THE KOREAN ECONOMIC REVIEW
Volume 6, Number 2, Winter 1990.

TAX EVASION AND BRIBERY

SUNG TAI KIM*, JU HYUN PARK**

I. INTRODUCTION

One of the most important features of modern income tax systems is how the government collects fixed tax revenues efficiently and equitably. The problem is directly related to tax evasion. The presence of tax evasion entails a lower revenue thus making some other taxpayers pay more taxes than they should. Tax auditing scheme is inevitable to let taxpayers report their income truthfully. The question is how to characterize a tax auditing scheme which leads truth-telling at least cost.

The question of tax evasion is first analyzed by Sandmo and Allingham (1972) who wirte a seminal paper on income tax evasion. They analyze the individual taxpayer's decision on whether and to what extent to avoid taxes by deliberate underreporting. S-A approach is related to the studies of economics of criminal activity, as in the papers by Becker (1968). The model has three main ingredients of a general tax evasion model: the tax rate(t), the penalty rate(φ), and the probability of auditing(p) which are exogenously given. S-A examined the effects of changes in three parameters on reported income.

The S-A model is classical in the sense that it has been developed and extended in various ways by among others Sandmo (1971), Kolm (1973), Welss (1976), Cowell (1985), and Pencavel (1979). Most of those papers are concerned about the comparative static results of changes in t, φ, and p. Kolm points out some weak points of the S-A model. Kolm emphasizes the role of the government tax revenue constraints, auditing cost, and policy maker's imperfect knowledge on taxpayer's utility function. Welss shows some cases where cheating and random taxes are socially useful. More cheating means having more risky asset, which implies wealth after tax is more variable. Under certain conditions more variable wealth increases welfare of taxpayer. Sandmo (1981) attempts to incorporate tax evasion into the analysis of optimal income taxation. Cowell following Sandmo (1981) deals with

*Department of Economics, Chongju University
**Korea Institute for Defense Analyses
The eariler version of this paper was presented at the 6th World Congress of the Econometric Society, Barcelona, Spain, August 1990 and the Annual Meeting of the Korean Economic Association, Seoul, Korea, February 1990. We would like to thank anonymous referees for their helpful comments on the paper.

other types of tax evasion such as the phenomenon of 'working off the books'. Cowell examines the effect of government instruments on the increments to participate in legal and illegal work activities.

It is only recently that researchers analyze the tax evasion problem adopting a game theoretic approach. While the previous literature represented by the S-A model is mostly concerned about the comparative static analysis, a new approach studies mechanism design problem. The question is how to design a tax auditing scheme that is efficient, equitable, and incentive compatible. Geensberg (1984) adopts a repeated game approach to study an optimal auditing scheme. Townsend (1979) formulates a general model of auditing in the context of a two-agent pure exchange economy. His remarkable contribution is represented by the Revelation Principle. Based on Townsend, Reinganum and Wilde (1985) study income tax compliance problem in a principal-agent framework. R-W ask what is the optimal tax form and level of taxation and what level of fines should be imposed for non-compliance (or underreporting of income). R-W compare alternative auditing policies, namely cut-off policy and random audit policy. Border and Sobel (1987) characterize an optimal tax auditing scheme in general setting. Mookherjee and Png (1989) find general conditions under which random audits are optimal. They also examine the robustness of Townsend's results in the presence of random audits.

All of R-W, B-S, M-P, and Townsend postulate the tax evasion problem in the context of the single principal and the single agent. The principal plays a role of the government that tries to achieve the social goal such as social welfare maximization and a role of the tax collector that simply collects taxes. However, in the real world the tax collector differs from the government in terms of their objectives. The tax collector does not care about social welfare but care about his or her own well-being. The situation where the taxpayer wants to pay less taxes and the tax collector wants more income leads to a criminal activity—bribery. As long as the tax collector differs from the government there always exists the possibility of bribery in the process of collecting taxes.

Even if in many countries, especially in less developed countries, bribery becomes a serious economic and social problem, it has been completely ignored by the tax evasion literature. Tax bribery results in efficiency losses and inequitable resource allocation, since auditing is costly and bribery distorts tax burden of each taxpayer. This paper examines the tax compliance problem in the presence of bribery in the context of a sequential game. In the model there are the single principal (the goverment) and the two agents (the tax collector and the taxpayer). We characterize an optimal auditing scheme that controls both criminal activities—tax evasion and bribery.

In section 2 we formulate the basic model where there is no bribery. We explain the assumptions regarding on the government (the tax collector), and the taxpayer. A general characterization of an optimal auditing scheme is given in the context of a sequential game. In section 3 we extend the basic model to the model with bribery. We characterize the optimal tax auditing scheme in the presence of bribery. The Incentive Compatible equilibrium and the Bribery equilibrium are compared. In section 4 we conclude the paper.

II. THE BASIC MODEL

There are two groups of taxpayers and the tax collector in the economy. The first group is an honest group while the second one is a dishonest group. The taxpayers in the honest group always report their true incomes. The taxapyers in the dishonest group may underreport their true income. Both groups consist of identical persons so that we will consider only the representative taxpayer from each group. The income of an honest group is publicly informed. Thus we will consider only the dishonest group taxpayers. Hereafter the taxpayer means the dishonest group taxpayers.

The model considers two person game. One is the taxpayer (TP) and the other is the tax collector (TC). The taxpayer observes his or her income I between 0 and $\bar{I}$, which is uniformly distributed on that interval. After observing I, he may underreport his income as $\hat{I}$, i.e., $\hat{I} \leq I$. $I-\hat{I}$ will be the amount of underreported income. If $I-\hat{I}>0$, the taxpayer commits a crime, namely tax evasion. The tax collector observes I only if he audits the taxpayer, at a cost per audit $c>0$.

If the taxpayer is not audited, his transfer to TC is $t\hat{I}$, where t is the proportional tax rate $0 \leq t \leq 1$. If an audit is performed, TP pays $\varphi(I-\hat{I})$, where φ represnets the fine rate. If $\hat{I}>I$, there is no reward for overreporting. The auditing rule is random audits.

