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計畫參與人員：博士班研究生-兼任助理：范志萍、張家瑋
碩士班研究生-兼任助理：林純祺、陳紀瑩
大學生-兼任助理：呂一軒

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Tax Auditing as a Public Goods Game: Experimental Evidence on the Incentive to Punish Evaders

Li-Chen Hsu^{*}

Department of Public Finance
National Chengchi University
64, Section 2, Chih-Nan Road
Taipei, Taiwan 11605, R.O.C.
TEL: (886) 0-2938-7313
FAX: (886) 2-2939-0074
E-mail: lchsu@nccu.edu.tw

Abstract – In the literature of tax compliance, the audit probabilities, no matter certain or uncertain, are exogenously determined by the government. This paper provides an experimental examination of the behavior of tax evasion when the audit probabilities are endogenously determined by taxpayers. Players in the experiment pay taxes on the income declared and they transfer some or all of their tax payments to a punishment account after they saw the declarations by all group members. The size of the punishment account determines the number of group members to be audited. The experimental evidence shows that the endogenous auditing mechanism significantly improves compliance as compared to not having an audit. Players are willing to sacrifice a large amount of tax payments that they originally planned to fund a public good for detecting and punishing the evaders.

Keywords: Tax compliance; Public goods; Punishments; Experiments

JEL Classification: C92, H26, H41

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INTRODUCTION

The issue of tax compliance has attracted extensive attention since Allingham and Sandmo's (1972) pioneering theoretical paper. Due to the advantage of quarantining unwanted disturbances outside the laboratories, in recent years more and more researchers have relied on experimental methods to explore the behavior of tax evasion. Experimental studies on tax compliance generally examine the effects of the fiscal variables (tax rates, audit probabilities, and penalty rates) on the levels of compliance. The common findings are that compliance increases significantly with audit probabilities and fine rates, while the effects of tax rates on compliance are inconclusive.

In practice tax rates and penalty rates are observable, but the governments are oftentimes reluctant to announce the audit probabilities. However, most existing experimental studies that find significant and positive relationships between audit probabilities and compliance assume that subjects face constant audit probabilities.¹ Spicer and Thomas (1982) and Alm, Jackson, and McKee (1992a) are two exceptions. Spicer and Thomas (1982) divide subjects into three groups. In the first group, the subjects are given precise information regarding audit probabilities (0.05, 0.15, and 0.25). In the second group, subjects are informed that imprecise the audit probability is low, high, or medium. In the third group, subjects have no information on audit probabilities. They found that the increase in audit probabilities deterred evasion when information was precise, but this result did not necessarily hold when the information was

¹ Experimental studies that assume certain audit probabilities and find compliance increases significantly with audit probabilities include Spicer and Thomas (1982, when the audit probability is precise), Witte and Woodbury (1985), Crane and Nourzad (1986), Dubin and Wilde (1988), Alm, McKee, and Beck (1990), Dubin, Graetz, and Wilde (1990), Beck, Davis, and Jung (1991), Alm, McClelland, and Schulze (1992), Alm, Sanchez, and de Juan (1995), Pommerehne and Weck-Hannemann (1996), Cullis, Jones, and Lewis (2006), and Gërkhani and Schram (2006, for Dutch subjects).

imprecise or when there was no information at all. In the study of Alm, Jackson, and McKee (1992a), the audit probability is 0.04 in the treatment without uncertainty and is either 0.02 or 0.06 in the treatment with decision uncertainty. They found that uncertainty in audit probabilities raises compliance significantly when the tax revenue is discarded but the opposite trend occurs when the tax revenue is used to fund the public good.

The experimental evidence above suggests that certain and uncertain audit probabilities may result in very different effects on compliance. Since in reality the governments are usually reluctant the audit probabilities, studying tax compliance in an environment with uncertainty in audit probabilities is imperative. This paper proposes an endogenous auditing mechanism in which the audit probability is determined by the taxpayers. Players in the experiment pay taxes on the income declared and they transfer some or all of their tax payments to a punishment account after they saw the declarations by all group members. The size of the punishment account determines the number of group members to be audited, or the audit probability. The main findings of this paper are that endogenous auditing significantly improves compliance as compared to not having an audit, and that players are willing to sacrifice a large amount of tax payments that they originally planned to build a public good for detecting and punishing the evaders.

