Experimental Evidence on Tax Compliance and Voluntary Public Good Provision

Li-Chen Hsu*

Department of Public Finance
National Chengchi University
E-mail: lchsu@nccu.edu.tw

Abstract: Various experimental studies have examined the effects of tax parameters on tax compliance. While some studies neglect tax revenues, others consider the tax-funded public good. Here we consider not only the public good funded by taxes, but also the public good established through voluntary contributions. Our experimental evidence shows that a more preferable publicly provided public good will significantly improve tax compliance and induce more voluntary contributions. However, a more preferable privately provided public good has only the latter effect. This suggests that the privately provided public good is complementary to the publicly provided public good, but the inverse does not hold. We also find that the increase in the audit probability can curb tax evasion, and that changes in income and tax rates have no effect on either tax compliance or voluntary contributions.

Keywords: Experiments; Public goods; Voluntary contributions; Tax compliance

JEL Classification: C92, H26, H41

* Financial support from the National Science Council (grant number: NSC 93-2415-H-004-008) is gratefully acknowledged.
1. 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 efforts have been devoted to examining individual tax evasion behavior using experimental methods. Most experimental studies on tax compliance follow the basic theoretical settings of Allingham and Sandmo (1972) and a later comment by Yitzhaki (1974), although some modifications are made to facilitate the experimental manipulations. A prevalent conclusion is that tax compliance increases with the audit probability and penalty rate, whereas the effect of changes in the tax rate remains indeterminate.

A number of experimental studies have addressed various issues of tax compliance. For instance, Spicer and Thomas (1982) examine the certainty in audit probabilities on compliance. Collins and Plume (1991) study the relationship between the decision regarding the level of work effort put into income earning activities and tax evasion. Spicer and Hero (1985) test the hypothesis as to whether the reported income is affected by other taxpayers’ evasion behavior. Cross-country examinations include Alm and Torgler (2006) and Gërxhani and Schram (2006). Kahneman and Tversky’s (1979, 1982, 1984) idea of decision framing is also applied to tax compliance and tested by Robben, Webley, Elffers, and Hessing (1990), Robben, et al. (1990), and Cullis, Jones, and Lewis (2006). Furthermore, Alm, Jackson, and McKee (1992b) and Alm,

---


2 For instance, in Allingham and Sandmo (1972) and Yitzhaki (1974), individuals’ preferences reveal decreasing absolute risk aversion and they seek to maximize their expected utility. However, it is often assumed in the experimental studies that individuals maximize their expected income.
Jackson, and McKee (1993) examine the relationship between the levels of income and tax evasion.

A number of experimental studies incorporate government expenditure, which was originally neglected in the papers by Allingham and Sandmo (1972) and Yitzhaki (1974), but which is explicitly modeled by Cowell and Gordon (1988). Among the studies that take government expenditure into consideration, Alm and his coauthors apply the voluntary contribution mechanism and have developed a series of inspiring experiments on this issue [Alm, Jackson, and McKee (1992a), Alm, Jackson, and McKee (1992b), Alm, McClelland, and Schulze (1992), Alm, Jackson, and McKee (1993)]. The voluntary contribution mechanism was originally employed in the experiments on the private provision of public goods. In this mechanism, subjects voluntarily contribute some or all of their endowments to a public good. How each subject benefits from the public good consumption depends on the total contribution made by the group. Instead of contributing to the public good directly, in Alm, et al.’s tax compliance experiments, subjects decide how much income is to be reported to the tax authority. The level of the public good is then determined based on the total amount of the tax payments.

Though neglecting the use side of the tax revenue is unrealistic in investigating individual tax evasion behavior, the tax-funded public good is apparently not the only category of public good existing in the real world. In reality, many public goods are provided by the private sector alone and obtain no support from the government. Churches, Red Cross, private shelters and dog pounds, and private lighthouses are the examples. Since by definition public goods are not

---


restricted to being provided by the public sector, the experiments by Alm, et al. actually give rise to some interesting questions: Besides paying taxes to fund the publicly provided public good, if individuals also contribute voluntarily to the public good provided by the private sector, how will they allocate their income between the two goods? Furthermore, will a more preferable publicly provided public good crowd out voluntary contributions? Likewise, will a more preferable privately provided public good discourage tax compliance?

The present paper intends to investigate these issues by considering two public goods: one is the tax-funded publicly provided public good, and the other is the privately provided public good, which is established through individuals’ voluntary contributions. We vary the marginal per capita returns (MPCRs) of the two public goods to observe the subsequent changes in tax compliance and voluntary contributions. The effects of income and other fiscal variables such as tax rates and audit probabilities will also be examined. Our main results exhibit positive own effects, that is, a higher MPCR of the publicly provided public good will significantly improve tax compliance, and a higher MPCR of the privately provided public good will significantly induce more voluntary contributions. The cross effect is asymmetric: a higher MPCR of the publicly provided public good will not only crowd out no voluntary contributions, but it will instead induce more such contributions. However, although a higher MPCR of the privately provided public good can also improve tax compliance, the effect is not statistically significant. We also find that the increase in the audit probability can improve tax compliance but not voluntary contributions, and that changes in income and tax rates have no effect on either tax compliance or voluntary contributions.