The payoffs of TP and TC are as follows.

(TP): Income − tax − fine
(TC): tax + fine − auditing cost,

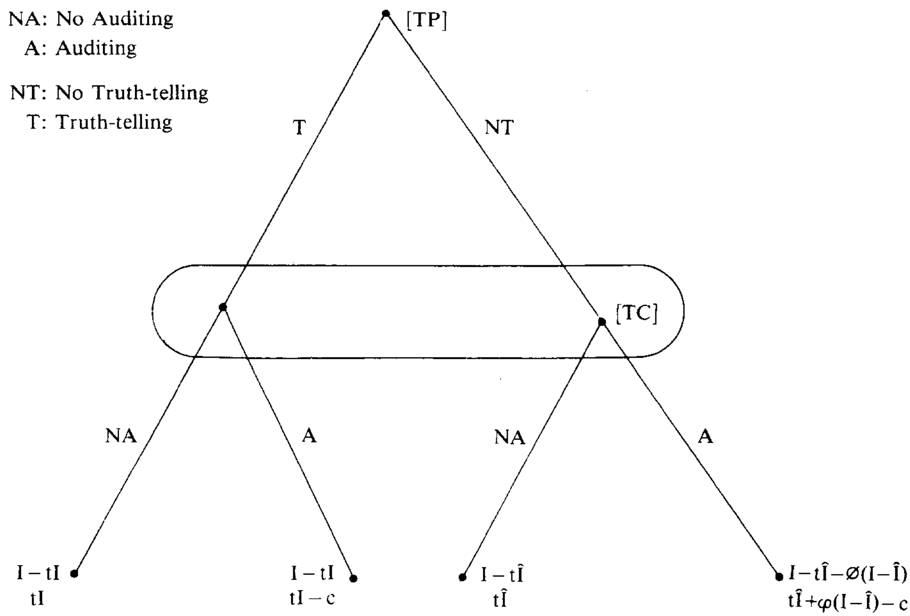
where tax = $t\hat{I}$, fine = $\varphi(I-\hat{I})$, and auditing cost = c only if an audit is performed. Thus the tax evasion and auditing game between TC and TP can be depicted as the game tree as shown in Figure 1. The payoffs are shown at the final nodes in the game tree, where the first rows represent the payoffs of TP and the second rows represent the payoffs of TC.

Let $r(I,\hat{I})$ denote expected income after tax to TP where I is true income and $\hat{I}$ is reported income. Then

$$(1)\quad r(I,\hat{I}) = (1-p)(I-t\hat{I}) + p(I-t\hat{I} - \varphi(I-\hat{I}))$$

where p denotes the probability of auditing. Given t, p, and φ TP chooses the optimal reporting income $\hat{I}$ to maximize $r(I, \hat{I})$.

The expected revenue to TC is



[Figure 1]

(2) $R(I,\hat{I}) = \int\{(1\text{-}p)\ t\hat{I} + pt\hat{I} + p\varphi(I\text{-}\hat{I}) - cp\}\ dG(I)$

where G(I) denotes the distribution function of income.

The objective of the tax collector is to maximize the expected revenue, that is

$$\max_{t,p,\varphi} R(I,\hat{I})$$
$$\text{subject to } 0 \leqslant t \leqslant 1,\ 0 \leqslant p \leqslant 1,\ t \leqslant \varphi \leqslant 1, \text{ and}$$
$$\text{the TP's optimal reporting rule.}$$

The third constraint shows that the fine rate must be as high as the tax rate, but is subject to the upper bound.[1] The tax authority wants to induce TP's truthful-telling with the least cost.

First, consider the optimal strategy of the taxpayer.[2]

Lemma1

Given t,p, and φ, the taxpayer's optimal strategy is

(3) (i) $\hat{I} = 0$, if $t > p\varphi$. (ii) $\hat{I} = I$, if $t \leqslant p\varphi$.

[1]If φ is too large, the taxpayer cannot pay the penalty. Therefore φ must be bounded above. Here for analytic convenience we assume that the upper bound of φ is 1. However it does not affect our results.

[2]As R-W (1985) we assume that whenever the taxpayer is indifferent it takes action which is most preferred by the tax collector.

Using Lemma1, we rewrite the government tax revenue as

$$\text{(i) } R = p\varphi I\mu - cp, \quad \text{if } t > p\varphi,$$
$$\text{(ii) } R = tI\mu - cp \quad \text{if } t \leqslant p\varphi.$$

Thus the government problem becomes

$$\text{(i) Max } R = p\varphi I\mu - cp \quad \text{subject to } t > p\varphi, \text{ and } 0 \leqslant t, p, \varphi \leqslant 1.$$
$$\text{(ii) Max } R = tI\mu - cp \quad \text{subject to } t \leqslant p\varphi, \text{ and } 0 \leqslant t, p, \varphi \leqslant 1.$$

Setting up the Lagrangian for the problem, we have the following Theorem as a solution.

Theorem1

Under the assumptions we have postulated, the optimal auditing scheme is

$$t^* = p^* = \varphi^* = 1, \text{ if } I\mu > c,$$
$$p^* = 0 \text{ and, } t^* \text{ and } \varphi^* \text{ are irrelevent if } I\mu < c,$$
$$p^* = t^*, \varphi^* = 1 \text{ and } 0 \leqslant t^*, p^* < 1 \text{ if } I\mu = c.$$

Theorem1 characterizes the optimal tax auditing scheme in the absence of bribery. We may notice that Theorem1 is another version of Reinganum and Wilde (1985) in the context of a simple linear model. Since in random audits the auditing probability does not depend on the TP's reporting income, either $P^* = 1$ or $P^* = 0$ must be optimal. It is intuitively clear that when $P^* = 0$ the tax rate is irrelevent because $\hat{I} = 0$ always. When $P^* = 1$, that is TP is always audited, $\hat{I} = I$ and $t^* = 1$ maximizes expected revenue. The decision of whether to audit or not depends on average income and the audit cost.

