

Tax Evasion, Corruption, and the Remuneration of Heterogeneous Inspectors

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Abstract

In an economy where corruption is pervasive, how should tax inspectors be compensated? The optimal compensation scheme must take into account the strategic interaction between taxpayers and tax inspectors. Pure “tax farming” (paying tax inspectors a share of their tax collections) is optimal only when all tax inspectors are corruptible. When there are both honest and corruptible inspectors, the optimal compensation scheme lies between pure tax farming and a pure wage scheme. Paradoxically, when inspectors are hired beforehand, it may be optimal to offer contracts that attract corruptible inspectors but not the honest ones.

Key words: Tax evasion, Corruption, Signaling game

JEL classification: H26, K42

1 Introduction

The treatment of tax evasion in the tax compliance literature dates back at least to the classic paper of Allingham and Sandmo (1972). The tax administration needs to design an audit strategy in order to deter or reduce evasion. Audits that allow to disclose true, as opposed to reported, incomes are then carried out by agents whose objectives are assumed to be in line with the goals of the tax administration. This however overlooks the role of utility-maximizing agents, whose objectives may conflict with that of the administration. Such agents can and may side-contract with citizens to evade tax payments. In fact, in a hierarchical structure where a principal delegates a task to an agent along with some discretion over certain decisions, there is much room for collusion.

One of the first attempts to formalize collusion in a hierarchy using the principal-agent framework can be found in Tirole (1986). Since then, a large corruption and tax administration literature has emerged. Chander and Wilde (1992) generalize the tax evasion paper of Graetz et al. (1986) by taking into account the possibility of collusion between a tax evader and an official auditor whose cost of dishonesty is (relatively) low. In their a two-class economy only high-income individuals have the possibility to evade. It all begins when taxpayers send required income reports to the tax agency, which opens the door to strategic transmission of information. Chander and Wilde (1992), however, do not address the problem of optimal remuneration of the inspectors. This problem is dealt with by Besley and McLaren (1993), Hindriks et al. (1999), and Mookherjee and Png (1995) in different contexts.

Besley and McLaren (1993) compare three distinct remuneration schemes, that provide different incentives to the inspectors. They characterize the conditions under which each scheme generates the greatest amount of tax revenues net of administration costs. They consider in a simple model the existence of honest as well as dishonest inspectors and taxpayers. The presence of different types of auditors introduces an adverse selection dimension. However, even though

monitoring is costly, there is no moral hazard problem since it is the principal that monitors and exerts costly effort to disclose corruption. Hindriks et al. (1999) consider a model where all the actors are dishonest. They however allow for general remuneration schemes and more importantly for extortion. Finally, Mookherjee and Png's (1995) paper, to which this one is closely related, also considers only corruptible agents but they remove the exogenous matching of the auditor and the evader (polluter in their case) often assumed in the literature. They consider a moral hazard problem since for evasion to be disclosed the inspector has to exert a costly nonobservable effort.

Our model distinguishes itself from the models cited above in several respects. Like Chander and Wilde (1992), we consider the existence of strategic information transmission, but use a more general model with a continuum of possible incomes. In most of the literature on corruption, the bribe the evader pays the inspector is the solution of a Nash bargain and the parties agree to report the income that maximizes their joint profit. In contrast to the literature, in this model, the tax evader chooses unilaterally the amount to evade. Therefore, the report may be different from the one that maximizes the joint expected profit. We also allow for both moral hazard as in Mookherjee and Png and adverse selection as in Besley and McLaren. General remuneration schemes ranging from pure tax-farming to pure wage systems are also allowed. Finally, corruption is considered to be structural, i.e., given a weak judiciary system and mild punishments for corruption or evasion, collusion is always beneficial. This assumption fits well with the situation in many developing countries. This paper investigates the remuneration contract that maximizes the tax receipts of the administration in an environment with structural corruption. The tax and penalty systems are set up by the social planner, while the tax administration has total discretion over the form of the contracts it proposes to its employees.

The remainder of the paper is as follows. The next section describes the different actors of the model. Section 2.1 models the relationship between the auditors and the taxpayers as a signaling game. Section 3 solves the model, first in the case where all inspectors are identical and second when they differ. Section 4 considers the implications of different extensions of the model. Section

5 concludes.

2 The general setting

Consider an economy with a continuum of taxpayers endowed with exogenous incomes on which taxes must be paid. The distribution of income in the economy is common knowledge and denoted $f(\theta)$ on the support $\Theta = [\underline{\theta}, \bar{\theta}]$; however, a particular taxpayer's income is private information and can be observed only through costly audits. Therefore, taxpayers may misreport their income. Tax compliance is enforced by the tax agency, the fund-raising arm of the government, which is composed of tax inspectors (or auditors) that review the taxpayers' reports. An auditor is assigned the task of detecting attempted fraud and denouncing the evaders in exchange for remuneration determined by the tax agency. In order to discover cheaters, the auditors need to exert a costly nonobservable effort. Moreover, some may pursue their own agenda and be prone to bribery. Subsequent to a side-contract between a taxpayer and an inspector, an additional audit can take place with a given exogenous probability. This audit will reveal the true income of the taxpayer and whether corruption occurred or not, with the agents fined accordingly. The taxpayers and inspectors are risk-neutral and the tax agency aims at maximizing its revenue. Let us now provide a more formal description of the different actors of the economy and their interactions.

The government, as a passive actor, determines the environment in which the tax agency, taxpayers, and inspectors evolve. This environment consists of the tax and penalty system given by the following triplet $\langle T, \phi_a, \phi_t \rangle$, where T is the tax function and $T(\theta)$ represents the amount of tax an individual who reports an income θ and has not been proven to earn another income will have to pay; ϕ_i for $i = a, t$ represent the fine functions where a stands for auditor and t for taxpayer. Therefore, $\phi_t(\theta, m)$ is the fine a tax evader with income θ reporting m must pay in addition to the full tax liability, and $\phi_a(\theta, m)$ is the fine owed by the inspector that shielded the evader in exchange for a bribe. The functions display the following properties for $i = a, t$:

- (i) $T(\theta) < \theta$ and $T'(\theta) \geq 0$, (ii) $\phi_i(\theta, m) \geq 0$ for all m, θ , (iii) $\phi_i(\theta, m)$ is non-decreasing in θ ,
(iv) $\phi_i(\theta, m)$ is non-increasing in m , (v) $\phi_i(\theta, \theta) = 0$.

Condition (i) states that tax liabilities cannot exceed income and are nondecreasing with it. From condition (ii), over- and under-reporting are both sanctioned, conditions (iii) and (iv) ensure that the fines increase as the distance between true and reported incomes widens. Finally, condition (v) rules out rewards for truthful reports.

The tax agency has complete discretion over the remuneration scheme of the auditors. The payment to inspectors is fully determined by the couple (w, η) where $w \in \mathbb{R}$ is a fixed wage paid for every file reviewed and $\eta \in [0, 1]$ is a commission rate on a specific file. The tax agency pays therefore a salary of $w + \eta T(\theta)$ to an inspector that audits a report of θ . The tax agency's objective is to maximize revenue and it is aware of the possibility for evasion and corruption. All the reports confirmed by the auditors are verified again with an exogenous probability λ (determined out of the model) and true income is then perfectly assessed. If true income as revealed by the audit is different from the reported and confirmed income, it is possible to distinguish cases of pure evasion from those where corruption also took place, i.e., the auditor can prove that no bribery occurred and that shirking is the reason for not discovering the true income of the taxpayer.

Each taxpayer has an exogenous income $\theta \in \Theta$ which is private information and is sometimes referred to as the taxpayer's type. The taxpayer sends an income report to the tax agency and aims at maximizing the expected payoff such a report implies. A strategy for a taxpayer is a function

$$s : \Theta \longrightarrow M$$

where $m = s(\theta)$ is the report a taxpayer sends if θ is the true income. In choosing this strategy, the taxpayer also takes into account a possible visit of an inspector who may be either corruptible or honest. Such a taxpayer evades the amount $u(\theta, m) = T(\theta) - T(m)$.

The auditor is offered a remuneration contract by the tax agency for the collection of taxes.

The contract is accepted or rejected by the auditor if its expected payoff is lower than what can be obtained elsewhere, i.e., on the reservation utility. It is assumed that the inspector is hired from a large pool of people, and that an exogenous proportion, β , of the individuals composing the pool is prone to corruption. Because it is impossible to distinguish a corruptible from an honest inspector, there is an adverse selection problem. Moreover, because an auditor spends costly and unobservable effort to investigate a report in order to discover hard evidence of evasion, there is also a moral hazard problem. A strategy for the auditors is a function

$$e^i : M \longrightarrow I = [0, 1] \text{ for } i = h, d$$

where $e^i(m)$ is the level of effort the auditor devotes to a file reporting an income m , where h stands for honest and d for dishonest. The effort level is normalized to represent the probability of discovering the true income of the taxpayer. There is a disutility of effort $\psi(e^i)$ in monetary terms. It is assumed that $\psi' \geq 0$, $\psi'' \leq 0$, and $\psi(0) = \psi'(0) = 0$. From the meeting of a corruptible inspector and an evader, corruption can emerge, the evader paying a bribe to the inspector who in turn confirms the false report.

The timing of the game is the following:

1. A move by nature determines the couple (β, λ) .
2. The government announces the tax function $T(\theta)$, and the fine functions $\phi_i(\theta, m)$ for $i = a, t$;
3. The tax agency then announces the remuneration scheme (w, η) .
4. Each taxpayer sends an income report to the tax agency.
5. A corruptible or honest auditor verifies the report where income m is declared, forms some beliefs about the true type of the taxpayer, and devotes an effort $e^i(m)$ to the file, for $i = h, d$.
6. The auditor and the taxpayer meet and one of the following states of nature materializes
 - the auditor fails to discover the taxpayer's true type and confirms the report;

- the agent discovers the taxpayer's true income θ , negotiates a bribe $b(\theta, m)$ and confirms the report;
 - the agent discovers the taxpayer's true income and announces it to the tax agency.
7. For all the confirmed reports, a move by nature determines whether or not the file will be audited (with probability λ).

