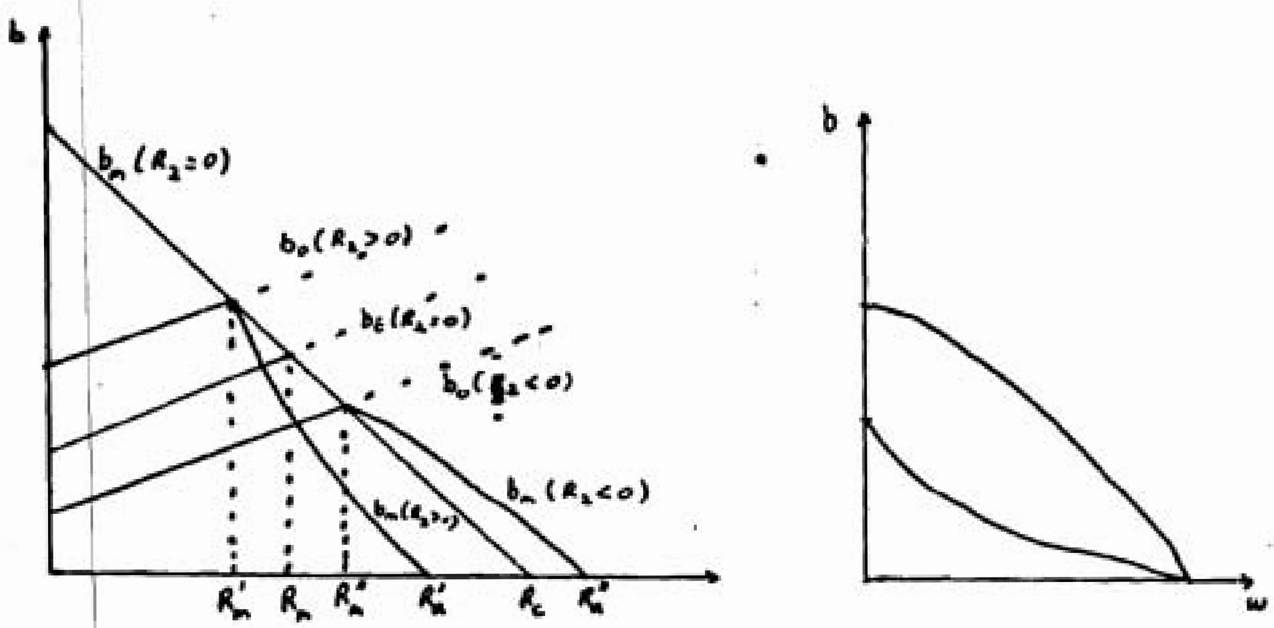


Figure 8. Bribe-Exposure Limit System



evaders. This will change the degenerate range, as R_m shifts, but the broad analysis is still applicable.

The lower bound for the interior solution is therefore still (a modified) R_m. The corruption solution and its upper bound are, however, different. From (7) it can be seen that the total marginal reward R_1+2wR_2 can not exceed R_c in a bargaining equilibrium, as the system will become honest above this. Proposition 3 used this fact to show that the bureaucracy must be honest if R_1 is at or above the value R_a, where,

$$R_a = R_c - 2R_2y^*, \quad y^* = \sum_i y_i.$$

y^* is the total evasion detected and exposed by the agent to the principle when the system is honest. Under quadratic incentives, R_a plays the role that R_c does when the incentive system is linear. Though the precise solution for bribe and exposure levels is much more difficult, the solution has basically the same form (figure 8).

The solution of the principal's problem of maximizing net revenues is also similar in form. For the reasons given in the previous section the optimal quadratic system must have the parameter R_1 between R_m and R_a (inclusive).

10. CONCLUSION

The paper started by separating out societies which can ensure honesty in the tax bureaucracy independent of the incentive scheme for tax collectors. This depended on what may be termed a social weakness factor $(1-p_o)$. For a strong society, this factor is less than or equal to zero, and honesty is ensured. The paper focused on the situation in which the social factor is positive, and bureaucratic honesty depends on the incentive system. Two social types the corruption deterring society and the weak society were identified and analyzed.

In these two societies a critical marginal reward level was identified which plays an important role in the design of an incentive scheme for tax collectors. This critical level is a multiple of two components, the penalty factor on tax evasion detected $(1+P_0)$, and the social factor $(1-p_0)$. Honesty can be ensured even in these potentially corrupt societies if the equilibrium marginal reward to agents for disclosing all detected evasion is set at this critical level. Ensuring honesty may not however be the best policy from the government's perspective.