---

5 In a voluntary contribution experiment, Blackwell and McKee (2003) also consider two public goods, but both are privately provided public goods. One is the ‘local’ public good, which benefits only the own group, and the other is the ‘global’ public good, which is available to all participants in the same experimental session.
The next section provides a simple model of tax compliance and the experimental design. In Section 3 we present the results of our experiments. Section 4 provides a conclusion and discussion.

2. EXPERIMENTAL DESIGN

2.1. The Model

Consider an economy of $n$ individuals. Individual $i$ is endowed with an exogenous income $e_i$, of which $x_i$ ($x_i \leq e_i$) is declared to the tax authority. The declared income is taxed at the rate $t$. The taxes paid by all individuals are used to fund a publicly provided public good $Y$ so that $Y = \sum_i tx_i$. There is a fixed probability $\pi$ that the individual will be audited. If caught cheating, then besides making up the evaded taxes $t(e_i - x_i)$, he needs to pay a fine, which is $\theta$ times the evaded tax. After paying taxes and the fine, if there are any, the individual allocates the rest of his income between private good consumption and a voluntary contribution ($c_i$) to a privately provided public good $Z$. The size of $Z$ is therefore $Z = \sum c_i$.

---

6 Among those experimental studies in which tax revenue is used to fund the public good, Alm, Jackson, and McKee (1992a), Alm, Jackson, and McKee (1992b), and Alm, McClelland, and Schulze (1992) assume that the evaded taxes and fines are discarded, and are not used to fund the public good. Becker, Büchner, and Sleeking (1987) assume instead that there is a balanced government budget. In Gërxhani and Schram (2006) the evaded taxes are added to the public good, but the fine is not. In Kim (2002), the public transfer is independent of the taxpayers’ tax payments. Here we assume that the evaded taxes and fines are discarded. The reasons for this design are as follows. First, it makes the instructions simpler. Second, if the evaded taxes and fines are used to fund the public good, then subjects may have an incentive to evade more taxes than they are actually willing to evade. This incentive may be neglected in a large economy, but it may be substantial in small groups, which are usually used in experimental studies.
The marginal per capita return (MPCR) of $Y$ is $m$ and that of $Z$ is $r$. That is, each dollar of taxes paid and each dollar of voluntary contributions made by anyone yield, respectively, a return of $m$ and $r$ to each individual. Notice that $m$ and $r$ need to meet the condition $1/n < m, r < 1$. The reason is that if $m$ and $r$ are greater than one, then everyone will pay taxes as much as they can or will donate all of their income. By contrast, if $m$ and $r$ are less than $1/n$, then no one will pay taxes or give any income.

Similar to many other experimental studies on tax evasion and public good provision, here we assume that individual $i$’s utility function is additively separable in the private good and two public goods and that $i$ maximizes his expected monetary payoff $EP_i$. Therefore, we can express individual $i$’s problem as:

$$
\text{Max}_{x_i, c_i} EP_i = \pi \{y_i - c_i - tx_i - t(y_i - x_i) - \theta (y_i - x_i) + m(tx_i + \sum_{j \neq i} tx_j) + r(c_i + \sum_{j \neq i} c_j)\} \\
+ (1 - \pi)\{y_i - c_i - tx_i + m(tx_i + \sum_{j \neq i} tx_j) + r(c_i + \sum_{j \neq i} c_j)\}
$$

The first-order conditions are:

$$
\frac{\partial EP_i}{\partial x_i} = t(\pi \theta + \pi + m - 1) \quad (1)
$$

$$
\frac{\partial EP_i}{\partial c_i} = -1 + r < 0. \quad (2)
$$

Equation (1) indicates that the optimal strategy for the individual is to report the full income if and only if $(\pi \theta + \pi + m) > 1$ and to report zero income if and only if $(\pi \theta + \pi + m) < 1$. An interior solution exists if and only if $(\pi \theta + \pi + m) = 1$. Since $\pi$, $\theta$, and $m$ are constants, the chance for (1) to bind is slim. For instance, if $\pi = 0.05$ and $m = 0.5$, then the fine must be nine
times the evaded taxes for (1) to bind. On the other hand, (2) will never bind so that the
dominant strategy for the tax payer is to contribute nothing to the privately provided public good
(Z). This is straightforward since under the linear payoff function everyone has an incentive to
completely free ride as long as \( r < 1 \). Equation (1) also indicates that the magnitude of \( r \) has no
effect on tax compliance and (2) shows that the magnitudes of \( t, \theta, \pi, \) and \( m \) will not affect the
individual’s optimal contribution decision.