The following section of this paper explains the experimental design for exploring the behavior of tax evasion when audit probabilities are endogenously determined. Section 3 discusses the results of the experiments. Section 4 concludes.

EXPERIMENTAL DESIGN

The experimental design is similar to those in the existing public goods experiments and

Alm et al.'s tax compliance experiments. In the experiment, subjects receive income and they pay taxes on the income declared. If there is an auditing process, their true incomes are audited by an endogenously determined probability, which will be explained later. They pay the evaded taxes and a fine if they are caught cheating. The taxes are used to fund a public good whose size depends on the tax payments (and fines if there is an audit) of all group members. The group members' payoffs come from the benefits derived from the public good and a private good, which is their income net of taxes and the evaded taxes and penalties if there are any. To prevent subjects' emotional reactions from being aroused or subjects' incentives from being affected, neutral terms are used in the instructions. For instance, in the Subjects' Instructions they are informed that their true income will be "checked" instead of "audited." The term "taxes" is also avoided and are replaced by "investments."

Two treatments, NoAudit and EndogP, are conducted in this research. Table 1 summarizes the magnitudes of the experimental parameters used in the two treatments. The first treatment is the NoAudit treatment, which serves as the baseline treatment. The NoAudit treatment is actually a public goods game, with a slight difference in the contributing mechanism from the traditional public goods experiments: subjects in the public goods experiments contribute some or all of their income to the public good directly, while in the NoAudit treatment subjects declare some or all of their income and contribute a certain proportion of the declared income to the public good. This proportion is set at 0.3 of their income declared or the tax payments are 30 percent of their income declared. The MPCR of the public good is 0.5, namely, each dollar of taxes paid by anyone yields, respectively, a return of 0.5 dollars to each group member. Notice that the MPCR must meet the condition $(1/\text{group size}) < \text{MPCR} < 1$. The reason for this is that if the MPCR is greater than one, then everyone will have the incentive to pay as much tax as he

or she can. By contrast, if the MPCR is less than the reciprocal of the group size, then no one will have the incentive to pay taxes.

[Table 1 about here]

The magnitudes of the tax rate and MPCR of the public good in the EndogP treatment are the same as those in the NoAudit treatment, but differing from the NoAudit treatment, subjects' true incomes are audited after declarations. If subjects are caught cheating, they need to pay the evaded taxes and fines, which is three times the evaded taxes. The magnitudes of the tax rate, MPCR of the public good and fine rate were chosen to be comparable with those used in existing experimental studies.²

The experimental procedures were run as follows. In the first treatment, there is no auditing procedure. This treatment is called the no-audit treatment, or NoAudit. Two sessions, with 24 subjects in each session, were conducted in the NoAudit treatment. The second treatment involved an auditing process, in which the audit probability was endogenously determined by players. We call this treatment the endogenous-audit-probability treatment, or EndogP. The EndogP treatments involves four sessions, each also with 24 subjects. The subjects were recruited from economics courses at National Chengchi University in Taiwan. None of them had ever participated in any public goods or tax compliance experiments. All sessions were conducted in the computer lab of the Department of Public Finance at the National Chengchi University.

Each session contained twenty rounds. In each round every twelve subjects were randomly and anonymously assigned to groups of four and they were re-matched when a new round started. Therefore, two independent samples are obtained from each session. At the

² For instance, Alm et al. have in various experiments set the MPCRs of the publicly provided public good to be 0.25, 0.4, and 0.75, the tax rates to be 0.1, 0.3, 0.4, and 0.5, and the fine rates to be 1, 2, and 3.

beginning of each round, the four subjects in the same group were randomly assigned the income levels 40, 60, 80, and 100 points, respectively. When a new round started, the levels of income were randomly reassigned. Subjects knew their own income and the distribution of income, but not the income levels of the other three group members.