In both societies a minimum marginal reward level was also identified below which the system degenerated into a completely corrupt one. In such a situation the agents act solely in their own interest, ignoring the incentive structure. The latter does however influence the cost of evasion detected, in the form of bribes which need to be given. Evasion will therefore still be costly, and taxpayers will not evade all their taxes.

What may be thought of as normal corruption prevails between the minimum and the critical level. The effects of corruption in the two types of societies are quite different. In the corruption deterring (CD) society, corruption results in transfer of rents from the government to the evader and the tax collector. There is no effect on evasion as the marginal cost of evasion is unchanged. In the weak society in contrast, corruption is associated with higher evasion.

The marginal reward level which maximizes government net revenue collection also lies in the minimum-critical range (inclusive). As bureaucratic pay structures are notoriously difficult to change, this may be one reason why governments hesitate to increase penalty rates. An increase in the penalty factor would raise the critical level, and move the incentive structure away from optimality. This could result in lower net revenues. A dramatic illustration of such revenue reduction was given in the linear incentive system.

In the weak society case the optimal marginal reward level takes a particularly simple form. The simplest incentive system, which maximizes net revenue receipts is a linear one with the sole marginal reward parameter equal to the critical value R_c. An equivalent, in terms of net revenue, quadratic incentive scheme, was also identified for this society. With the marginal reward set at the critical level the two parameters of this scheme can be varied in offsetting ways. The optimal quadratic scheme was found to involve slightly declining marginal reward for exposure of detected evasion. As the quadratic approximation is likely to be fairly good for this range, a more general nonlinear incentive system may not yield significantly different results.

In the consumption deterring society the shape (concave, linear, convex) of the optimal incentive scheme was more difficult to determine. Analysis of the linear incentive scheme showed that the optimal incentive is strictly less than in a weak society. If a quadratic scheme is used, the equilibrium marginal reward is also bounded above by the critical value R_c. The optimal trade-off between the two parameters cannot be determined analytically. As a CD society is characterized by a convex expectation of marginal return from bribes, one can hypothesize that the optimal incentive scheme will be concave. A formal analysis of this issue, could be pursued in future work.

Another direction for future research is to allow the agent's detection effort to vary. In general, detection depends on the effort expended by the tax inspector in obtaining and analyzing information. With bribes as well as rewards linked to evasion detected there may be an incentive for the agent to increase detection effort. The variable effort case is also linked to the issue of the tax agent using threats of investigation to increase bribe payments. This will modify the threat point on which the bargain between the agent and the tax evader is based. It also opens the door to strategic interplay between the two.

Some numerical content also needs to be given to ~~the model~~, to gauge its correspondence to reality, even though ~~formal empirical~~ testing may not be possible. Income tax evasion estimates in Virmani (1986), and the data on which these were based, though far from perfect, can be used for this purpose.

References

Allingham, M. and Sandmo, A. (1972) "Income tax evasion: a theoretical analysis," Journal of Public Economics, 1, 323-338.

Bhagwati, Jagdish N. (1982) "Directly unproductive, profit-seeking (DUP) Activities," Journal of Political Economy, vol. 90, no. 5.

Cowell, F. A. (1985) "The Economics of Tax Evasion: A Survey," Economic and Social Research Council Programme, no. 80.

Goode, R. (1981) "Some economic aspects of tax administration," International Monetary Fund Staff Papers, 28, 249-274.

Greenberg, J. (1984) "Avoiding tax avoidance: a (repeated) game-theoretic approach," Journal of Economic Theory, 32, 1-13.

Kemp, M. c. and Ng, Y-K. (1979) "On the importance of being honest," Economic Record, 55, 41-46.

Kolm, S-Ch. (1973) "A note on optimum tax evasion," Journal of Public Economics, 2, 265-270.

Koskela, E. (1983a) "A note on progression, penalty schemes and tax evasion," Journal of Public Economics, 22, 127-133.

Krueger, Anne O. (1974) "The Political Economy of the rent-seeking society," American Economic Review, LXVI, vol. 3.

Pencavel, J. H. (1979) "A note on income tax evasion, labor supply and nonlinear tax schedules," Journal of Public Economics, 12, 115-124.

Polinsky, M. and Shavell, S. (1979) "The optimal trade-off between the probability and magnitude of fines," American Economic Review, 69, 880-891.

Reinganum, J.F. and Wilde, L.L. (1984) "Income tax compliance in a principal-agent framewrok," Journal of Public Economics, 25, 1-18.

Sandmo, A. (1981) "Income tax evasion, labor supply and the equity-efficiency tradeoff," Journal of Public Economics, 16, 265-288.

Singh, B. (1973) "Making honesty the best policy," Journal of Public Economics, 2, 257-263.