III. THE EXTENDED MODEL WITH BRIBERY

In this section we extend the basic model considering the existence of bribery. From this point on the tax collector differs from the government. We may think of the model as a three-person game.

There are three players in the tax auditing game-the government (G), the tax collector (TC), and the taxpayer (TP). As before TP represents the representative taxpayer from dishonest group.

Government

(A.1.) The objective of the government is to maximize tax revenue by setting the parameter values of fiscal tools, the tax rate t, the fine rate for tax evasion

φ, the probability of auditing p, as well as the fine rate for attempting bribery δ.

(A.2.) The salary rate of the TC, α, is fixed to be less than 1. Thus αR is the total amount of salary for TC and (1-α)R is the net tax revenue for the government, where R denotes the government total tax revenue.

At the initial stage of the game, the government announces t,φ,p, and δ, taking into account the optimal responces of TC and TP to a specific set of fiscal tools.

Taxpayer

(A.3.) TP observes his realized income I and decides whetehr to report his true income to TC, given a set of fiscal parameter values. In the case of truth-telling, TP's realized after tax income will be I-tI.

(A.4.) If TP underreports his income, that is $\hat{I} \leqslant I$, then he will be audited with the proability of p. If TP is not audited, his realized after tax income will be I-t$\hat{I}$.

(A.5.) If an audit is performed, then TP pays fines $\varphi(I-\hat{I})$.

(A.6.) Being audited, TP may or may not offer bribe B to TC. If bribe is accepted by TC, the whole fines for tax evasion $\varphi(I-\hat{I})$ will be exempted. However, if bribe is not accepted by TC, TP pays the extra fines for attempting bribery, δB, in addition to fines for tax evasion.

The realized net income of TP is,

$$\begin{aligned} r(I,\hat{I}) &= I - t\hat{I} - \varphi(I-\hat{I}) - \delta B && \text{if bribe is not accepted (NAC)} \\ &= I - t\hat{I} - B && \text{if bribe is accepted (AC).} \end{aligned}$$

Tax collector

(A.7.) TC audits TP's reported income with the probability p which is predetermined by the government.

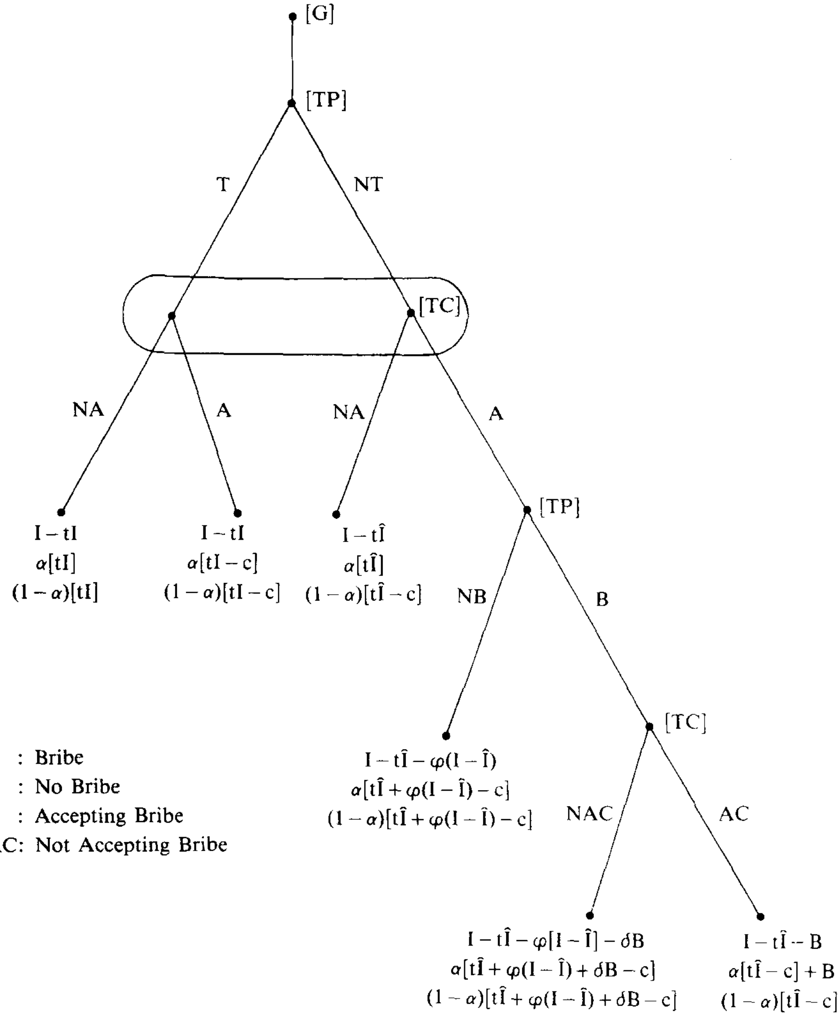
(A.8.) If TC finds that TP has underreported his income, TC levies fines $\varphi(I-\hat{I})$ for underreported income. After that TC may be offered bribe B by TP. In that event TC should determine whether to accept bribe or not.

Without bribe TC's income will be $\alpha[t\hat{I} + \varphi(I-\hat{I}) - c]$. If bribe is offered by TP, then TC's income will be

$$\begin{aligned} &\alpha[t\hat{I} - c] + B && \text{if TC accepts bribe,} \\ &\alpha[t\hat{I} + \varphi(I-\hat{I}) - c + \delta B] && \text{if TC rejects bribe.} \end{aligned}$$

We can depict the process of tax collection in the presence of bribery as a game tree shown in Figure 2.

In Figure 2 three rows at each final node represent the payoffs of TP, TC, and the government. At each stage of the game decision maker is shown in the bracket at each node. At the first stage of the game the government [G] moves announcing t, p, φ, and δ. Next the taxpayer [TP] decides reporting income $\hat{I}$. If $\hat{I} = I$, TP reports his true income, otherwise he underreports his realized income. It can be shown that TP's overreporting strategy is always weakly dominated by underreporting strategy. Upon being reported on TP's income, TC simply audits reported income with the probability p. The reason why TC is in the bracket at the third stage rather than G is that TC just executes tax auditing for the government. At the fourth stage of the game TP decides whether to bribe. At the final stage of the game TC decides whether to accept bribe.