In the NoAudit treatment, subjects were required to declare the points that they were assigned. The points declared could not be below zero, nor could it exceed the points assigned. Thirty percent (which is the tax rate) of the declared points was invested in the X account (the public good). The payoff from the X account for each subject was the product of the MPCR of the X account (which is 0.5) and the total investment in the X account by the group. The rest of the income was invested in each subject's own private account (private good). The subject's payoff was the points left in the private account plus earnings from the X account. At the end of each round, each subject was informed from his (her) computer screen of a result report, which contained the following information: the amount of points assigned to the subject, the amount of points declared and the amount of points invested in the X account by each of the four group members, the total points declared and the total investment in the X account by the group, the points left in the subject's private account, the earnings from the X account, the subject's payoff for this round, and the subject's cumulative payoff until this round.

Each round in the EndogP treatment involved two stages. The first stage was a declaration stage, in which the same procedures in the NoAudit treatment were run. At the end of the first stage a result report similar to that in the NoAudit treatment was shown on each subject's computer screen, with the payoff for this round replaced by the payoff for this stage in this round and the cumulative payoff unreported.

After reviewing the result report of the first stage, subjects proceeded to the second stage, an

auditing stage, in which the auditing procedure was run as follows. Each subject decided on transferring some or all of the points that he (she) originally invested in the X account to the Y account. If the total points in the Y account reached some thresholds, then some group members were audited. The relationship between the total points in the Y account and the number of group members audited is indicated in Table 2. For instance, if the total points in the Y account reached 8 points but less than 18 points, then two group members' true incomes would be audited.

The Y account is actually a step-level public good. The tax payers contribute some or all of their tax payments to the Y account voluntarily and use the fund cumulated in it to audit and punish those who evade taxes. Since the main purpose of the Y account is to punish evaders, the Y account is also called the punishment account and the punishment rate is defined accordingly as the ratio of the subject's tax payment that is transferred to the punishment account to the subject's original tax payment.

[Table 2 about here]

If the subject was caught underreporting, his (her) payoff this round would be reduced by the sum of the under-investment to the X account (i.e., the taxes evaded) and three times this amount (i.e., the fines). If his (her) payoff this round was not enough for such a reduction, then the insufficient part would be subtracted from his (her) payoff from the past and/or future rounds. This reduction would be re-invested to the X account. That is, the evaded taxes retrieved and the fines became part of the public good. The size of the X account after the auditing was the total investment in the X account by the group minus the total points transferred to the Y account by the group and plus the evaded taxes and fines retrieved from the group member(s) who was (were) detected underreporting.

At the end of second stage, each subject received a result report from the computer screen. In addition to the information provided in the first-stage result report, other information includes: the amount of points the subject transferred from his investment in the X account to the Y account, whether he (she) was audited, his (her) reduction, the total amount of points transferred from the X account to the Y account by the group, the number of group member(s) audited and the total reduction, the size of the X account after the auditing, the subject's payoff this round and his (her) cumulated payoff until this round.

Subjects were given written instructions in Chinese. The experimenter read the instructions aloud, performed the calculations of the examples in the instructions on the whiteboard, and answered any questions raised by the subjects. The NoAudit sessions each last about 60 minutes and the EndogP sessions each lasted about 80 minutes. The average payoff of all participants was NT\$432.70 (with a standard deviation of NT\$28.04, a maximum of NT\$492.80, and a minimum of NT\$363.28).³

RESULTS

Table 3 summarizes the data resulting from the entire twenty rounds and the last ten rounds in each treatment. Since the subjects who are endowed with higher income inherently have a greater ability to pay taxes and to make contributions, the compliance rate, which is defined as the reported income divided by the true income, is used when performing statistical analyses. Similarly, the punishment rate is defined as the amount of points the subject invested in the Y account divided by his (her) investment in the X account.