Notice that although in many countries donations to charities or some certain foundations
and organizations are deductible from the taxable income, in the model and the following
experimental designs we do not consider this stipulation. The reason for this is that not
everyone chooses itemized deductions when filing tax returns, and for those who do choose
itemized deductions, there exists an upper limit for these deductions. For instance, in the U.S.
this limit is 20 to 50 percent of taxable income and in Taiwan it is 20 percent. Incorporating
this stipulation will make subjects’ instructions complicated.

2.2. Experimental Parameters

Table 1 summarizes the magnitudes of the experimental parameters used in the five
treatments. Comparisons among these treatments help us to examine the effects of changes in
the tax rate, audit probability, and the MPCRs of the publicly and privately provided public
goods on tax compliance and voluntary contributions. We recruited subjects from economics
courses at National Chengchi University in Taiwan. None of them had ever participated in any
public goods or tax compliance experiments. Thirty-six to 44 subjects were used for each
treatment, with the exact number of subjects involved depending on how many of them
eventually showed up.
In each treatment subjects were informed that they each were randomly assigned a subject number, which ranged from 1 to 50. Subjects were also randomly and anonymously assigned to groups of four and they remained in the same groups for all 12 rounds. At the beginning of each round, the four group members were randomly assigned incomes of NT$15, NT$20, NT$25, and NT$30, respectively. When a new round began, these levels of income were reassigned to the four group members. Subjects knew their own income and the distribution of income, but not the other three group members’ levels of income. In order to be fair to all subjects, each of them was assigned each level of income three times, but to prevent any expectations that might bias the subjects’ decisions, they were unaware of this during the experiments.

Subjects were required to make two decisions on a decision form in each round. First, they decided to declare some or all of their income. A certain proportion of the declared income would be invested in the $Y$ account (the publicly provided public good). This proportion actually served as the tax rate, which was 0.2 or 0.3 in the experiments. The payoff from $Y$ for each subject was the product of the MPCR of $Y$ and the total investment in $Y$ by the group. Second, they decided to contribute some or all of their remaining income to the $Z$ account (the privately provided public good). The payoff from $Z$ to each subject was the product of the MPCR of $Z$ and the total contribution by the group. The rest of the income was invested in each subject’s own $X$ account (the private good). The individual subject’s payoff

7 In Alm, et al.’s experiments, subjects play the game for 20-25 rounds. There are two justifications for the shorter play employed in this study: First, in many public goods experiments, the lengths for the games are 10 to 15 rounds. The length of 12 rounds used here is comparable to the public goods experiments. Second, since subjects have to make two decisions (reporting income and contributing to the privately provided public good) and make some calculations, the decision time for each round is more than those in the audit experiments and public goods experiments. Shorter rounds can prevent any problems resulting from impatience.
before auditing was his (her) earnings from the $Y$ and $Z$ accounts plus the money he (she) eventually left in the $X$ account.

We put 50 balls in a transparent bag, with the numbers 1 through 50 written on each ball. In each round of the BA (basic audit), HM (high $m$), HR (high $r$), and HRT (high $r$ and $t$) treatments, we drew one ball from the bag after all subjects had made their decisions. The subject whose subject number coincided with the number on the ball was audited so that the audit probability in the four treatments was 0.02. In the HRP (high $r$ and $\pi$) treatment, three balls were drawn so that the resulting audit probability was 0.06. If the subject was caught underreporting, his (her) payoff this round would either be reduced by the evaded taxes plus a fine which was three times the evaded taxes or zero if it was insufficient for paying the fine and evaded taxes.

In the BA treatment, the tax rate was 0.2 and the MPCR$s$ of the two public goods were 0.5. In the HM treatment, we raised the MPCR of public good $Y$ to 0.7 and maintained the magnitudes of all other parameters the same as those in BA. In the HR treatment, we raised the MPCR of public good $Z$ to 0.7 instead. Therefore, comparing HM with BA tells us whether a relatively more preferable publicly provided public good will encourage (or crowd out) voluntary contributions and curb tax evasion. Similarly, the effects of a relatively more preferable privately provided public good on the two observations can be inferred by comparing HR with BA.

In the remaining two treatments (HRT and HRP) we used HR as the control treatment and varied the tax rate and audit probability. Both HRT and HRP were the same as HR in every aspect except that the tax rate in HRT was raised to 0.3 and the audit probability in HRP increased to 0.06. By comparing HRT with HR, we can observe the effect of the change in the
tax rate on voluntary contributions and tax evasion. Similarly, by comparing HRP with HR, we
can discern how the change in the audit probability affects the two decisions by subjects.