B : Bribe
NB : No Bribe
AC : Accepting Bribe
NAC: Not Accepting Bribe

[Figure 2]

We can find a solution of the game by backward induction. First consider TC's decision rule.

TC's decision rule

TC accepts bribe B if and only if condition (AB) holds.

$$\alpha[t\hat{I} - c] + B \geqslant \alpha[t\hat{I} + \varphi(I - \hat{I}) + \delta B - c]$$

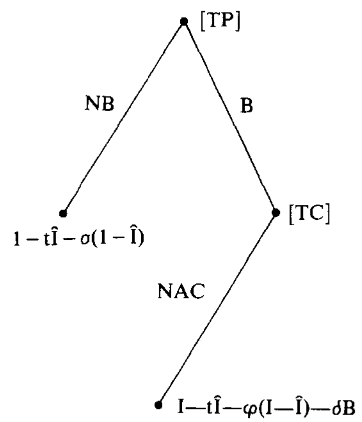
$$\text{or} \quad B(1 - \alpha\delta) \geqslant \alpha\sigma(I - \hat{I}) \tag{AB}$$

Condition (AB) means that TC accepts B iff TC's income upon accepting B is greater than TC's income upon not accepting B.

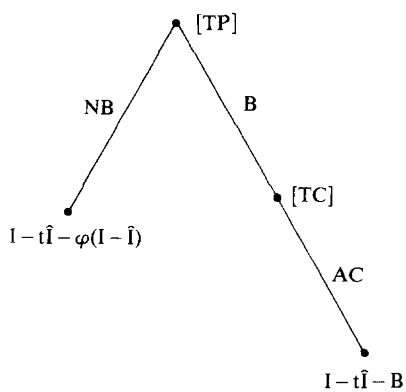
TP's second decision rule

Considering TC's decision rule TP decides whether to bribe and the optimal amount of bribe, B*. If TC chooses not to accept bribe, a sub-tree of the game looks like Figure 3a. In this case TP always decides not to bribe, since his realized income without offering bribe is greater than the other case, i.e.,

$$I - t\hat{I} - \varphi(I - \hat{I}) > I - t\hat{I} - \varphi(I - \hat{I}) - \delta B.$$



[Figure 3a]



[Figure 3b]

The case where TC chooses to accept bribe is shown in Figure 3b. In this event TP chooses to offer bribe to TC if and only if condition (B) holds,

$$I - t\hat{I} - B \geqslant I - t\hat{I} - \varphi(I - \hat{I}) \text{ or } B \leqslant \varphi(I - \hat{I}) \tag{B}$$

Thus if condition (AB) and (B) hold, TP will bribe and TC will accept it. From condition (AB) and (B), we obtain

$$(5)\ \frac{\alpha}{1-\delta\alpha}\varphi(I-\hat{I})\leqslant B\leqslant\varphi(I-\hat{I}).$$

AS shown in equation (5), B* can be any value between $\frac{\alpha}{1-\delta\alpha}\varphi(I\text{-}\hat{I})$ and $\varphi(I\text{-}\hat{I})$. B* depends on the bargaining power of TP and TC. If TP has the full bargaining power, B* will be the minimum $\frac{\alpha}{1-\delta\alpha}\varphi(I\text{-}\hat{I})$, while $B^*=\varphi(I\text{-}\hat{I})$ in the opposite case. Here we assume that TP has the full bargaining power since in most cases TP is the first mover in the bribery game.[3]

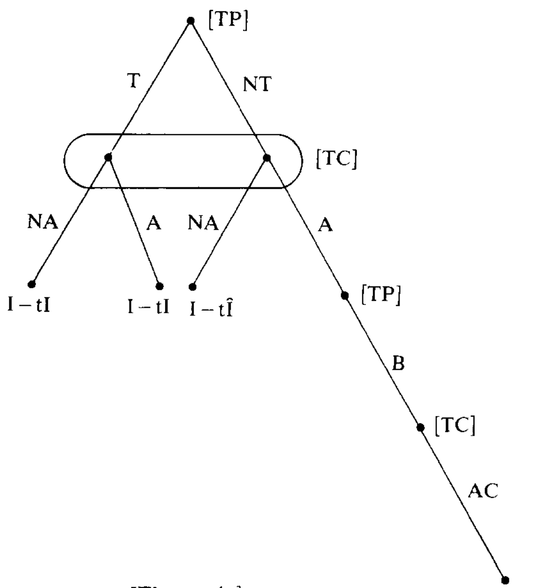
$$\text{Therefore } B^* = \max\left[0, \frac{\alpha}{1-\delta\alpha}\varphi(I\text{-}\hat{I})\right]. \qquad \text{(ABB)}$$

$$\text{Furthermore } B^* = \frac{\alpha}{1-\delta\alpha}\varphi(I\text{-}\hat{I}) \quad \text{if } \frac{\alpha}{1-\delta\alpha}\leqslant 1,$$

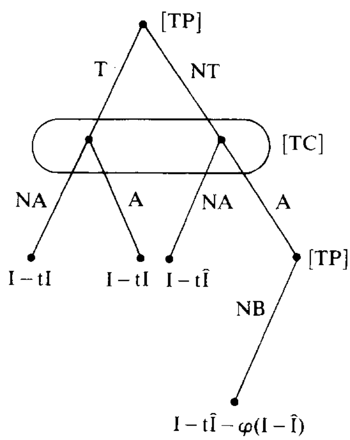
$$= 0 \qquad \text{if } \frac{\alpha}{1-\delta\alpha}>1.$$

TP's first decision rule

TP's first decision is whether to report true realized income. Figure 4a shows the game tree with bribe and Figure 4b shows one without bribe.



[Figure 4a]



[Figure 4b]

[3]This assumption does not affect our results of this paper.