2.1 The auditor-taxpayer problem

The relationship between the taxpayer and the auditor concerns stages 4 to 6 of the above timing. Involving two players, one moving first by sending a message that conditions the second player's action, this game belongs to the class of signaling games. The taxpayer (sender) sends a message (the report) to the auditor (the receiver) whose strategy (the intensity of audit) depends on this information. Thus, there exists strategic information transmission.

2.1.1 The signaling game

The signaling sub-game between the taxpayer and the inspector occurs if and only if the inspector has accepted the remuneration contract.¹ It can be represented by the following game tree:

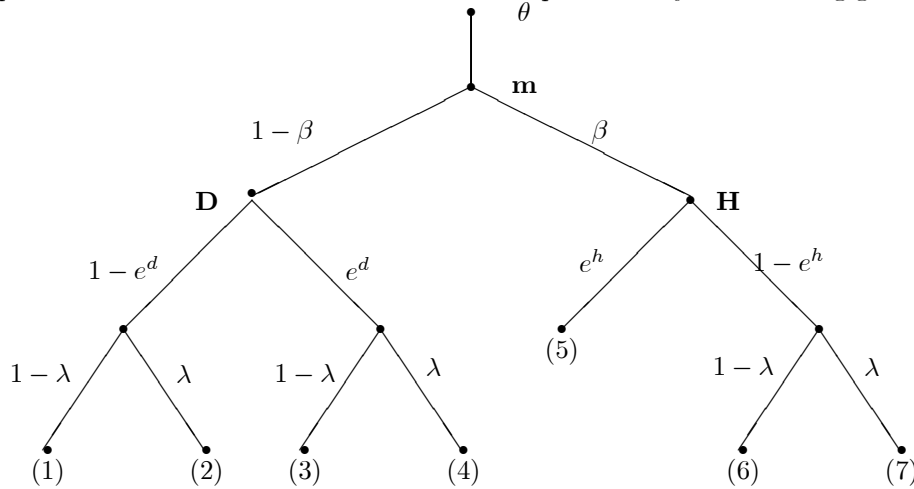


Fig. 1: Game tree for a dishonest taxpayer

¹ Note also this is only *one* of many files the inspector has to audit. Hence, the inspector plays several games, one for each file. It is assumed that these games and the payoffs they imply are independent.

The taxpayer's payoff function is denoted by $U(\theta, m, e^h, e^d)$ and that of the auditor, for a given remuneration contract, by $V^i(\theta, m, e^i; w, \eta)$ for $i = h, d$. The concept of sequential equilibrium introduced by Kreps and Wilson (1982) will be used in this paper. Attention will be focused on the pure strategies sequential equilibria, leaving aside the possibility for the players to randomize among different actions. A sequential equilibrium in our model is given by a reporting strategy $s^*(\cdot)$ for the taxpayers that is optimal with respect to the auditors' strategies $e^{h*}(\cdot)$, $e^{d*}(\cdot)$ that in turn are optimal to each other and with respect to the taxpayers' strategy, given the beliefs $\mu^{h*}(\cdot)$, $\mu^{d*}(\cdot)$ the auditors hold about the taxpayer's true income. Let us denote by $\Omega(\Theta)$ the set of all probability distributions over Θ . The belief function is $\mu^i : M \mapsto \Omega(\Theta)$, where $\mu^i(\theta|m)$ is the posterior probability, derived from a bayesian updating process, that the report m has been sent by a taxpayer whose income is θ . For $m \in M$ and $\mu^i \in \Omega(\Theta)$, let $BR^i(m, \mu^i)$ be the set of pure best responses of the i -auditor to the message m given the beliefs μ^i , i.e.,

$$BR^i(m, \mu^i) \equiv \text{Arg max}_{e^i \in I} \int_{\Theta} V^i(\theta, m, e^i; w, \eta) \mu^i(\theta|m) d\theta \quad \text{for } i = h, d$$

Definition 1 *An auditing equilibrium for the signaling sub-game is a set of strategies s^* for the taxpayers, e^{h*} and e^{d*} for the auditors and beliefs μ^* such that:*

- (i) $\forall \theta \in \Theta, s^*(\theta) \in \text{Arg max}_{m \in M} U(\theta, m, e^{h*}(m), e^{d*}(m))$;
- (ii) $\forall m \in M, e^{i*}(m) \in BR^i(m, \mu^*)$, for $i = h, d$;
- (iii) $\forall m \in M, \forall \theta \in \Theta, \mu^*(\theta|m) = f(\theta) / \int_{r \in s^{-1}(m)} f(r) dr$, if the denominator is > 0 and any distribution otherwise.

Condition (i) states that taxpayers choose reports that maximize their expected payoff given the audit strategy of the inspectors. Condition (ii) implies that the auditors' strategies are best to that of the taxpayers given the beliefs they hold. It also implies a consistency requirement that both honest and dishonest auditors have the same beliefs in and out of equilibrium. Condition (iii) gives the beliefs of the auditors about the type of the taxpayers based on their reports. The effort levels exerted by h - and d -auditors are indirectly linked through the strategy of the taxpayers, which depends on both efforts. It remains now to make explicit the payoffs of the different players. We assume all are risk neutral and thus want to maximize disposable income.

The honest auditors refuse all bribery by definition. One can imagine that the cost they bear from the stigma of being caught in corruption is infinite; the value of their integrity is priceless. Their expected payoff from auditing a report of m emanating from a θ -taxpayer is

$$V^h(\theta, m, e^h; w, \eta) = w + \eta T(m) + \eta e^h(m) \mathbb{E}_\mu[u(\theta, m)] - \psi(e^h(m)), \quad (1)$$

which is the sum of the salary paid for a report m and the extra profit that accrues when the auditing effort allows for discovering and denouncing the evader minus the cost of the effort.

The corruptible auditors, on the contrary, are motivated solely by bribery whenever it is profitable. They incur no cost from the stigma of being caught. However, whenever an evader offers them a bribe $b(\theta, m)$, they can be audited and fined afterwards. The expected payoff of the dishonest auditors is therefore given by

$$V^d(\theta, m, e^d; w, \eta) = w + \eta T(m) + e^d(m) \mathbb{E}_\mu[b(\theta, m) - \lambda \phi_a(\theta, m)] - \psi(e^d(m)). \quad (2)$$

Their payoff has the same structure as that of the honest auditors except that the reward they get from auditing equals the bribe minus the expected value of the fine.

To compute the expected utility of a dishonest θ -taxpayer who reports m , we need to consider the game tree given in figure 1. The payoff at each final node is as follows: (1) = (6) = $T(m)$, (2) = (5) = (7) = $T(\theta) + \phi_t(\theta, m)$, (3) = $T(m) + b(\theta, m)$ and finally (4) = $T(\theta) + \phi_t(\theta, m) + b(\theta, m)$. Taking the expectation of the different payoffs gives the expected utility

$$\begin{aligned} U(\theta, m; e^h, e^d) &= \theta - T(\theta) + u(\theta, m) \\ &\quad - [\lambda + \beta(1 - \lambda)e^h(m)](u(\theta, m) + \phi_t(\theta, m)) - (1 - \beta)e^d(m)b(\theta, m). \end{aligned} \quad (3)$$

With respect to a truthful report, there is an expected premium from cheating that is given by the last three terms. The first one is the evaded amount saved for sure and enters the premium with a positive sign; the last two terms constitute the expected disbursement the taxpayer will suffer, depending on whether the audit is carried out by a corruptible or honest auditor and the

subsequent audit, and have a negative sign. A taxpayer's evasion decision depends on the sign of this premium. Evasion occurs if and only if it is positive.

An important property of the signaling game played by taxpayers and auditors is monotonicity. Monotonic signaling games constitute an important class of games since many refinements are equivalent, i.e., lead to the same selection of equilibria, in this class as shown by Cho and Sobel (1990). In a monotonic signaling game, all the senders have the same preferences over the set of pure best responses of the receivers. In this game, monotonicity must be considered with respect to both types of auditors. The game is clearly monotonic since all taxpayers prefer lower probabilities of audit from the honest (resp. dishonest) auditors that of the dishonest (resp. honest) ones being fixed. Formally, $U(\theta, m; e^i, e^j) > U(\theta, m; e^{i'}, e^j)$ for all $\theta \in \Theta$ and $m \in M$, for $e^i < e^{i'}$, and e^j fixed, for $i, j = h, d$ and $i \neq j$.

2.1.2 The bribery

In the above signaling game, bribery arises only when a dishonest auditor exerts sufficient effort to find evidence of evasion. The above model differs from earlier contributions in corruption because the taxpayer is sovereign over the report to send. The auditor can only confirm the report or denounce the evader. Therefore, if the auditor accepts a bribe, the report is not forcefully maximizing the joint expected surplus of the players as is usual in the literature. This also rules out the possibility of extortion considered by Hindricks et al. (1999). Suppose a θ -taxpayer who reported m has been discovered by a corruptible auditor. Under which conditions will bribery emerge, and what is the price to pay for the auditor to confirm the report? This price is negotiated by the parties, which are assumed to have identical bargaining powers and adopt the Nash solution. The threat point is denouncement in which case the taxpayer pays $T(\theta) + \phi_t(\theta, m)$ and the auditor receives $w + \eta T(\theta) - \psi(e(m))$. If the players agree on corruption, the taxpayer pays b to the auditor who confirms the report, but with a probability λ they are again caught and this time fined. The taxpayer's expected payment is therefore $(1 - \lambda)T(m) + b + \lambda[T(\theta) + \phi_t(m, \theta)]$ while the auditor

expects to receive $w + \eta T(m) + b - \lambda \phi_a(\theta, m) - \psi(e(m))$. By an obvious computation the expected gains from corruption are obtained as the difference between the agreement and the disagreement payoffs. The expected gain of the taxpayer is:

$$P_t^e(\theta, m, b) = (1 - \lambda)[u(\theta, m) + \phi_t(\theta, m)] - b$$

and that of the auditor:

$$P_a^e(\theta, m, b) = b - \lambda \phi_a(\theta, m) - \eta u(\theta, m).$$

A bribe will be paid if and only if both players gain from it, i.e., the price is not too high for the taxpayer and not too low for the auditor. A necessary condition for bribery is thus:

$$(1 - \lambda)[u(\theta, m) + \phi_t(\theta, m)] > \lambda \phi_a(\theta, m) + \eta u(\theta, m). \quad (4)$$