Tirole, Jean. (1985) "Hierarchies and Bureaucracies: On the Role of Collusion in Organizations," Discussion Paper, Massachusetts Institute of Technology.

Virmani, Arvind. (1983) "The microeconomics of a corrupt tax bureaucracy," Report No. DRD54, Development Research Department, World Bank.

______. (1986) "Measuring Income Tax Incentives Under Evasion," DRD Discussion Paper No. 187, World Bank.

Watson, Harry. (1985) "Tax evasion and labor markets," Journal of Public Economics 27, 231-246.

Appendix 1. HONEST BUREAUCRACY CASE

This appendix considers the case in which external incentives incorporated in the detection system ensure honesty independent of the reward mechanism. The marginal reward from complete exposure of detected evasion is non-negative even if a fixed salary is given to the agent. The general framework of corruption detection ensures honesty if the expectation of returns from taking bribes is non-positive at the zero bribe level.

In this case the problem reduces to the standard one, considered in previous papers, of the taxpayer minimizing expectation of tax and penalty costs. Putting $b_i=0$ and $w_i=(1+P_o)y_i$ in (10), and ignoring the constraint, the necessary conditions are,

$$S'(X_i)=T'(D_i)+\pi(1+P_o)((1-H_1)T'(D_i+H(X_i,Z_i))-T'(D_i)$$

$$=\begin{cases} t_1(1-\pi(1+P_o)H1) & \text{for linear taxes,} \\ T'(D_i)(1-\pi(1+P_o)) & \text{for full detection.} \end{cases} \qquad \text{(A1)}$$

As we would expect, the marginal resource cost of evasion is less than the marginal tax rate because of the expectation that some evasion will be detected and penalized. The comparative static results are also affected by the inclusion of resource costs and by partial detection.

Comparative static analysis shows that an increase in penalty or detection probability reduces evasion if either the tax structure is linear or if there is complete detection on investigation $(H(.)=X_i)$. [41] This is not assured in general, however, because in the presence of resource costs of

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41. i.e. $T(Z)=t_o+t_1Z$.

evasion, marginal detection costs can be negative for a tax evader. This in turn is more likely if the marginal tax rate applicable to detected income (t_2) is much higher than on the declared income (t_1), and marginal detection of evasion (H_1) is significantly less than one. That is,

$$t_1 - (1-H_1)t_2 < 0,$$

which holds for instance if t_1 is 20%, t_2 is 30% and H_1 is less than 0.33. Thus there can be sub-sets of risk neutral taxpayers for whom an increase in penalty or detection probability increases evasion over some ranges of these variables.

The effect of increased detection uncertainty can also be analysed in terms of a mean preserving spread (MPS), by writing H as $A\bar{H}$ and adjusting A simultaneously with π. With a general (convex) tax function, decreased detection uncertainty can decrease evasion. This cannot happen when detection is assumed to be of the all or none type, ie. H=X, and A is initially one. Convexity of the tax function ensures a decrease in marginal detection costs. 42/ With a linear tax an increase in detection uncertainty has no effect on evasion.

The principal's problem is an easy one in this case. Exposure dependent rewards are unnecessary. Therefore R_o can be set equal to the market wage. Unless otherwise specified R_o will be assumed fixed in subsequent discussion.

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42. Evasion is negatively related to uncertainty (MPS) in the piece-wise linear tax function case also, if $t_1<t_2$ (except possibly at the corners). The reason is the same.

Appendix 2. Corrupt Bureaucracies

2.1 Second differentials and sufficient conditions for a bargaining solution

$$L_{bb} = 2(1-p_o-2p_1b) - 2p_1\underline{F} = -2(1-p_o-2p_1b+p_1\underline{F}) < 0$$

$$L_{bw} = -[(1+P_o)(1-p_o-2p_1b) + (R_1+2w\ R_2)] = L_{wb} < 0$$

$$L_{ww} = -2(1+P_o)(R_1+2wR_2)+2R_2\underline{F} < 0$$

if $R_2 \leq 0$ <u>or</u> if $R_2 > 0$ and $R_1 > R_2[\underline{F}/(1+P_o)-2w]$

$$|L| = L_{bb}\ L_{ww} - L_{bw}\ L_{wb} = 4\underline{F}[p_1(1+P_o)(R_1+2wR_2) - R_2(1-p-2p_1b+p_1\underline{F})]$$

$$-[(1+P_o)(1-p_o-2p_1b) - (R_1+2wR_2)]^2 > 0$$

for a maxima.