(Case 1) $\delta \leqslant \frac{1-\alpha}{\alpha}$: Figure 4a

In this case TP offers bribe and TC accepts it. The expected income of TP, when TP's reported income is $\hat{I}$ is

$$(6)\ \ p(I - t\hat{I} - B) + (1\text{-}p)(I - t\hat{I}).$$

Thus TP chooses $\hat{I}$ to maximize (6), that is

$$(7)\ \ \underset{\hat{I}}{\text{Max}}\ p(I - t\hat{I} - B) + (1\text{-}p)(I - t\hat{I})$$

subject to $B = \frac{\alpha}{1-\delta\alpha}\varphi(I - \hat{I})$.

TP's decision rule will be $\hat{I} = I$ if $p\varphi\frac{\alpha}{1-\delta\alpha} - t \geqslant 0$,

$\hat{I} = 0$ if $p\varphi\frac{\alpha}{1-\delta\alpha} - t < 0$.

Since $\frac{\alpha}{1-\delta\alpha} \leqslant 1$, the expected fine rate must not be smaller than t to induce TP's truth-telling. This condition is more stronger than the other condition $p\varphi \geqslant t$ in the absence of bribery. It simply indicates that in the presence of bribery the penalty for tax evasion must be more strict than in the absence of bribery.

(Case 2) $\delta > \frac{1-\alpha}{\alpha}$: Figure 4b

In this case there will be no bribe at all. In the absence of bribery TP's expected income is

$$(8)\ \ p(I - t\hat{I} - \varphi(I - \hat{I})) + (1\text{-}p)(I - t\hat{I})$$
$$= (1 - p\varphi)I + (p\varphi - t)\hat{I}.$$

TP chooses $\hat{I}$ to maximize (8).
TP's decision will be $\hat{I} = I$ if $p\varphi \geqslant t$,

$\hat{I} = 0$ if $p\varphi < t$.

Condition $\delta > \frac{1-\alpha}{\alpha}$ implies that if the fine rate for attempting bribery is high enough given fixed α, there will be no bribe. When there is no bribe, the condition for truth-telling is equivalent to one in section 2.

Thus we have the following Lemmas that characterize TP's optimal reporting rule and bribe decision rule, given t, p, φ, and δ, α.

Lemma2: TP's decision rule (truth-telling)

(i) If $\delta \leqslant \frac{1-\alpha}{\alpha}$ and $p\varphi\frac{\alpha}{1-\delta\alpha} - t \geqslant 0$, then $\hat{I} = I$, $B^* = 0$ (a)

(ii) If $\delta > \frac{1-\alpha}{\alpha}$ and $p\varphi - t \geqslant 0$, then $\hat{I} = I$, $B^* = 0$. (b)

Once TP reports his true income, he does not offer bribe at all as shown in (ii) in Lemma2. Also once the government sets, t, p, φ, it had better the highest δ to induce TP's truth-telling.

The following Lemma characterizes no truth-telling case.

Lemma3: TP's decision rule (no truth-telling)

(i) If $\delta \leqslant \frac{1-\alpha}{\alpha}$ and $p\varphi\frac{\alpha}{1-\delta\alpha} - t < 0$,

then $\hat{I} = 0$ and $B^* = \frac{\alpha}{1-da}\varphi(I-\hat{I})$ (c)

(ii) If $\delta > \frac{1-\alpha}{\alpha}$ and $p\varphi - t < 0$, then $\hat{I} = 0$ and $B^* = 0$. (d)

Government decision rule

The objective of the government is to maximize its expected revenue. There are four cases (a), (b), (c), and (d). The expected revenue for four cases are as follows.

Case (a) and case (b): when $\hat{I} = I$ and $B^* = 0$, the expected revenue is

(9) $$R(I, \hat{I}) = \int(1\text{-}\alpha)\,[(1\text{-}p)\,tI + p(tI - c)]\,dG(I) = (1\text{-}\alpha)\,[tI\mu - pc],$$

where $I\mu = \int I\,dG(I)$ is average income.

(10) Case (c): when $\hat{I} = 0$ and $B^* = \frac{\alpha}{1-\delta\alpha}\varphi(I - \hat{I})$,

$$R(I, \hat{I}) = -(1\text{-}\alpha)\,pc$$

(11) Case (d): when $\hat{I} = 0$ and $B^* = 0$,

$$R(I, \hat{I}) = (1\text{-}\alpha)\,p(\varphi I\mu - c)$$

The government chooses t, p, φ, and δ to maximize (9) through (11) subject to each parameter constraints. Let us find a solution to each problem.

Case (a): $\hat{I}=I$, $B^*=0$

(12) $\underset{t,p,\varphi,\delta}{\text{Max}}$ (9) subject to $\delta \leqslant \frac{1-\alpha}{\alpha}$ and $p\varphi\frac{\alpha}{1-\delta\alpha} \geqslant t$.

Notice that there are usual parameter restrictions, $0 \leqslant t,p \leqslant 1$, $t \leqslant \varphi \leqslant 1$, and $0 < \delta \leqslant \bar{\delta}$. Given α, the government had better set the highest δ, since higher δ induces more TP's truth-telling without any cost. Thus, $\delta^* = \frac{1-\alpha}{\alpha}$ when $\frac{1-\alpha}{\alpha} < \bar{\delta}$ and $\delta^* = \bar{\delta}$ when $\frac{1-\alpha}{\alpha} \geqslant \bar{\delta}$. Next, φ must be the maximal value to allow for the second constraint to be satisfied. Thus, $\varphi^*=1$.

If $\delta^* = \frac{1-\alpha}{\alpha}$, then the problem becomes

$$\underset{t,p}{\text{Max}}\ (1\text{-}\alpha)\ [tI\mu - pc] \text{ subject to } p-t \geqslant 0.$$

Setting up the Lagrangian for this problem, we solve

(13) $\text{Max } L = (1\text{-}\alpha)\ [tI\mu - pc] - \lambda(t-p)$

The solution to this problem is

(14-a) $p^* = t^* = \varphi^* = 1$ and $R^* = (I\mu - c)(1\text{-}\alpha)$ if $I\mu > c$,
(14-b) $0 \leqslant p^* = t^* \leqslant 1$ and $R^* = 0$ if $I\mu = c$,
(14-c) $p^* = 0$ and t^*, φ^* are irrelevent, and $R^* = 0$ if $I\mu < c$.