Throughout the paper, this condition is assumed to hold because the institutional setting is working so poorly that agents always find it profitable to engage in bribery. So the joint expected profit from corruption is

$$P_{a,t}^e = (1 - \lambda)[u(\theta, m) + \phi_t(\theta, m)] - \lambda \phi_a(\theta, m) - \eta u(\theta, m). \quad (5)$$

Note that the bribe does not appear in the formula because it merely redistributes profit and does not affect its value. Moreover, this value is fixed ex ante by (the choice of) the taxpayer and the inspector cannot influence it, or at least influences it only indirectly through the auditing strategy. This is in contrast to most of the literature, which often assumes that the parties jointly decide on the report that maximizes their joint expected profit. The discretion of the taxpayer over the report enables her by the same token to set the amount of the bribe once the rules of the game are fixed. As already noted, the bribe is bargained à la Nash and since the bargaining powers are equal, the expected gains from bribery are equalized. This gives a bribe equal to

$$b(\theta, m) = \frac{1}{2} [(1 - \lambda + \eta)u(\theta, m) + (1 - \lambda)\phi_t(\theta, m) + \lambda \phi_a(\theta, m)]. \quad (6)$$

For θ (resp. m) fixed, the bribe decreases (resp. increases) with m (resp. θ). As long as bribery is profitable, strengthening the repression by for instance increasing the fine functions or raising

the salary of the inspector through the variable component η , increases the price of the auditor's silence. Intuitively, increasing ϕ_t increases the cost the taxpayer would support if denounced; increasing ϕ_a or η makes corruption costlier for the auditor. A higher probability of detection however decreases the bribe. Therefore, increasing ϕ_a and η while lowering ϕ_t until (4) is violated is the way to stop corruption. This operation however does not forcefully guarantee a reduction in evasion. Indeed, the dishonest taxpayers may still find it rewarding to understate their income even if they are certainly punished whenever caught.

2.2 The tax agency problem

The preceding section analyzed the game played by taxpayers and inspectors assuming the latter accepted the proposed remuneration contract. Since the tax agency offers a take-it or leave-it contract to the auditors, the contract is accepted if its expected payoff is greater than the outside opportunity, denoted \bar{V}^i for $i = h, d$, of the auditors. Each auditor will have a large number of reports, randomly chosen, to audit. The expected payoff from the contract is therefore given by:

$$V_e^i(w, \eta) = \int_{\Theta} V^i(\theta, s(\theta), e^i(s(\theta)); w, \eta) f(\theta) d\theta, \quad \text{for } i = h, d. \quad (7)$$

Once inspectors accept the contract, the tax agency expects to collect the following amount from a θ -taxpayer reporting m

$$\begin{aligned} \mathcal{R}(w, \eta; \theta, m, e^d(m), e^h(m)) &= (1 - \eta)T(m) - w + \lambda(1 - \beta)e^d(m)\phi_a(\theta, m) \\ &\quad + [\lambda + \beta(1 - \lambda)e^h(m)](u(\theta, m) + \phi_t(\theta, m)) - \beta\eta e^h(m)u(\theta, m). \end{aligned}$$

This revenue reflects the fact that the tax agency does not know whether the report will be audited by a corruptible or honest inspector. The revenue is determined at equilibrium and depends on the strategies adopted by the players. To compute the total expected revenue at equilibrium it suffices to integrate over the whole population

$$\mathcal{R}(w, \eta) = \int_{\Theta} \mathcal{R}(w, \eta; \theta, s(\theta), e^d(s(\theta)), e^h(s(\theta))) f(\theta) d\theta. \quad (8)$$

The tax agency solves the following program:

$$\text{Maximize}_{w,\eta} \mathcal{R}(w,\eta) \text{ subject to } V_e^h(w,\eta) \geq \bar{V}^h \text{ and } V_e^d(w,\eta) \geq \bar{V}^d, \quad (9)$$

to obtain the remuneration contract that maximizes total revenue under the ex ante participation constraints of the auditors.

3 Equilibrium analysis

The preceding section described the different actors of the economy and the way they interact. This section determines of the equilibrium outcome of the overall game by backward induction. First, the equilibrium of the signaling game is derived under the assumption that the auditors have accepted the contract offered by the tax agency. Afterwards, the optimal remuneration contract, solution of the program (9), is computed. If both types of auditors accept the contract, a first general result that holds true in this setting is the following:

Proposition 1 *At equilibrium, for any report, the corruptible auditors exert a higher effort than the honest ones, i.e. $e^{d^*}(m) > e^{h^*}(m) \ \forall m \in M$.*

Proof: From (4) and (6) it is immediate that $b(\theta, m) - \lambda\phi_a(\theta, m) > \eta u(\theta, m)$. Upon observing the report m , the first order condition of the corruptible (resp. honest) auditors optimization program is $\mathbb{E}_{\mu^*}(b(\theta, m) - \lambda\phi_a(\theta, m)) = \psi'(e^{d^*}(m))$ (resp. $\eta \mathbb{E}_{\mu^*}(u(\theta, m)) = \psi'(e^{h^*}(m))$). For the equilibrium to fulfill the consistency requirement, both types of auditors must hold the same beliefs μ^* . Therefore, $\psi'(e^{d^*}(m)) > \psi'(e^{h^*}(m))$; the result follows directly since $\psi(\cdot)$ is a convex function. ■

This result is quite intuitive. Indeed, in determining the optimal level of effort, the auditors equate the marginal cost of effort to its expected marginal benefit. Since corruption is always beneficial, the expected marginal benefit is always higher for the dishonest auditors. Therefore, the corruptible auditors who foresee the possibility of extra illegitimate profit work harder to obtain it.

The characterization of the equilibria would constitute a formidable task in such a general specification. To get further insight on what's going on, more restrictions need to be added. Following most of the literature and consistent with existing penalty systems, the fine functions are restricted to multiplicative functions of the evaded amount, i.e., $\phi_i(\theta, m) = \phi_i u(\theta, m)$, with $\phi_i > 0$, for $i = a, t$. The bribe the evaders have to pay and their expected payoff are then:

$$b(\theta, m) = \frac{1}{2}((1 - \lambda)(1 + \phi_t) + \lambda\phi_a + \eta)u(\theta, m) = \alpha u(\theta, m),$$

and

$$\begin{aligned} U(\theta, m; e^h, e^d) &= \theta - T(\theta) + \{1 - (1 + \phi_t)(\lambda + \beta_a(1 - \lambda)e^h(m)) - \alpha(1 - \beta_a)e^d(m)\}u(\theta, m) \\ &= \theta - T(\theta) + \gamma(m)u(\theta, m). \end{aligned}$$

At equilibrium, each individual is maximizing the premium from cheating given the auditors' strategy. Thus, no taxpayer must gain by choosing the report of another type. This is the incentive compatibility constraint found in the literature of games with asymmetric information. The incentive compatibility approach to signaling games can be found in Mailath (1987) or Banks (1990). One thus obtains the following condition:

$$\gamma(s(\theta)) \cdot u(\theta, s(\theta)) \geq \gamma(s(\theta')) \cdot u(\theta, s(\theta')) \quad \forall \theta, \theta' \in \Theta. \quad (10)$$

At equilibrium, if a θ -type chooses the action of a θ' -type, the receiver does not perceive it as a deviation, but instead only assigns the type θ' to the sender. A direct implication of condition (10) above is the following proposition (see the appendix for the proof)

Proposition 2 *At any equilibrium, the taxpayers' strategy is monotone increasing, i.e., $\forall \theta, \theta' \in \Theta, \theta < \theta'$ implies $s(\theta) \leq s(\theta')$.*

This proposition merely states that richer taxpayers will report higher incomes. The main difficulty with signaling games is the multiplicity of equilibria, which dramatically reduces the predictive power of the models and thus their usefulness. The plethora of equilibria is typical in signaling games. This is because the concept of sequential equilibrium places almost no restrictions

on the beliefs of the auditors for reports that must not be observed at a given equilibrium, i.e., out-of-equilibrium reports. The beliefs at such messages can take any conceivable form, and auditors can have some unreasonable beliefs which will generate an infinity of equilibrium outcomes. Many refinements that restrict the out-of-equilibrium beliefs to become reasonable, justifiable or appropriate have been proposed in the literature in order to restore the predictive power of the signaling models. The best known are the Never a Weak Best Response by Kohlberg and Mertens (1986), the Intuitive Criterion by Cho and Kreps (1987) and the Universal Divinity (UD) concept by Banks and Sobel (1987). This latter will be used in this paper, but the three criteria have been shown to be equivalent in the type of game dealt with here, i.e., monotonic games, by Cho and Sobel (1990). UD requires that for every out-of-equilibrium report auditors single out the evader that is the “most” likely to defect from the equilibrium and put a probability one on such a taxpayer. Fixing $s(\cdot)$, $e^h(\cdot)$ and $e^d(\cdot)$ auditors and taxpayers’ strategies in a sequential equilibrium, let us note by $\kappa(\theta, p | s, e^h, e^d)$ the expected retained proportion of the evaded amount that makes the θ -taxpayers indifferent between reporting their equilibrium report $m = s(\theta)$ getting their expected equilibrium payoff, and making the out-of-equilibrium announcement p :

$$\kappa(\theta, p) \cdot u(\theta, p) = \gamma(m) \cdot u(\theta, m). \quad (11)$$

Suppose the auditors adopt new strategies $e^{d'}(\cdot)$ and $e^{h'}(\cdot)$ such that $\gamma'(p) > \kappa(\theta, p)$, then the taxpayer prefers to defect from the equilibrium by reporting p . For any equilibrium θ is said to be more likely to defect to p than θ' if $\kappa(\theta, p) < \kappa(\theta', p)$.