³ When these experiments were conducted, the exchange rates between the NT (New Taiwan) dollar and the US dollar were in the range of 32:1 to 33:1. The part-time hourly wage rate for an undergraduate student in Taiwan is about NT\$120.

[Table 3, Figures 1 and 2 about here]

Figures 1 and 2 illustrate respectively the information regarding compliance. Figure 1 shows that the average compliance rates in both treatments start high in the first round: 0.607 in the NoAudit treatment and 0.787 in the EndogP treatment, but opposite patterns appear as the games proceed. The compliance rate in the NoAudit treatment decreases almost monotonically across rounds and reaches the lowest levels in the final two rounds, with an average compliance rate of 0.372 over the entire twenty rounds and of 0.297 for the last ten rounds. On the contrary, the compliance rate in the EndogP treatment maintains at the high level and rises steadily. Starting round twelve, 90 percent or more of the income is reported honestly. The average compliance rate is 0.879 over the entire twenty rounds and 0.921 for the last ten rounds. The two-sided Mann-Whitney U test shows that the compliance rate is significantly higher in the EndogP treatment than in the NoAudit treatment by looking at entire twenty rounds ($p = 0.000$) or the last ten rounds ($p = 0.000$).

Figure 2 depicts the percent of subjects reporting zero and full income in the two treatments. The percent of subjects reporting zero income starts very low in both treatments, with 4.17 percent in NoAudit and 2.08 percent in EndogP. The percent of subjects evading all taxes rises in the NoAudit treatment and reaches the maximum of 47.92 percent in round 19, with an average of 20.73 percent across all twenty rounds. On the contrary, the percent of subjects evading all taxes in the EndogP treatment remains at low levels, with an average of 1.93 percent across all twenty rounds. In the last ten rounds, at most one or two percent of subjects behave so, and in rounds 17, 19, and 20 no one evade any taxes. The two-sided Mann-Whitney U test shows that the percent of subjects evading all taxes is significantly higher in the NoAudit treatment than in the EndogP treatment regardless of looking at entire twenty rounds ($p = 0.000$).

or the last ten rounds ($p = 0.000$).

An opposite trend is observed when we look at the behavior of fully complying. The percent of subjects who fully comply starts 8.33 percent in the first round and maintain at low levels across rounds. On average 5.42 percent of subjects fully comply and in rounds 15 and 18 no one reports full income. The percent of subjects who are completely honest starts at 15.63 percent in round, increases sharply and reaches the maximum of 65.63 percent in round 17. The average across all twenty rounds is 47.66 percent, which is much higher than the 5.42 percent in the NoAudit treatment. The two-sided Mann-Whitney U test shows that the percent of subjects fully complying is significantly higher in the EndogP treatment than in the NoAudit treatment regardless of looking at entire twenty rounds ($p = 0.000$) or the last ten rounds ($p = 0.000$).

These findings indicate that the endogenous auditing mechanism improves compliance significantly than if there is no audit at all. Alm, Jackson, and McKee (1992a, 1992b, 1993), Alm, McClelland, and Schulze (1992), and Alm, Sanchez, and de Juan (1995) report that the average compliance rates with a fixed audit probability and under the condition of public good provision generally fall into the range of 0.266 to 0.675. The level of compliance in the EndogP treatment is also higher than those in the experiments with fixed auditing probabilities. While the results from existing public goods experiments are diversified under different values of the experimental parameters (the magnitudes of the MPCRs, the levels of endowments, and the sizes of groups, etc.), the magnitudes and the downward trend of the compliance rate in the NoAudit treatment are also comparable with some experimental studies, such as Andreoni (1988), Isaac and Walker (1988a, 1988b), and Isaac, Walker, and Williams (1994).