If $\delta^* = \bar{\delta} < \frac{1-\alpha}{\alpha}$, then the problem becomes

(15) $\text{Max } (1\text{-}\alpha)(tI\mu\ -\ pc)$ subject to $p\ k \geqslant t$,

where $= \frac{\alpha}{1-\bar{\delta}\alpha} < 1$. The solution to this problem is

(16-a) $p^* = 1$, $t^* = k$, and $R^* = (1\text{-}\alpha)\ [kI\mu - c]$ if $kI\mu > c$,
(16-b) $0 \leqslant t^* = P^*k \leqslant 1$ and $R^* = 0$ if $kI\mu = c$,
(16-c) $p^* = 0$ and t^*, φ^* are irrelevent, and $R^* = 0$ if $kI\mu < c$.

Case (b): $\hat{I}=I$, $B^*=0$

(17) Max (9) subject to $\delta > \frac{1-\alpha}{\alpha}$ and $p\ \varphi - t \geqslant 0$.

This problem is collapsed to problem (13), since the constraint $\delta > \frac{1-\alpha}{\alpha}$ dose not affect the decisions on t, p, and φ.

In both cases (a) and (b), $\hat{I} = I$ and $B^* = 0$ except when $p^* = 0$. R^* is the maximal revenue that the government can raise given situation, then solutions (14) and (16) are the equlibrium of the game. We call the equilibrium characterized in (14-a) and (14-b) the Incentive-Compatible equilibrium and the one characterized in (16-a) and (16-b) the Incentive-Compatible k equilibrium, and the one in (14-c) and (16-c) the zero revenue equilibrium.

Theorem2

(i) IC equilibrium:

Suppose $\frac{1-\alpha}{\alpha} < \bar{\delta}$, then $t^* = p^*$, and $\varphi^* = 1$. Furthermore,

$$\begin{array}{ll} p^* = 1 & \text{if } I\mu > c, \\ 0 \leqslant p^* \leqslant 1 & \text{if } I\mu = c. \end{array}$$

(ii) IC(k) equilibrium

Suppose $\frac{1-\alpha}{\alpha} \geqslant \bar{\delta}$, hen $t^* = kp^*$ and $\varphi^* = 1$, where $k = \frac{\alpha}{1-\bar{\delta}\alpha}$. Furthermore,

$$\begin{array}{ll} p^* = 1 & \text{if } kI\mu > c, \\ 0 \leqslant p^* \leqslant 1 & \text{if } kI\mu = c. \end{array}$$

(iii) zero revenue equilibrium

Either when $\frac{1-\alpha}{\alpha} < \bar{\delta}$ and $I\mu < c$ or when $\frac{1-\alpha}{\alpha} \geqslant \bar{\delta}$ and $kI\mu < c$, $p^* = 0$ and t^* and φ^* are irrelevent since $\hat{I} = B^* = 0$.

Even in the presence of bribery, the government can induce TP's truthful reporting. Now consider the Bribery equilibrium.

Definition: Bribery equilibrium

Bribery equilibrium is an equilibrium in which $B^* > 0$, $\hat{I} < I$.

B equilibrium can exist only in case (c).

Case (c): when $B^* = \frac{\alpha}{1-\delta\alpha}\varphi(I-\hat{I})$ and $\hat{I} = 0$, the government problem is

$$\text{(18) Max -pc } (1\text{-}\alpha) \text{ subject to } \delta \leqslant \frac{1-\alpha}{\alpha},\ p\ \varphi\frac{\alpha}{1-\delta\alpha} - t < 0$$

Regardless of value of $\bar{\delta}$ a solution to problem (18) is $p^* = 0$ and R^* will be zero. But, once $p^* = 0$, there will be no bribe chance, thus it is not a B equilibrium. Thus we have the following Theorem.

Theorem3
Under the assumptions (A.1.)-(A.8.), there does not exist Bribery equilibrium.

Theorem 3 implies that the government can deter bribery perfectly by setting the appropriate parameter values of fiscal tools -t, φ, p as well as the fine rate for bribery δ. This result comes from the fact that when conditions for the existence of Bribery equilibrium are satisfied, the government will set $p=0$, since it has no benefit from auditing. Suppose an auditing is performed, then TP offers bribe and TC accepts it. In this event both TP and TC can be benefited from bribery while the government obtains nothing and only pays the auditing cost.

Case (d): when $B^*=0$, $\hat{I}=0$.

Clearly there does not exist a solution for this problem, since the constraint is not binding. Only in the limiting case where $p\varphi=t$, there is a solution which is equivalent to case (b) solution.

Now we examine the role of α, the salary rate of TC that is exogenously given. If α is large enough so that $\delta>\frac{1-\alpha}{\alpha}$ is satisfied and $I\mu>c$, then the government sets $\delta^*=\frac{1-\alpha}{\alpha}$ to prevent bribery and we have IC equilibrium.

When α gets smaller so that the constraint $\bar{\delta}\leqslant\frac{1-\alpha}{\alpha}$ is satisfied, and $kI\mu>c$ is satisfied, then we have IC(k) equilibrium. Thus there exists a critical α^{**} such that if $\alpha>\alpha^{**}$, then there exists IC equilibrium and if $\alpha\leqslant\alpha^{**}$, then there exists IC(k) equilibrium. Clearly α^{**} solves the following equation $\bar{\delta}=\frac{1-\alpha}{\alpha}$.

Suppose α becomes further smaller to make k smaller as well such that the condition $kI\mu\geqslant c$ is not satisfied, then we will have either zero revenue equilibrium. There exists a critical α^* such that if $\alpha<\alpha^*$, then there exists zero revenue equilibrium and if $\alpha^*\leqslant\alpha\leqslant\alpha^{**}$, there exists IC(k) equilibrium. Clearly α^* satisfies the following equation $kI\mu=c$ or $\frac{\alpha}{1-\bar{\delta}\alpha}I\mu=c$.