Definition 2 *A universally divine equilibrium in our game is a sequential equilibrium in which for any out-of-equilibrium report p , $\mu(\theta | p) > 0$ only if*

$$\theta \in \text{Arg min}_{\theta'} \kappa(\theta', p | s(\cdot), e^h(\cdot), e^d(\cdot)).$$

A zero probability is put on any type of evader breaking the equilibrium as long as there exists another one who gains more by defecting from the supposed equilibrium. It is important to note that the type most likely to defect can be singled out because we have multiplicative fine functions. The taxpayers then act as if they had in front of them an “average” auditor, where the weights

are the expected proportion of the evaded amount lost upon a successful audit by the tax agency, an honest auditor or a corruptible auditor.

According to proposition 2, the reporting strategies are increasing monotonically in any equilibrium. Any discontinuity in the strategies is thus a jump discontinuity and there is a countable number of them since the strategies must also be almost everywhere differentiable. One can thus expect to have pooling, separating or hybrid equilibria. However, the following proposition ensures that requiring the equilibrium to be universally divine, only separating equilibria, where the type of the taxpayer is revealed, survive.

Proposition 3 *In the signaling game played by the taxpayers and the auditors, only separating equilibria meet the universal divinity requirement.*

The proof of this proposition is in the appendix. The same type of result is found in Hindriks (1996) and Reinganum and Wilde (1986b).

3.1 The benchmark cases

Before turning to the analysis of the general game, it is useful to study the situation in which the auditors are all honest ($\beta = 1$) or all dishonest ($\beta = 0$). While the moral hazard problem is still relevant, there is no adverse selection in these cases since all the auditors are alike. Both the equilibrium of the auditors/taxpayers signaling game and the optimal remuneration scheme are characterized. It is assumed for the time being that $\bar{V}^h = \bar{V}^d = 0$, i.e., all auditors have the same reservation utility normalized at zero for the sake of simplicity.

3.1.1 Only honest auditors

Suppose first that all the auditors are honest ($\beta = 1$), i.e., whenever they discover a cheater, the latter is denounced. The expected payoff of an auditor who reviews a file with report m is given by (1) to be maximized by $e^{h*}(m)$, while a θ -taxpayer chooses to report $m = s^*(\theta)$ if it maximizes the expected gain from misreporting

$$[1 - (1 + \phi_t)(\lambda + (1 - \lambda)e^h(m))]u(\theta, m).$$

It is straightforward to compute the first-order conditions of the different players and derive an equilibrium that resembles that of Reinganum and Wilde (1986a), where the audit probability is a decreasing function of the report which is increasing in true income. However, since another important purpose of the paper is to determine the optimal remuneration scheme, focus will be placed on simple equilibria, as the one derived by Hindricks (1996), characterized by constant audit effort and evasion levels. Suppose the auditors decide to investigate each report with an intensity $e^{h*}(m) \equiv \frac{1-\lambda(1+\phi_t)}{(1-\lambda)(1+\phi_t)} \quad \forall m \in M$ for all signals. This makes the taxpayers indifferent with respect to the report since their expected gain from cheating is constant and equals zero. To obtain an equilibrium, it is assumed that the taxpayers adopt the strategy that is consistent with that of the auditors. The latter's expected payoff is maximized at e^{h*} if the first order condition $\psi'(e^{h*}) = \eta \mathbb{E}_\mu(u(\theta, m))$ holds. Since the equilibrium is separating, the beliefs are point beliefs and for this condition to hold whatever the report, the evaded amount must be constant. Denoting this amount by u^{h*} , we must have $u^{h*} = \psi'(e^{h*})/\eta$. It will be shown that this equilibrium is universally divine and can be sustained by appropriate beliefs.

In this simple equilibrium, the auditors' strategy is insensitive to both the remuneration scheme and the penalty they face. The commission rate η affects only the evasion decision, higher values implying less evasion. From a report m , the inspectors in charge of such a file expect a payoff of $w + \eta T(m) + \eta e^{h*} u^{h*} - \psi(e^{h*})$. The overall expected payoff from the contract (w, η) is given by

$$\mathbf{V}_e^{h*} = w + \eta \mathbf{T} - (1 - e^{h*}) \eta u^{h*} - \psi(e^{h*}),$$

while the tax agency expects to collect an amount of tax cum fines of

$$\mathcal{R}^{h*} = (1 - \eta) \mathbf{T} - w - ((1 - \lambda)(1 + \phi_t) - \eta)(1 - e^*) u^* + \phi_t u^*$$

where $\mathbf{T} = \int_{\Theta} T(\theta) f(\theta) d\theta$ is the average true tax liability. What type of contract will the agency propose to the auditors in order to maximize the collected amount? It is useful to rewrite the tax agency revenue as a function of the auditors' effort and utility, the following way

$$\mathcal{R}^{h*} = \mathbf{T} - \psi(e^{h*}) - \mathbf{V}_e^{h*}.$$

This expression makes clear that both the effort exerted by the auditors and the utility they derive from a given contract are wasteful for the agency. A straightforward consequence is that no rent should be left to the employees, and the tax agency must propose a contract that will make the participation constraint binding. For any $1 \geq \eta > 0$, it suffices to propose $w^{h*}(\eta)$ such that $\mathbf{V}_e^{h*} \equiv 0$. A straightforward computation gives:

$$w^{h*}(\eta) = \int_0^{e^{h*}} (1-e)\psi''(e)de - \eta\mathbf{T}. \quad (12)$$

It may well be that $w^h(\eta) < 0$, meaning that the inspectors must pay for the right to collect taxes. The optimal fixed wage to be paid depends on the commission rate only through the size of the tax base. The higher the tax base the lower the wage. The tax agency always collects $\mathcal{R}^{h*} = \mathbf{T} - \psi(e^{h*})$, the sole leakage with respect to the no-evasion case is the transfer that has to be given to the auditors to compensate them for the disutility of effort.

3.1.2 Only dishonest auditors

Suppose now that $\beta = 0$, i.e., all the auditors are prone to corruption whenever it is financially beneficial. The focus will again be on simple equilibria. For the taxpayers to be indifferent about the report they make the probability of an audit must be $e^{d*}(m) \equiv (1 - \lambda(1 + \phi_t))/\alpha \quad \forall m \in M$.² Unlike the honest auditors, the corruptible ones choose their effort level depending on the remuneration scheme and the penalty system. The auditing effort is decreasing with both the commission and the penalty rates, i.e., $\partial e^{d*}/\partial \eta < 0$ and $\partial e^{d*}/\partial \phi_a < 0$. For this strategy to be an equilibrium strategy, the taxpayers must all evade the same amount $u^{d*} = \psi'(e^{d*})/(\alpha - \lambda\phi_a)$. Since corruption is profitable, it always takes place when an audit provides compelling evidence

² Recall that the audit effort is also a probability, so to keep things within bounds, some restrictions need to be added. It is easy to see that the condition we need for $0 \leq e^{d*} \leq 1$ is

$$\frac{1 - \eta - \lambda(1 + \phi_a)}{1 + \lambda} \leq \phi_t \leq \frac{1 - \lambda}{\lambda}.$$

One can plot in the space (ϕ_a, ϕ_t) the set in which that condition is satisfied. The remainder of the paper assumes that the punishment rates belong to this set, denoted \mathcal{P} .

of evasion. The overall expected payoff of an auditor from a contract (w, η) is then

$$\mathbf{V}_e^{d*} = w + \eta \mathbf{T} - (\eta - (\alpha - \lambda \phi_a) e^{d*}) u^{d*} - \psi(e^{d*}),$$

while the tax agency expects to collect

$$\begin{aligned} \mathcal{R}^{d*} &= (1 - \eta) \mathbf{T} - w - ((1 - \lambda)(1 + \phi_t) - \eta - \lambda \phi_a e^{d*}) u^{d*} + \phi_t u^{d*} \\ &= \mathbf{T} - \psi(e^{d*}) - \mathbf{V}_e^{d*} \end{aligned}$$

in taxes and fines. As in the preceding case, effort and rent are costly to the agency which must offer its employees a contract that will leave them no rent equalizing their expected payoff to the value of their outside option. For a given commission rate η , there exists a fixed wage $w^{d*}(\eta)$ such that the utility of the auditors is $\mathbf{V}_e^{d*} \equiv 0$ and the agency collects $\mathcal{R}^{d*} = \mathbf{T} - \psi(e^{d*})$. Again, the loss in tax collection corresponds to the amount that must be paid to the auditors for the compensation of the audit effort's disutility. Notice that the revenue collected is lower with respect to the case of honest auditors, since the dishonest ones work harder. It is easy to compute as

$$w^{d*}(\eta) = \int_0^{e^{d*}(\eta)} \left(\frac{\eta}{\alpha - \lambda \phi_a} - e \right) \psi''(e) de - \eta \mathbf{T}. \quad (13)$$

Whether the auditors are all honest or all dishonest, the tax agency offers a contract such that for any commission the fixed wage is such that no rent is left to the auditors. If the auditors are honest, all remuneration contracts provide the same revenue because the effort level is fixed. However, when the auditors are corruptible, the monitoring effort, which determines the leakage in revenue collected, depends on the commission rate. Therefore all the remuneration contracts are not equivalent, unlike the full-honesty case. It is clear from the expression above that the revenue collected is a decreasing function of the effort exerted by the auditors, which is a decreasing function of the commission rate. Therefore, the unique optimal remuneration contract is $(1, w^{d*}(1))$, i.e., a commission of 100 percent associated with the fixed part which leads to full rent extraction $\mathbf{V}_e^d \equiv 0$. The tax agency therefore “privatizes” the collection of taxes; the revenue-maximizing system when all auditors are corruptible is the pure tax-farming system.