$$L_{by} = (1-p_o-2p_1b)(1+P_o) + R_1+2R_2(\underline{w}+y_i)$$

$$L_{wy} = (1+P_o)[R_1+2R_2w) + R_1 + 2R_2(\underline{w}+y_i)]$$

If $L_w=0$ $\quad R_1+2R_2w = (1+P_o)(1-p_o-2p_1b)$ and the above differentials reduce to,

$$L_{by}= 2[R_1+2R_2w + R_2(y_i-w_i)]$$

$$L_{wy} = (1+P_o)\, L_{by}$$

$$L_{bw}=L_{wb} = -2(R_1+2wR_2) = -2(1+P_o)(1-p_o-2p_1b)$$

$$|L| = 4\underline{F}[(p_1(1+p_o)^2-R_2)(1-p_o-2p_1b) - p_1R_2\underline{F}] = 4\underline{F}V$$

2.2 Bribe Limit Case: Degenerate Solution

In the degenerate sub-case of the bribe limit solution, detected evasion is zero ($w_i=0$) and the bribe paid can be obtained from (6") of text as,

$$b_i[2(1-p_o-2p_1b)+p_1b_i] - y_i[R_1+(1+p_o)(1-p_o-2p_1b)] = 0 \quad \text{(A2.1)}$$

Recalling that $b=\underline{b}(i)+b_i$, treating $\underline{b}$ as exogeneous, and totally differentiating A2.1, we find that

$$\frac{\partial b_i}{\partial R_1} = \frac{y_i}{-L_{bb}} > 0 \qquad \text{where } L_{bb}= -2(1-p_o-2p_1b+p_1\underline{F}) < 0 \quad \text{(A2.2)}$$

$$\frac{\partial b_i}{\partial R_1} = \frac{2p_1 y_i}{-L_{bb}} > 0$$

$$\frac{\partial b_i}{\partial \underline{b}} = \frac{4p_1 b_1 - 2p_1(1+P_o)y_i}{-L_{bb}} \gtrless 0 \quad \text{as} \quad b_i \gtrless \frac{(1+P_o y_i}{2}$$

Let $b_i = \dfrac{(1+P_o)y_i}{2} + v_i$. Therefore $b = \dfrac{(1+P_o)y}{2} + v$

where $y = \sum_i y_i$, $v = \sum_i v_i$.

Substituting these in A2.1 and simplifying, we have

$$p_1\frac{(1+P_o)^2 y_i}{4} = R_1 - v_i[p_1 v_i^2 + 2(1-p_o-2p_1 b)\ v_i + p_1(1+P_o)]$$

Let $y^* = \dfrac{4\ R_1}{P_1(1+P_o)^2}$

Then $y_i \gtrless y^*$ implies $\dfrac{\partial b_i}{\partial \underline{b}} \lesseqgtr 0$

If $y_i \leq y^*$ for all i, and b_i must be positively related to $\underline{b}(i)$. This will ensure that equilibrium is unique. Therefore $y_i \leq y^*$ is a sufficient condition for a unique equilibrium. If $y_i > y^*$ for some i, this does not rule out a unique equilibrium, but could result in paradoxical effects on large evaders. Thus a rise in marginal rewards (R_1) to tax collectors in the penalties (P_o) on tax evaders could result in lower bribe costs, and possibly higher evasion. This result is similar to the linear case in the weak society.

Strictly the effect of exogenous changes depends not on the effect on bribe cost, but on the marginal bribe cost. Returning therefore to the partial equilibrium with $\underline{b}(i)$ assumed exogenous we have the marginal cost of evasion detected,

$$MC_d = \frac{\partial b_i}{\partial y_i} = \frac{R_1 + (1+P_o)(1-p_o-2p_1 b)}{-L_{bb}} > 0$$

For expositional simplicity let $-L_{bb} = 2m$ and $R_1 + (1+P_o)(1-p_o-2p_1 b) = n$.

$$\text{Then } \frac{\partial MC_d}{\partial R_1} = \frac{1}{2m}\left[1 - \frac{2p_1 m(1+P_o) - 6p_1 n}{m}\frac{\partial b_i}{\partial R_1}\right]$$

On substituting from equation A2.2 and simplifying, we have

$$\frac{\partial MC_d}{\partial R_1} = \frac{1}{2m}[1 + \frac{p_1 y_i}{m^2}[3R_1 + (1+P_o)[2(1-p_o-2p_1 b)-p_1 b_i+p_1(1+P_o)y]]$$

$$> 0 \text{ as } (1-p_o-2p_1 b) + \frac{p_1}{2}[(1+P_o)y_i - b_i] > 0 \qquad (\text{see } I_{bb})$$

Similarly we find that,

$$\frac{\partial MC_d}{\partial(1+p_o}\gtrless 0 .$$

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