Therefore we have the following Theorem.

Theorem 4

(1) If $I\mu\geqslant c$, then there exist α^{**} and α^* ($\alpha^*<\alpha^{**}$) such that if $\alpha^{**}<\alpha$, then there exists IC equilibrium, if $\alpha^*\leqslant\alpha\leqslant\alpha^{**}$, then there exists IC(k) equilibrium, and if $\alpha<\alpha^*$, then there exists zero revenue equilibrium.

(2) If $I\mu<c$, then regardless of α (in this case $\alpha^{**}<\alpha^*$) only zero revenue equilibrium exists.

Theorem 4 implies that if the government can set α the government had better set α to be greater than α^* to induce TP's truth-telling and to prevent bribery. However when it comes to revenue raising the optimal α that is greater than α^* must be chosen. For this problem we have the following Theorem.

Theorem5
There exists α^{***} such that $\alpha^{**}<\alpha^{***}\leqslant\alpha^{**}$ and for α^{***} the government raises

the maximum net revenue.

Theorem5 implies that the government must set α to be greater than α^* to induce TP's thruth-telling. When $\alpha^*<\alpha$ the total revenue, that is the sum of TC's salary and the government net revenue, is monotonically increasing in α. However, for $\alpha^{***}<\alpha$, the government revenue is decreasing in α since the portion of total revenue that goes to TC becomes too large. In conclusion the government must set α appropriately so that it is not too low and not too high. For too low α the government cannot induce TP's truth-telling and for too high α the government simply loses its net revenue without affecting revenue raising scheme.

Also the government must set the highest fine rate for attempting bribery to prevent bribery. Thus δ^* is either $\bar{\delta}$ or $\frac{1-\alpha}{\alpha}$.

IV. CONCLUDING REMARKS

In this paper we extended the basic model of tax evasion where the government plays a role of the tax collector simultaneously. In the extended model the tax collector differs from the government and her objective is to maximize her income which consists of salary that is proportional to the government tax revenue and bribe income. The tax collector optimally decides whether to accept bribe from the taxpayer. The taxpayer chooses reporting income and the amount of bribe when his underreporting is audited.

In a three-person game which can be represented by a sequential game, there can be two sorts of equilibrium. One is Incentive-Compatible equilibrium and the other is Bribery equilibrium. In IC equilibrium the taxpayer reports his true income and offers no bribe to the tax collector. In B equilibrium the taxpayer reports zero income and offers the positive amount of bribe.

If α the salary rate of the tax collector is high enough, then we will have IC equilibrium in which positive revenue is raised and $P^*=1$ if average income exceeds the auditing cost, while $p^*=0$ if average income is less than the auditing cost. In IC equilibrium it must hold that $t^*=p^*\varphi^*$.

If α is smaller and bounds δ^*, the optimal fine rate for attempting bribery to be $\bar{\delta}$, then IC(k) equilibrium exists. Positive revenue which is smaller than the revenue from IC equilibrium is raised if $kI\mu$ exceeds the auditing cost, where k is less than 1. Also $kt^*=p\ \varphi$ must hold in IC(k) equilibrium.

We show that Bribery equilibrium does not exist. It implies that the existence of bribery in the real world simply indicates that the government control over various fiscal tools to prevent bribery are not appropriate.

To prevent bribery it is recommended that the salary rate for the tax collector must exceed a certain level, if the government can set its value. However the government must set α to be not too high to raise the maximum government net revenue.

REFERENCES

BECKER, GARY S. (1968), "Crime and Punishment: An Economic Approach," *Journal of Political Economy* 76, pp. 169-217.

BORDER, KIM and JOEL SOBEL (1987), "A Theory of Auditing and Plunder," *Review of Economic Studies,* LIV, pp. 525-540.

GEENSBERG, JOSEPH (1984), "Avoiding Tax avoidence: A (Repeated) Game-Theoretic Approach," *Journal of Economic Theory* 2, pp. 1-13.

KOLM, SERGE-CHRISTOPHE (1973), "A Note On Optimum Tax Evasion," *Journal of Public Economics* 2, pp. 265-270.

MOOKHERJEE, DILIP and I. PNG (1989), "Optimal Auditing, Insurance, and Redistribution," *Quarterely Journal of Economics* CIV, pp. 399-416.

REINGANUM, J.F. and L.L. WILDE (1985), "Income Tax Compliance in a Principal-Agent framework," *Journal of Public Economics* 25, pp. 1-18.

SANDMO, AGNAR (1981), "Income Tax Evasion, Labour Supply, and The Equity-Efficiency Tradeoff," *Journal of Public Economics* 16, pp. 265-288.

________ and M.G. ALLIGHAM (1972), "Income Tax Evasion: A Theoretical Analysis," *Journal of Public Economics* 1, pp. 323-328.

TOWNSEND, ROBERT M. (1979), "Optimal Contracts and Competitive Markets with Costly Verification," *Journal of Economic Theory* 21, pp. 265-293.

WEISS, LAURENCE (1976), "The Desirability of Cheating Incentives and Randomness in The Optimal Income Tax," *Journal of Political Economy* 84, pp. 1343-1352.

APPENDIX

(Proof of Lemmal)

The problem of TP is to choose $\hat{I}$ to maximize $(p\varphi - t)\,\hat{I} + I$. Thus $\hat{I} = 0$, if $t > p\varphi$, and $\hat{I} = 1$ if $t \leqslant p\varphi$. (Q.E.D.)

(Proof of Theoreml)

First $\varphi^* = 1$ is optimal since by setting up the highest φ the government can induce TP to report true income. Once $\varphi^* = 1$, the problem (i) and (ii) become

(i′) Max $R = pI\mu - cp = p(I\mu - c)$ s.t. $t > p$ and $0 \leqslant t, p \leqslant 1$,

(ii′) Max $R = tI\mu - cp$ s.t. $t \leqslant p$ and $0 \leqslant t, p \leqslant 1$.