The discussion in the last two sections can be subsumed in the following proposition:

Proposition 4 *If all the tax inspectors are identical, the tax agency offers a remuneration contract $(\eta, w^{i*}(\eta))$ for $i = h, d$ such that:*

- (a) *the auditors accept the contract;*
- (b) *a triple $(s^{i*}(\cdot), e^{i*}(\cdot), \mu^{i*}(\cdot))$ that is a universally divine sequential equilibrium is the outcome of the signaling game played by the taxpayers and auditors, with*
 - (i) $s^{i*}(\theta) = T^{-1}(T(\theta) - u^{i*})$ for all $\theta \in \Theta$ and $u^{i*} > 0$;
 - (ii) $e^{i*}(m) = e^{i*}$ for all $m \in M$, and $0 < e^{i*} < 1$;
 - (iii) $\mu^{i*}(\theta|m) = 1$ for $m = s^{i*}(\theta)$, $\mu^{i*}(\underline{\theta}|p) = 1$ for $p < s^{i*}(\underline{\theta})$ and $\mu^{i*}(\bar{\theta}|p) = 1$ for $p > s^{i*}(\bar{\theta})$.
- (c) *if the auditors are honest, all the contracts $(\eta, w^{h*}(\eta))$ are equivalent;*
- (d) *if the auditors are dishonest pure tax farming $(1, w^{d*}(1))$ is the **unique** revenue maximizing contract;*
- (e) *the revenue collected is greater when auditors are honest.*

Full rent extraction is possible in these benchmark cases because the tax agency has complete information with respect to the integrity of its employees. The next section focuses on the case where this no longer holds.

3.2 Heterogeneous inspectors

Let us now turn to the more interesting situation where the proportion of honest auditors working in the tax agency is $0 < \beta < 1$. The auditors are indistinguishable and only one remuneration contract is offered. The tax agency suffers now from information asymmetries. To derive the same type of simple equilibria, the taxpayers have to be indifferent, as in the preceding section, about the report to make. The audit probabilities must then be such that $\gamma(m) \equiv 0$. More importantly at such an equilibrium e^h and e^d that satisfy this condition must also be constant. Indeed, the condition could hold while $\partial e^i / \partial m < 0 < \partial e^j / \partial m$ for $i, j = h, d$ and $i \neq j$. However, from the first order conditions, the audit probabilities depend on the evaded amount and at equilibrium the auditors have the same beliefs, therefore the audit intensities must be either both increasing or both decreasing. In the (e^h, e^d) plane, the equation $\gamma(m) \equiv 0$ is defined by a line pivoting around (e^{h*}, e^{d*}) , having a slope of $-\frac{\beta}{(1-\beta)} \frac{(1-\lambda)(1+\phi_t)}{\alpha}$ which depends on the relative number of

honest to dishonest auditors and the different parameters of the model (see figure 2). The first-order conditions for the honest and dishonest auditors are respectively $\psi'(e^h) = \eta \mathbb{E}_\mu(u(\theta, m))$ and $\psi'(e^d) = (\alpha - \lambda\phi_a) \mathbb{E}_\mu(u(\theta, m))$. The beliefs are point beliefs and for these conditions to hold the evaded amounts must be independent of the income, and we denote the constant evaded amount by \bar{u} . For a given $(\lambda, \phi_a, \phi_t, \beta)$ vector of parameters, denoted by

$$\bar{\Psi}(\eta) = \left\{ ((e^h, e^d), 0 \leq e^h, e^d \leq 1; \text{ such that } \psi'(e^d) = \frac{\alpha - \lambda\phi_a}{\eta} \psi'(e^h)) \right\},$$

and by

$$\bar{\Gamma}(\eta) = \left\{ ((e^h, e^d), 0 \leq e^h, e^d \leq 1; \text{ such that } \gamma = 0) \right\}.$$

The equilibrium audit efforts pair is determined by the intersection of these two sets, i.e., $(\bar{e}^h(\eta), \bar{e}^d(\eta)) = \bar{\Psi}(\eta) \cap \bar{\Gamma}(\eta)$. The set of equilibria is obtained by varying η in the interval $[0, 1]$. It is straightforward to show that for a given set of parameters, there exists a **unique** intersection point, that is a unique equilibrium. This equilibrium will be studied with reference to the benchmark cases. For a given η , the equilibrium that arises in each of the latter cases has already been established. If the same commission rate is adopted by the tax agency in the case of a mixture of honest and dishonest auditors, two cases must be considered depending on whether the parameters of the model imply $u^{h*} \geq u^{d*}$.

Case 1: $u^{h*} > u^{d*}$ the evasion is greater when all auditors are honest. Suppose that $\bar{e}^h > e^{h*}$ then, to satisfy $\gamma \equiv 0$, it is necessary that $\bar{e}^d < e^{d*}$. However, $u^{h*} > u^{d*} \implies \psi'(e^{d*}) < \frac{\alpha - \lambda\phi_a}{\eta} \psi'(e^{h*})$ thus an increase in the level of effort of the honest auditors and a decrease in that of the dishonest ones cannot satisfy the conditions. Hence if $u^{h*} > u^{d*}$ then $\bar{e}^h < e^{h*}$ and $\bar{e}^d > e^{d*}$.

Case 2: $u^{h*} < u^{d*}$ the evasion is greater when all auditors are dishonest. The same reasoning shows that if $u^{h*} < u^{d*}$ then $\bar{e}^h > e^{h*}$ and $\bar{e}^d < e^{d*}$.

Using the same arguments, it is easy to show that the equilibrium level of evasion is in between that of the two extreme cases, i.e., $\bar{u} \in (u^{i*}, u^{j*})$ for $i, j = h, d$ and $i \neq j$. It must be noted that in case 1, one may encounter a non-existence of equilibrium problem. This comes from the fact

that for some values of the parameters, one could have $\bar{e}^d > 1$ while this never happens in case 2. Indeed, in this latter case, the equilibrium effort pair lies in the triangle ABC in figure 2, while in case 1 it is at the north-west of point A. For high β s one could thus have no equilibrium since the audit effort required from the dishonest auditors is too high. Thus, in the remainder of this paper, only case 2 is considered, the results being symmetric for case 1 whenever an equilibrium exists. At this equilibrium, taxpayers evade less than if there were only dishonest auditors.

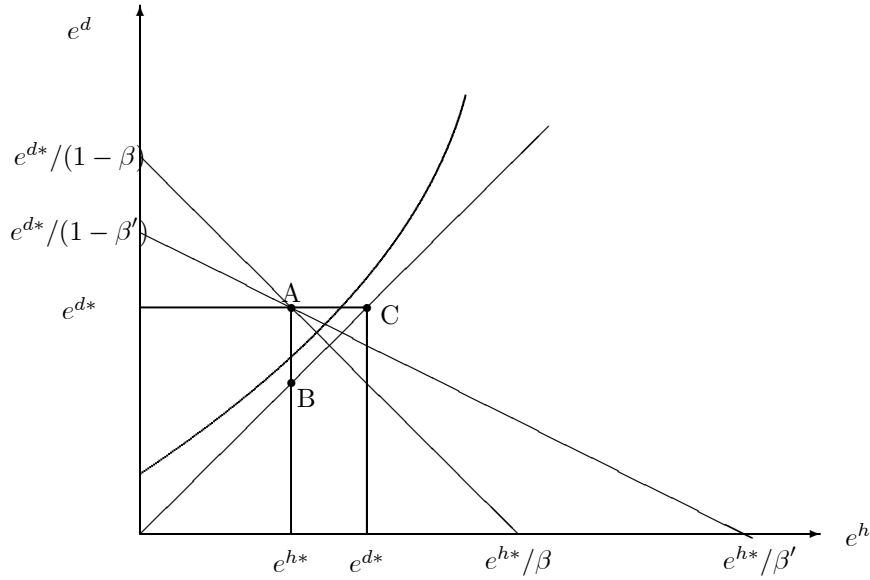


Figure 2. Equilibrium for $\beta' \neq \beta$ and $(\lambda, \phi_a, \phi_t, \eta)$ fixed.

The tax agency anticipates the equilibrium that will arise depending on the contract proposed to the auditors. It will choose this contract to maximize the revenue collected. The auditors' expected payoff from a common contract (w, η) is

$$\bar{\mathbf{V}}_e^h = w + \eta \mathbf{T} - (1 - \bar{e}^h) \eta \bar{u} - \psi(\bar{e}^h)$$

for the honest ones and

$$\bar{\mathbf{V}}_e^d = w + \eta \mathbf{T} - (\eta - (\alpha - \lambda \phi_a) \bar{e}^d) \bar{u} - \psi(\bar{e}^d)$$

for the corruptible ones. This shows that $\bar{\mathbf{V}}_e^d > \bar{\mathbf{V}}_e^h$, i.e., the corruptible auditors' payoff is larger than that of the honest ones. In fact, the following relationship between the auditors' utility is

readily derived³

$$\overline{\mathbf{V}}_e^d = \overline{\mathbf{V}}_e^h + \int_{\bar{e}^h}^{\bar{e}^d} e\psi''(e)de,$$

where the integral term is the extra utility the corruptible inspectors get; it is the *informational rent* of dishonesty. This is quite intuitive since the dishonest auditors always have the option to behave honestly. The tax agency collects the following revenue in taxes and fines

$$\begin{aligned}\overline{\mathcal{R}} &= (1 - \eta)\mathbf{T} - w - [((1 - \lambda)(1 + \phi_t) - \eta)(1 - \beta e^h) - \lambda(1 - \beta)\phi_a e^d - \phi_t] \bar{u} \\ &= \mathbf{T} - \beta [\psi(\bar{e}^h) + \overline{\mathbf{V}}_e^h] - (1 - \beta) [\psi(\bar{e}^d) + \overline{\mathbf{V}}_e^d].\end{aligned}$$