The very high level of compliance maintained in the EndogP treatment can be attributed to

the endogenous auditing mechanism. Figure 3 sketches the relationships between the compliance rate, punishment rate, and the audit probability across rounds. The subjects transfer an average of 20 to 30 percent of their tax payments to the punishment account each round. The punishment rate and the audit probability generally have a negative relationship with the compliance rate. However, a small amount of the taxes evaded induces a large amount of fund directed to the punishment account. For instance, an average of only 6.88 percent of the income is unreported in the last five rounds, but 19.93 percent of the tax payments are used to audit the evaders, indicating that the tax payments that are directed to audit the evaded tax is larger than the amount of the evaded tax.⁴

CONCLUSION

This paper presents an experimental test to explore the behavior of tax evasion when the audit probability is endogenously determined by taxpayers. The experimental evidence shows that that endogenous auditing significantly improves the compliance rate, lowers the percent of players completely evading, and raises the percent of players fully complying as compared with not having an audit at all. Players are willing to sacrifice a large amount of tax payments that they originally planned to fund a public good for detecting and punishing the evaders. The evidence also shows that some players are extremely selfish. They pay the full taxes to fund the public good not based on altruism, but because of the fear that they might be audited. They switch all or almost all of their tax payments to the punishment account even if the amount of the evaded tax is small or zero.

⁴ An average of 6.88 percent of the income unreported means that an average of 6.88 percent of the taxes is evaded, or 93.12 percent of the taxes are collected. The amount of taxes directed to auditing is 19.93 percent of the taxes collected, or equivalently 18.56 percent of the tax base, which is larger than the amount of the evaded tax.

TABLE 1
EXPERIMENTAL PARAMETERS

Treatment	NoAudit	EndogP
Tax rate	0.3	0.3
Audit probability	0	endogenous
Fine rate	0	3
MPCR	0.5	0.5
Group size	4	4
Number of sessions	2	4
Number of subjects in one session	24	24
Total number of subjects	24	96
Number of rounds	20	20
The number of independent samples	4	8

TABLE 2
THE RELATIONSHIP BETWEEN THE Y ACCOUNT AND AUDIT

The total points in the Y account	0	2	8	18	32
The number of group members audited	0	1	2	3	4

TABLE 3
DESCRIPTIVE STATISTICS

	NoAudit		EndogP	
	Rounds 1-20	Rounds 11-20	Rounds 1-20	Rounds 11-20
Average compliance rate	0.372 (0.215)	0.297 (0.229)	0.879 (0.112)	0.921 (0.097)
Percent of subjects declaring zero income	20.73% (0.230)	28.33% (0.291)	1.93% (0.054)	0.94% (0.046)
Percent of subjects fully complying	5.42% (0.099)	4.58% (0.094)	47.66% (0.295)	58.13% (0.330)
Percent of subjects audited	-	-	58.59% (0.138)	53.33% (0.194)
Average punishment rate	-	-	0.251 (0.170)	0.221 (0.204)
Average earnings (in NT\$)	310.01 (23.91)	151.73 (15.97)	344.05 (22.60)	170.46 (12.40)

Notes: The observations are the average values of all individual subjects' average choices across all twelve rounds. The numbers in parentheses are the standard deviations of all subjects' average choices across all twelve rounds. The average earnings reported exclude the participation fee NT\$100.