We consider only (ii′) since (i′) is unbounded problem. Given any $0 \leqslant p \leqslant 1$, $t = p$ is optimal. Now the problem (ii′) becomes Max $R = p(I\mu - c)$. Thus $p^* = 1$ if $I\mu > c$. If $I\mu < c$, the $p^* = 0$ and t^*, φ^* are irrelevent since $\hat{I} = 0$. Finally $I\mu = c$, any $p^* = t^*$ between 0 and 1 is optimal. (Q.E.D.)

(Proof of Lemma2)
In (case 1) if $\delta \leqslant \frac{1-\alpha}{\alpha}$, then $B^* = \frac{\alpha}{1-\delta\alpha}\varphi(I-\hat{I})$. In addition from (7) if $p\varphi\frac{\alpha}{1-\alpha} - t \geqslant 0$, $\hat{I} = I$ and $B^* = 0$ accordingly. Thus (i) holds.

In (case 2) if $\delta > \frac{1-\alpha}{\alpha}$, then $B^* = 0$. Also if $p\varphi - t \geqslant 0$, then $\hat{I} = I$. Thus (ii) holds.
(Q.E.D.)

(Proof of Lemma3)
A similar proof may be given as Lemma 2. (Q.E.D.)

(Proof of Theorem2)
(i) When $\delta \leqslant \frac{1-\alpha}{\alpha} < \delta$, $\delta^* = \frac{1-\alpha}{\alpha}$. In (13) for any $0 \leqslant p \leqslant 1$, the constraint $p - t \geqslant 0$ implies $t^* = p^*$ is optimal since revenue is increasing in t. Now the government problem becomes to maximize $(1\text{-}\alpha)\, t\, (I\mu - c) = (1\text{-}\alpha)\, p\, (I\mu - c)$. Thus if $I\mu > c$, then $p^* = 1$ is optimal so that $p^* = t^* = \varphi^* = 1$ and $R^* = (1\text{-}\alpha)\, p\, (I\mu\text{-}c)$. If $I\mu < c$, then $p^* = 0$ is optimal. Once $p^* = 0$, t^* and φ^* are irrelevent since $\hat{I} = 0$ always. In this case $R^* = 0$. If $I\mu = c$, then any t^* and p^* between 0 and 1 are optimal and $R^* = 0$.

When $\frac{1-\alpha}{\alpha} < \alpha$ the problem (17) is collapsed to problem (13) and we have the same solution.

(ii) If $\delta^* = \delta < \frac{1-\alpha}{\alpha}$, then the government problem is (15). The constraint $pk \geqslant t$ implies that given any $0 \leqslant p \leqslant 1$, $t = pk$ is optimal. Now the problem becomes to maximize $(1\text{-}\alpha)\, p\, (kI\mu - c)$. Thus if $kI\mu > c$, then $p^* = 1$, $t^* = k$, and $R^* = (1\text{-}\alpha)\, (kI\mu - c)$. If $kI\mu < c$, then $p^* = 0$ and $R^* = 0$. Finally if $kI\mu = c$, then any $t^* = kp^*$ between 0 and 1 are optimal and $R^* = 0$. (Q.E.D.)

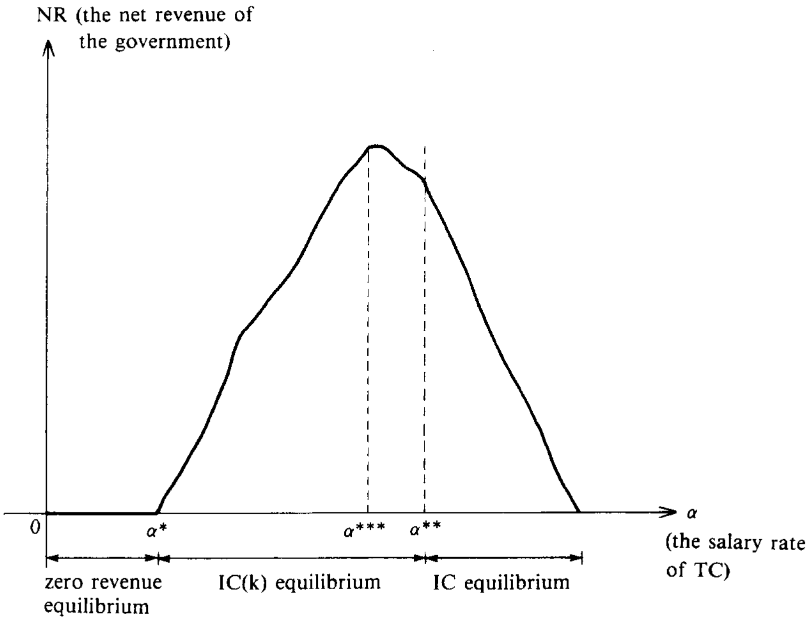
(Proof of Theorem3)
The proof of Theorem3 is already given in the main context.

(Proof of Theorem4)
The proof of Theorem4 is already given in the main context.

(Proof of Theorem5)
The government net revenue function $NR(\alpha)$ is as follows,

$$
\begin{array}{ll}
NR(\alpha) = 0 & \text{for } \alpha < \alpha^* \\
NR(\alpha) = (1\text{-}\alpha)\ (kI\mu - c) & \text{for } \alpha^* \leqslant \alpha \leqslant \alpha^{**} \\
NR(\alpha) = (1\text{-}\alpha)\ (I\mu - c) & \text{for } \alpha^{**} < \alpha.
\end{array}
$$

First NR is continuous in α. Second for $\alpha^{**} < \alpha$, NR is monotonically decreasing in α. As shown in Figure 5. $NR(\alpha^*) = 0$ and $NR(\alpha^{**}) > 0$. By the Mean Value Theorem, there exists α^{***} such that $NR(\alpha^{***}) \geqslant NR(\alpha^{**})$. (Q.E.D.)


NR (the net revenue of
the government)
0
α^*
α^{***}
α^{**}
α
(the salary rate
of TC)
zero revenue
equilibrium
IC(k) equilibrium
IC equilibrium

[Figure 5]