Again, the effort exerted by the inspectors and the rent they are left with are costly to the tax agency. Which remuneration scheme provides the greater tax cum fines collection? Both honest and dishonest auditors' participation constraints have to be respected in order to have an equilibrium. It is clear that to maximize the revenue no rent should be left to the honest auditors. Indeed, for η fixed, if w is such that at the equilibrium $\overline{\mathbf{V}}_e^h > 0$ it is possible to propose $w' < w$ such that $\overline{\mathbf{V}}_e^h = 0$ that is accepted by all the auditors without changing the equilibrium outcome and increase the revenue raised. The tax agency is bound to leave a rent to the dishonest auditors, i.e., $\overline{\mathbf{V}}_e^d > 0$ since otherwise the honest ones would not participate in the audit game and upset the equilibrium. For a given commission rate η , the optimal fixed wage is thus $\overline{w}(\eta)$ that saturates the honest auditors' participation constraint and is given by

$$\overline{w}(\eta) = \int_0^{\bar{e}^h(\eta)} (1 - e)\psi''(e)de - \eta\mathbf{T}. \quad (14)$$

It has the same structure as the case $\beta = 1$ except that now the effort depends on the commission rate since it is linked with the effort exerted by the dishonest auditors. The expected payoff of the honest auditors is equated to their outside option whereas the corruptible agents enjoy the

³ The argument runs as follows: from the f.o.c. and the separating property of the equilibrium, one obtains $\psi'(\bar{e}^h) = \eta\bar{u}$ and $\psi'(\bar{e}^d) = (\alpha - \lambda\phi_a)\bar{u}$. Afterwards, an easy computation gives $\overline{\mathbf{V}}_e^d - \overline{\mathbf{V}}_e^h = \psi'(\bar{e}^d)\bar{e}^d - \psi(\bar{e}^d) - [\psi'(\bar{e}^h)\bar{e}^h - \psi(\bar{e}^h)] = \int_{\bar{e}^h}^{\bar{e}^d} e\psi''(e)de > 0$ since ψ is convex.

informational rent of dishonesty. The expected revenue accruing to the tax agency is therefore

$$\overline{\mathcal{R}} = \mathbf{T} - \beta\psi(\bar{e}^h) - (1 - \beta) \left[\psi(\bar{e}^d) + \int_{\bar{e}^h}^{\bar{e}^d} e\psi''(e)de \right], \quad (15)$$

where for any commission rate no rent is left to the honest inspectors. The revenue loss with respect to the full tax liability then amounts to the compensation of disutility of effort for all the auditors and the informational rent that has to be left to the corruptible agents only. The overall optimal remuneration scheme is the one that minimizes this loss. It remains to characterize the optimal commission rate which is the solution of the following program:

$$\bar{\eta} \in \text{Arg min}_{\eta} L(\eta) = \beta\psi(\bar{e}^h(\eta)) + (1 - \beta)\psi(\bar{e}^d(\eta)) + (1 - \beta) \int_{\bar{e}^h(\eta)}^{\bar{e}^d(\eta)} e\psi''(e)de. \quad (16)$$

There is no problem of existence since the loss function is continuous and is minimized on a compact interval. Even though the first-order condition is readily computed, it is of almost no use because the expressions involved in this condition are rather complicated and identifying the local minima is impossible within such a general framework. However, the tax agency can compute the loss function for a fixed set of parameters and then determine the optimal commission rate. This expression does not allow for establishing a unique optimal commission rate, but the important fact is that in case of multiple solutions the collected revenue is the same and the tax agency is indifferent. To break the tie it is assumed that the agency chooses the contract that gives the higher payoff to the agents. All the parameters, the distribution of types β , the penalty system (ϕ_a, ϕ_t) , and the probability of discovering the conspiracy λ play important roles on the optimal remuneration contract.

Proposition 5 *If the population of tax inspectors is heterogeneous, the tax agency offers a single remuneration contract $(\eta, \bar{w}(\eta))$ such that:*

- (a) *the auditors accept the contract;*
- (b) *a quadruple $(\bar{s}(\cdot), \bar{e}^h(\cdot), \bar{e}^d(\cdot), \bar{\mu}(\cdot))$ that is a universally divine sequential equilibrium is the outcome of the signaling game played by the taxpayers and auditors, with*

- (i) $\bar{s}(\theta) = T^{-1}(T(\theta) - \bar{u})$ for all $\theta \in \Theta$ and $\bar{u} > 0$;
- (ii) $\bar{e}^h(m) = \bar{e}^h$, $\bar{e}^d(m) = \bar{e}^d$ for all $m \in M$, and $0 < \bar{e}^h < \bar{e}^d < 1$;

- (iii) $\bar{\mu}(\theta|m) = 1$ for $m = \bar{s}(\theta)$, $\bar{\mu}(\underline{\theta}|p) = 1$ for $p < \bar{s}(\underline{\theta})$ and $\bar{\mu}(\bar{\theta}|p) = 1$ for $p > \bar{s}(\bar{\theta})$;
- (c) the revenue maximizing contracts are $(\bar{\eta}, \bar{w}(\bar{\eta}))$ where the commission rates are given by (16); they yield the same revenue;
- (d) the selected contract leaves no rent to the honest inspectors and a strictly positive rent to the corruptible inspectors.

4 Some possible extensions

In this section we examine the effect on the equilibrium outcome of relaxing some assumptions that have been made implicitly or explicitly.

Ex post participation constraint

By writing the participation constraint of the auditors in ex ante terms, an implicit assumption in the analyses performed up to now is that the auditors can commit once hired to audit all reports with the equilibrium audit intensity. This is however a very strong assumption since ex post, for some low-income reports, the auditors have no incentive to audit (that intensively) anticipating that for the fixed wage paid these files will bring a negative payoff. The lack of commitment power can overturn the equilibrium. We suppose now that the auditors cannot (in fact have no incentive to) commit to audit all the files. The participation constraint then has to be satisfied for any report.⁴ Formally, this condition can be written as

$$w + \eta T(m) + \eta e^h(m) \mathbb{E}_\mu(u(\theta, m)) - \psi(e^h(m)) \geq 0 \quad \forall m \in M$$

for the honest auditors and

$$w + \eta T(m) + (\alpha - \lambda \phi_a) e^d(m) \mathbb{E}_\mu(u(\theta, m)) - \psi(e^h(m)) \geq 0 \quad \forall m \in M$$

for the corruptible ones. These equations must hold for any considered equilibrium. For the simple equilibria we are interested in here, they will be simplified. Indeed, since the evasion levels are the same, it is enough that the constraints be fulfilled and binding for the lower report in the

⁴ This is also a kind of limited liability constraint that has to be respected for any state of the nature (file to audit here), not only on average.

different scenarios considered. The necessity of taking into account the ex post incentives for the auditors to inspect translates into a cost for the tax agency. Indeed, by inducing the auditors to commit ex ante, the tax agency is shifting all the risk on the shoulders of these latter who on any report m bear a risk of $\eta(T(\theta) - \mathbf{T})$, where θ is the true income of the taxpayers reporting m . One clearly sees that on average the risk is zero and the auditors are induced to sign the contract ex ante. However, the auditors loose money ex post (if they audit) on all taxpayers whose income is below the mean. Now if the auditors refuse to bear this risk, the agency must pay them enough to audit all reports. One can then show that the cost, for the tax agency, of the lack of commitment from the inspectors to the audit strategy is independent of the distribution of honest/dishonest inspectors and equal to $C_{NC} = \eta(\mathbf{T} - T(\underline{\theta}))$. For a given commission rate, the fixed wage has to be set such that the inspector gains to audit the report, whatever it is. Since only equilibria in which the evasion level (audit effort) is independent of the true income (reported income) are investigated here, we must have

$$w + \eta(T(\underline{\theta}) - u) + \eta e^h u - \psi(e^h) = 0$$

for the honest auditor and the analogous expression for the corruptible ones. The fixed wage is computed from the above equation and the difference between it and the one that has to be paid in the commitment case gives the cost of impossibility of commitment. Repeating the same operations for all the scenarios shows that it is always the same and independent of the distribution of the auditors' types in the pool.

The introduction of ex post individual rationality constraints has very important implications for the optimal remuneration scheme, since the cost it induces directly relates to the commission rate. When all the auditors are honest ($\beta = 1$), we have already shown that from an ex ante point of view, the rate is irrelevant since the same tax revenue can be achieved for any of its possible values by adjusting the fixed wage. Now, the rate must be taken into account since higher rates imply higher costs to be borne, and less revenue. The optimal remuneration scheme is in this

case the *pure wage* system which sets $\eta = 0$. We do not consider this possibility in our model, then η will be fixed at its lowest possible (maybe chosen by a regulatory agency) level. If on the other hand the auditors are all corruptible ($\beta = 0$), the tax agency faces a trade-off between the cost stemming from the lack of commitment power and those induced by a high level of auditing effort due to low commission rates. One can write the revenue in the no-commitment case as $\mathcal{R}_{NC}^{d*} = \mathbf{T} - \psi(e^{d*}) - \eta(\mathbf{T} - T(\underline{\theta}))$. The optimal commission rate is

$$\eta_{nc} = \underset{\eta}{\text{Arg min}} \psi(e^{d*}(\eta)) + \eta(\mathbf{T} - T(\underline{\theta})).$$

The first-order condition is easily derived and the optimal rate is such that the marginal benefit of reducing η , $(\mathbf{T} - T(\underline{\theta}))$ stemming from the reducing of the no-commitment cost equals its marginal cost, $[1 - \lambda(1 + \phi_t)]\psi'(e^{d*}(\eta))/2\alpha^2$ stemming from the increase in effort that must be monetarily compensated. Taking into account ex post incentives, the tax agency switches from a pure tax-farming system to an intermediate system if the solution to the above minimization program is interior and a pure wage system otherwise.

In the case $0 < \beta < 1$ the results are harder to obtain since the optimal commission rate has not been fully characterized. The tax agency still faces the same trade-off between the cost induced by the loss function and that of no-commitment. One can however show that the latter cost reduces the level of the previous commission rate, i.e., $\bar{\eta}_{nc} \leq \bar{\eta}$ with

$$\bar{\eta}_{nc} = \underset{\eta}{\text{Arg min}} L(\eta) + \eta(\mathbf{T} - T(\underline{\theta})). \quad (17)$$

Indeed, either both are corner solutions, i.e. $\bar{\eta} = 0$, and $\bar{\eta}_{nc} = 0$, or $\bar{\eta} > 0$ and the introduction of a new cost that is linearly increasing in the commission rate forcefully leads to $\bar{\eta}_{nc} < \bar{\eta}$.