Figure 1. The Average Compliance Rates by Round

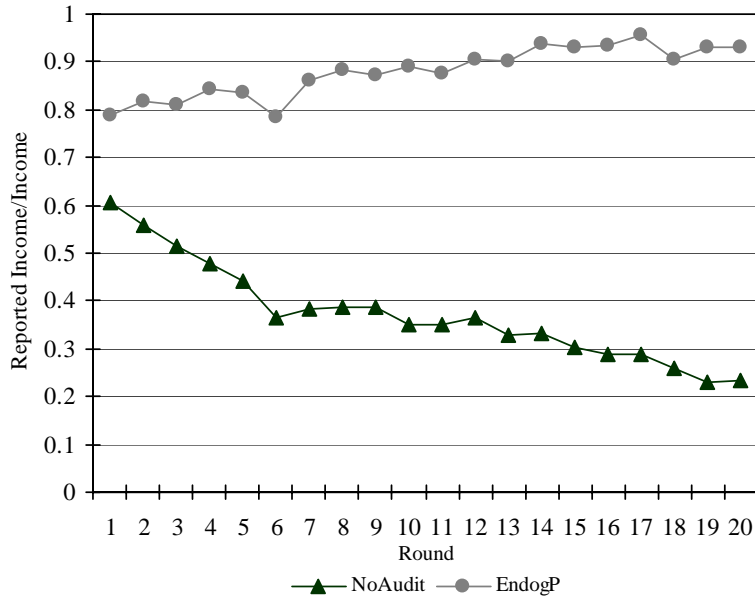
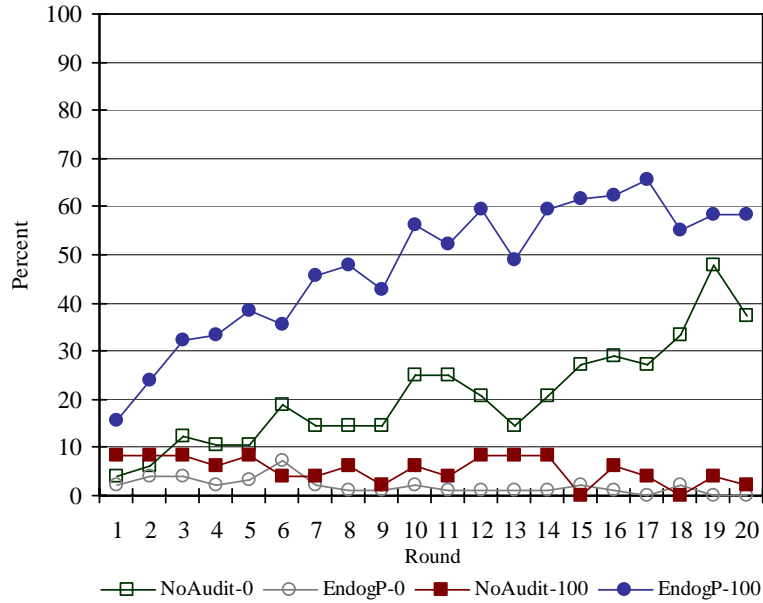
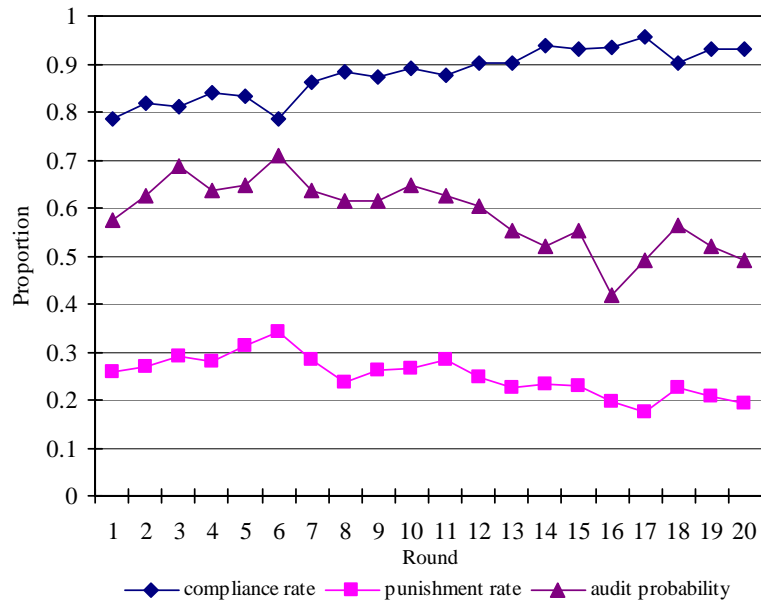


Figure 2. Percent of Subjects Completely Free Riding and Fully Complying by Round



No-Audit-0 and EndogP-0 indicate the percent of subjects in the two treatments reporting zero income. On the contrary, No-Audit-100 and EndogP-100 indicate the percent of subjects in the two treatments reporting 100 percent of income.

Figure 3. The Behavior of Punishment in the EndogP Treatment by Round



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