Integrity-dependent reservation utility

Since the inspectors are alike except for the integrity parameter, it is reasonable to assume, as we did, that they have the same set of opportunities outside the tax agency. However, does this imply that they have the same reservation utility? It could be that the corruptible agents can

take an advantage from their dishonesty for any other job, as they do in the agency, and thus have greater reservation utilities than the honest ones. In any case, it is assumed now that the inspectors have type-dependent reservation utilities. Denote by $\bar{V}^i > 0$ for $i = h, d$ the outside options. In the cases $\beta = 1$ or $\beta = 0$, the tax agency takes into account this rent to be paid and increases the fixed wage by the value of the new reservation utility. The only thing that changes is the revenue collected, which is lowered. At equilibrium, the optimal remuneration schemes are the same and this holds for both commitment and no-commitment cases.

The interesting case is $0 < \beta < 1$ when a mix of auditors are hired. Changing the reservation utility has no effect on the optimal commission rate since it is sufficient to increase the fixed wage until all participation constraints are met. The fixed wage being essentially a lump-sum transfer, this operation does not affect the equilibrium, except for the revenue collected. The relevant question for the tax agency is whether the difference in reservation utilities $\bar{V} = \bar{V}^d - \bar{V}^h$ is greater, equal or less than the informational rent the dishonest auditors enjoy at the equilibrium where outside options are alike, $IR = \int_{\bar{e}^h}^{\bar{e}^d} e\psi''(e)de$. Since the participation constraint of the honest is still required, the fixed wage has to be increased at least by \bar{V}^h . If $\bar{V} = IR$, then by increasing the fixed wage by exactly \bar{V}^h both the honest and dishonest auditors' individual rationality constraints are binding and the tax agency loses nothing more. In this case, the corruptible inspectors lose their informational rent since the gap between the reservation utilities has been used as a substitute for it. If $\bar{V} < IR$, then the honest agents' participation constraint is binding and the dishonest still receive a smaller rent since they lose part, and exactly \bar{V} , of their rent. If $\bar{V} > IR$, then giving \bar{V}^h is not enough to meet the participation constraint of the corruptible, the tax agency must then increase the fixed wage by $\bar{V}^h + \delta$ such that $\bar{V}^h + \delta + IR = \bar{V}^d$. Now the honest agents enjoy an informational rent since their utility is higher than their outside option, by δ , while for the dishonest one the constraint is binding. In conclusion, when the reservation utilities are different, the tax agency uses the gap as a perfect substitute for the informational rent that had to be given to the dishonest auditors who lose in this situation, the winners being the honest agents who in

some situations earn more than expected. The greater \bar{V} , the better off they are.

The employment contract as a signal

Up to now, we have considered the tax agency's revenue maximization problem as an ex post problem since the maximization is done under the constraint that the staff is already in place and all the auditors have to participate. It could be the case that the agency does not desire corrupt (or honest) individuals on its staff and could thus propose a contract that would allow for screening the auditors who self select according to the contract proposed. In fact, it is more realistic to think that in order to hire the inspectors, the agency has to propose, to a pool of skilled but unemployed auditors, a contract that is publicly observed ex ante. Those who are then interested will apply for employment. This is important since it conditions the equilibrium that will arise. Indeed, the public contract constitutes a signal for the taxpayers. Upon the proposal of the contract, one can infer which type of auditors it will attract. It is important to notice that in our model, the argument according to which efficiency wage deters corruption does not have any bite. In fact, corruption in this context depends only on equation (4); as long as (4) is satisfied the corruptible inspectors and the evaders will collude whenever they meet, irrespective of the remuneration scheme. Corruption is thus "structural" and depends on the penalty system.

A direct implication is that no contract exists that will attract only honest agents. Whenever the honest agents are attracted by a contract, it also attracts the dishonest. The adverse selection problem is quite harsh. On the other hand, there are contracts that will attract corruptible agents and repel honest ones.⁵ The set of contracts can be represented in the space (w, η) which is partitioned into three regions:

$$(a) \{(w(\eta), \eta), \text{ such that } w(\eta) \geq \bar{w}(\eta)\};$$

$$(b) \{(w(\eta), \eta), \text{ such that } w^d(\eta) \leq w(\eta) < \bar{w}(\eta)\};$$

⁵ Note here the analogy with the theory of insurance with adverse selection where any pooling contract, as the one proposed here (abstracting from the budget balance constraint), leads to an equilibrium with either only bad risk agents or both types accepting the contract. We do consider here neither the possibility nor the optimality of offering different employment contracts that will induce the collectors to self select.

(c) $\{(w(\eta), \eta), \text{ such that } w(\eta) < w^d(\eta)\}$.

Recall that $\bar{w}(\eta)$ is the fixed wage that makes the honest auditors' participation constraint binding if the agency staff is mixed, and $w^d(\eta)$ is the one that just induces the corruptible agents to accept the contract when $\beta = 0$. The contracts that belong to region (a) attract both the honest and the corruptible agents, in region (b) only dishonest auditors will apply for employment while nobody is willing to work for contracts that lie in (c). The latter contracts can never be optimal for the tax agency because they imply too much evasion. Even though the distribution of the pool is $(\beta, 1 - \beta)$, the distribution of the auditors hired by the tax agency is endogenous to the contract offered and the agency has the choice between $(\beta, 1 - \beta)$ where the contract attracts both types of auditors and $(0, 1)$ that only attract dishonest auditors. One can show that in case 1 $\bar{w}(\eta) > w^d(\eta)$ for all $\eta \in [0, 1]$. We have been unable to show it for case 2. If this condition were not to be satisfied in a region, then the agency loses the choice since in this region any wage attracting the dishonest auditors also attracts the honest ones. The tax agency now chooses the contract that will bring the highest expected revenue. At this end, it needs to compare the contracts in region (a) to those in region (b) and select the optimal one. For a given commission rate η the agency will offer $\bar{w}(\eta)$ if $L(\eta) \leq \psi(e^{d*}(\eta))$ and $w^d(\eta)$ otherwise. Surprisingly, there may be cases in which the tax agency does not want to hire honest auditors. The reason for this counterintuitive result is the following. Even though an honest inspector brings, in expected terms, more revenue than a dishonest one, because they denounce the cheaters, mixing them with the dishonest creates the adverse selection problem. The tax agency can thus prefer to offer contracts that will attract only the dishonest auditors, eliminating by the same token the adverse selection problem. This latter being suppressed, the moral hazard problem can be handled more efficiently and the contracts will be chosen to leave no costly rents to the dishonest. This is a kind of capitulation wage as proposed by Besley and McLaren (1993); however, the argument is much more complex.

Let us now show that $\bar{w}(\eta) > w^d(\eta)$ in case 1. Using equations (12) and (14) and the first-order

conditions in the different contexts, we have

$$\bar{w}(\eta) - w^d(\eta) = \eta(\bar{u} - u^{d*}) + \int_{\bar{e}^h(\eta)}^{e^{d*}(\eta)} e\psi''(e)de,$$

in case 1, the first expression is positive while the second one is always positive since as shown earlier $e^{d*}(\eta) > \bar{e}^h(\eta)$ for all η . In case 2, one must compare these two expressions and depending on which one dominates the analysis may or may not hold.

5 Concluding remarks

The main purpose of this paper has been to analyze the problem of a tax agency that wants to maximize its tax receipts in an environment where corruption is pervasive. The tax agency needs to employ inspectors to audit taxpayers and collect taxes. Inspectors can be either honest or dishonest and the only way the agency can influence their behavior is through the remuneration contract it offers. It transpires from the analysis that when all inspectors are prone to corruption pure tax-farming is the unique revenue maximizing contract whereas all contracts are equivalent when auditors are all honest. If in contrast the population of inspectors comprises both honest and dishonest inspectors, the tax agency has to propose a contract that lies between pure tax-farming and pure wage contract. For any chosen commission rate, the fixed wage component of the contract must be adjusted to extract all the rent of the honest tax inspectors. In the presence of honest auditors, the agency is unable to extract the rent of its corruptible agents. When the tax administration has the possibility to offer screening remuneration contracts during the hiring process, it may be optimal to offer capitulation wage contracts that attract only corruptible auditors. As surprising as it might seem, this result is rooted in a firm intuition. Indeed, the tax agency is facing a moral hazard as well as an adverse selection problem; a capitulation wage offer evacuates the latter problem and deals efficiently with the remaining moral hazard issue afterwards.

There are a number of directions in which this work can be fruitfully extended. First, while

it is reasonable to assume different degrees of integrity within the population of auditors, to assume all taxpayers are dishonest seems artificial. A more satisfactory model would also allow a fraction of taxpayers to be inherently honest following Erard and Feinstein (1994). However, this seemingly minor change dramatically complicates the model. The first important implication of the introduction of honest taxpayers is the unsustainability of simple equilibria with constant evasion amount (for dishonest taxpayers) and constant audit probability. Indeed, suppose instead an equilibrium with $\bar{e}^h(m) = \bar{e}^h$ and $\bar{e}^d(m) = \bar{e}^d$ implying $\gamma(m) = \gamma \geq 0 \ \forall m \in M$. All the dishonest taxpayers will then evade the same amount \bar{u} and the wealthiest dishonest taxpayer reports $\bar{m} = T^{-1}(T(\bar{\theta}) - \bar{u})$ while the honest θ -taxpayer with $\theta \in [\bar{m}, \bar{\theta}]$ report truthfully. For such reports, since there is no gain in auditing, all the inspectors want to reduce the audit probability to zero. In anticipation, some high-income dishonest taxpayers will report in the above interval upsetting the equilibrium. This simple reasoning holds for any constant audit function. The incorporation of honest taxpayers forces us to study more complex equilibria of the type derived by Reinganum and Wilde (1986a) or Erard and Feinstein(1994) with decreasing audit functions. This renders the analysis of the optimal remuneration scheme a formidable task. We leave this question open for future research.

Another interesting extension would be to consider the whole four-tier hierarchy by considering an active government that chooses the income tax schedule and penalty system to maximize its objective function. However, the government and the tax agency may have conflicting objectives, the former aiming at maximizing social welfare and the latter caring only about tax revenues. Such problems are dealt with in Cremer et al. (1990) and Sanchez and Sobel (1993). These papers do not however consider the corruption problem. This will also raise the problem of the distributional impact of evasion cum corruption, and the government will have to carefully choose the tax schedule in order to achieve its objective. As we have shown, the tax agency's resources are greater when the penalty system supports the eradication of corruption, which could also lead to a higher social welfare. However, one can easily imagine situations in which it is optimal from

a social welfare perspective to allow some corruption in order to increase the well-being of the auditors or to impose some restrictions on the remuneration scheme such as the non-negativity of the fixed wage, precluding by the same token its abusive use by the tax agency as an instrument for the extraction of the inspectors' rent.

Finally, it has been assumed that costs of appeal to a court are so low that there is no fear of extortion. However, there is compelling evidence that such practices exist especially in the developing countries where taxpayers are often victims of harassment from the inspectors, see Klitgaard (1988) and Hindriks et al. (1999). The latter formally introduce extortion in their model as the possibility for the inspector to unilaterally overstate a taxpayer's liability. Tax farming has appeared to be optimal in some situations in this paper. It would be interesting to see whether this result is overturned once extortion is possible, because of a weak judiciary system, and because the government cares about the well-being of the individuals. The latter must be protected against overzealous inspectors, and this is costly since the planner has to engage resources to monitor the inspectors' behavior as argued by Stella (1993).

Appendix

Proof of proposition 2:

The same line of proof as that in Banks (1990) is followed. The honest taxpayers' strategy is trivially monotone increasing since $s^h(\theta) = \theta$. Suppose that $s^d(\cdot)$ is not monotone increasing, so that $\exists \theta, \theta'$ such that $\theta < \theta'$ but $s^d(\theta) > s^d(\theta')$, since overreporting is never optimal we have $\theta > s^d(\theta)$. One can rewrite (10) as

$$\frac{\gamma(s^d(\theta))}{\gamma(s^d(\theta'))} \geq \frac{u(\theta, s^d(\theta'))}{u(\theta, s^d(\theta))}.$$

Differentiating the rhs of this expression while holding $s^d(\theta)$ and $s^d(\theta')$ constant gives

$$\frac{\partial[\cdot]}{\partial \theta} = \frac{\frac{\partial u(\theta, s^d(\theta'))}{\partial \theta} \cdot u(\theta, s^d(\theta)) - \frac{\partial u(\theta, s^d(\theta))}{\partial \theta} \cdot u(\theta, s^d(\theta'))}{[u(\theta, s^d(\theta))]^2}.$$

By the properties of the function $u(\cdot, \cdot)$, the numerator is negative while the denominator is positive. The rhs of our rewritten incentive compatibility condition is thus decreasing with θ . It then implies that

$$\frac{\gamma(s^d(\theta))}{\gamma(s^d(\theta'))} \geq \frac{u(\theta, s^d(\theta'))}{u(\theta, s^d(\theta))} > \frac{u(\theta', s^d(\theta'))}{u(\theta', s^d(\theta))}$$

which in turn implies that $\gamma(s^d(\theta))u(\theta', s^d(\theta)) > \gamma(s^d(\theta'))u(\theta', s^d(\theta'))$ contradicting the assumption that $s^d(\cdot)$ is an equilibrium strategy. ■

Proof of proposition 3: The objective is to show how the universal divinity criterion of Banks and Sobel eliminates all pooling and partially pooling equilibria of the game. Let us first identify the type most likely to defect from a given equilibrium with reporting strategy $s(\cdot)$. We have

$$\kappa(\theta, p | s^d(\cdot), e^h(\cdot), e^d(\cdot)) = \frac{\gamma(s^d(\theta))u(\theta, s^d(\theta))}{u(\theta, p)}$$

where p is the out-of-equilibrium report observed. Differentiating this expression with respect to θ , one obtains:

$$\begin{aligned} \frac{\partial \kappa}{\partial \theta} &= \frac{\frac{\partial}{\partial \theta} [\gamma(s^d(\theta))u(\theta, s^d(\theta))] u(\theta, p) - \gamma(s^d(\theta))u(\theta, s^d(\theta)) \frac{\partial u(\theta, p)}{\partial \theta}}{u^2(\theta, p)} \\ &= \frac{\gamma(s^d(\theta)) \left[\frac{\partial u(\theta, s^d(\theta))}{\partial \theta} u(\theta, p) - \frac{\partial u(\theta, p)}{\partial \theta} u(\theta, s^d(\theta)) \right]}{u^2(\theta, p)} \\ &= \frac{\gamma(s^d(\theta)) \partial u / \partial \theta}{u^2(\theta, p)} [u(\theta, p) - u(\theta, s^d(\theta))] \end{aligned}$$

The first term in the numerator of the first equation is simplified by the fact that at equilibrium the strategy is incentive compatible. The last equation is derived from the second by making use of the properties of the function $u(\cdot, \cdot)$ which is separable. The sign of the derivative allows to identify the type most likely to defect to p and depends on the position of p . Suppose first that the equilibrium is pooling, i.e., all the taxpayers adopt the strategy $s^{d*}(\theta) = m^* \forall \theta \in \Theta$ to which the auditors respond by constant audit efforts e^{d*} and e^{h*} resulting in the constant expected saved proportion of the amount

evaded γ^* . For this pooled message to be an equilibrium it must satisfy $m^* < \underline{\theta}$ since overreporting is never optimal. Let p be an out-of-equilibrium message, $\partial\kappa/\partial\theta$ is negative (resp. positive), the type most likely to defect is $\bar{\theta}$ (resp. $\underline{\theta}$) and universal divinity requires $\mu(\bar{\theta}|p) = 1$ (resp. $\mu(\underline{\theta}|p) = 1$) for p greater (resp. less) than m^* . Suppose the $\underline{\theta}$ -taxpayer chooses to separate by sending the message $m = m^* - \epsilon$ for ϵ positive and small. She then evades a little bit more but still less than the pooled average. Both the honest and corruptible auditors expected gain from auditing m is lower than that from auditing m^* , hence the separating taxpayer faces a lower probability and a higher expected payoff (for ϵ small enough) and will thus separate and break the pooling equilibrium. Repeating the same argument, the semi-pooling equilibria are also eliminated. ■

References

- Allingham, M. G., and A. Sandmo. (1972). Income tax evasion: a theoretical analysis. *Journal of Public Economics*, 1:323–338.
- Banks, J. (1990). A model of electoral competition with incomplete information. *Journal of Economic Theory*, 50:309–325.
- Banks, J., and J. Sobel. (1987). Equilibrium selection in signaling games. *Econometrica*, 55:647–661.
- Besley, T., and J. McLaren. (1993). Taxes and bribery: the role of wage incentives. *The Economic Journal*, 103:119–141.
- Chander, P., and L. Wilde. (1992). Corruption in tax administration. *Journal of Public Economics*, 49:333–349.
- Cho, I., and D. Kreps. (1987). Signaling games and stable equilibria. *Quarterly Journal of Economics*, CII:179–221.
- Cho, I., and J. Sobel. (1990). Strategic stability and uniqueness in signaling games. *Journal of Economic Theory*, 50:381–413.
- Cremer, H., M. Marchand, and P. Pestieau. (1990). Evading, auditing and taxing: the equity–compliance tradeoff. *Journal of Public Economics*, 43:67–92.
- Erard, B., and J. S. Feinstein. (1994). Honesty and evasion in the tax compliance game. *The Rand Journal of Economics*, 25:1–19.
- Graetz, M. J., J. F. Reinganum, and L. Wilde. (1986). The tax compliance game: toward an interactive theory of law enforcement. *Journal of Law, Economics and Organization*, 2:1–32.
- Hindriks, J. (1996). Income tax enforcement: the no-commitment game. *Chap 4 of unplished Ph.D dissertation*.
- Hindriks, J., M. Keen, and A. Muthoo. (1999). Corruption, extortion and evasion. *Journal of Public Economics*, 74:395–430.
- Kohlberg, E., and J. F. Mertens. (1986). On the strategic stability of equilibria. *Econometrica*, 54:1003–1038.
- Kreps, D. M., and R. Wilson. (1982). Sequential equilibria. *Econometrica*, 50:863–894.
- Klitgaard, R. (1988). Controlling corruption. *Berkeley: University of California Press*.
- Mailath, G. (1987). Incentive compatibility in signaling games with a continuum of types. *Econometrica*, 55:1349–1365.
- Mookherjee, D., and I. Png. (1995). Corruptible law enforcers: how should they be compensated. *The Economic Journal*, 105:145–159.
- Reinganum, J., and L. Wilde. (1986a). Equilibrium verification and reporting policies in a model of tax compliance. *International Economic Review*, 27:739–760.
- Reinganum, J., and L. Wilde. (1986b). Settlement, litigation and the allocation of litigation costs. *Rand Journal of Economics*, 17:557–566.
- Sanchez, I., and J. Sobel. (1993). Hierarchical design and enforcement of income tax policies. *Journal of Public Economics*, 50:345–369.
- Stella, P. (1993). Tax farming: a radical solution for developing country tax problems? *IMF Staff Papers*, 40:217–225.
- Tirole, J. (1986). Hierarchies and bureaucracies: on the role of collusion in organizations. *Journal of Law, Economics and Organization*, 2:181–214.
- Tirole, J. (1992). Collusion and the theory of organizations. in J. J. Laffont (ed.) *Advances in Economic Theory*, Vol. 2, Cambridge University Press.