Subjects were given written instructions. A sample of the Subjects’ Instructions for the
HM treatment is provided in the Appendix. The experimenter read the instructions aloud and
answered any questions raised by the subjects. At the end of each round, each subject received
an earnings report which indicated the information regarding his (her) own decisions, the total
investments in the Y and Z accounts made by the other three members, the total investments in
the Y and Z accounts including his (her) own, whether he (she) was audited and the amount of
evaded taxes and fines, his (her) payoff this round, and his (her) cumulated payoff until this
round. Each experiment typically lasted about eighty minutes. The average payoff of all
participants was NT$528.36 (with a standard deviation of NT$82.29, a maximum of NT$783.90,
and a minimum of NT$366.80).  

3. RESULTS

Our experimental design, like many others in public goods experiments, is repeated, thus
allowing subjects to learn about both the game and the reactions from their opponents. As was
mentioned by Andreoni and Miller (2002), this suggests looking at the first round, since subjects
have not gained any experience. However, Andreoni and Miller also point out that
forward-looking subjects may play strategically, and thereby looking at the final round may be
more suitable since by then strategic plays are unnecessary. Given their opinions, we will

---

8 When these experiments were conducted, the exchange rate between the NT (New Taiwan) dollar and the US
dollar was about 32:1. The part-time hourly wage rate for an undergraduate student in Taiwan is about NT$120.
All the resulting data are available from the author upon request.
particularly look at the final round, but we will also provide brief descriptive statistics of the first round and of the whole repetitions.

[Table 2 about here]

Table 2 summarizes the average values associated with various observations for all 12 rounds, and Figures 1 through 6 depict the trends of these observations across rounds. We will first look at tax compliance and voluntary contributions in Subsections 3.1 and 3.2, respectively. Since the subjects who are endowed with higher income naturally have a higher capacity to give and to pay taxes, to avoid any possible biases, we will look specifically at the ratios of the two choice variables to true income. Within each subsection, we will commence describing the data from each treatment, and then explore more closely the differences between the various treatments. Furthermore, we will run regressions by using the aggregate data from the five treatments to see how income levels affect compliance and voluntary contributions. The regression results can also help us to verify the results from the between-treatments comparisons. Finally, we will ask how well our data conform to the theoretical predictions. In Subsection 3.3 we combine tax compliance and voluntary contributions and explore the aggregate effects of each fiscal variable.

3.1. Tax Compliance

Figure 1 depicts the average compliance rate per round in various treatments. The compliance rate is defined as the ratio of the individual’s reported income to his (her) true income. At the beginning of the game the average compliance rates for various treatments start high and similarly, range from the lowest 67.3 percent in the HR treatment to the highest 80.5 percent in the HM treatment, and generally reveal a downward trend except in the HM treatment.
The average compliance rates reach the minimum in the final round for all treatments, ranging between the lowest 21 percent in the BA treatment and the highest 46.4 percent in the HM treatment. As reported in row 1 of Table 2, the average compliance rates over all 12 rounds fall between 43.5 percent and 64.8 percent. These magnitudes are in line with those found by Alm, Jackson, and McKee (1992a, 1992b, 1993) and Alm, McClelland, and Schulze (1992), who report that the average compliance rates under the condition of public good provision generally fall into the range of 33 to 67 percent.

Figure 1 also reveals that the HM treatment has the highest average compliance rates in all rounds except round 3. By contrast, the HR treatment has the lowest or nearly the lowest average compliance rates in most rounds. Imposing a higher tax rate (the HRT treatment) or a higher audit probability (the HRP treatment) under the high \( r \) condition can improve compliance, but still results in a lower compliance level than that in the HM treatment.

Using the final-round observations and performing a two-sided Mann-Whitney U test to compare the differences between two relevant treatments, it is shown that the compliance rate is higher in the HR treatment than in the BA treatment, but the difference is statistically insignificant \( (z = 0.863, p = 0.383) \). On the contrary, the compliance rate in HM is not only significantly higher than that in BA \( (z = 3.416, p = 0.001) \), but is also higher than that in HR \( (z = 2.378, p = 0.017) \). Furthermore, the difference between HR and HRT is insignificant \( (z = -1.101, p = 0.271) \) and that between HR and HRP is marginally significant \( (z = -1.673, p = 0.094) \).

The final-round observations also reveal that the compliance rate in the HM treatment is

---

9 In this test and others, we use each individual subject’s choice as the observation.
higher than those in HRT ($z = 1.735, p = 0.083$) and HRP ($z = 0.493, p = 0.622$), though the difference between HM and HRP is insignificant at conventional significance levels. This suggests that providing a more preferable privately provided public good plus a higher tax rate or a higher audit probability cannot result in a better compliance rate than simply providing a more preferable publicly provided public good.

[Table 3 about here]

Looking at the final round again and using the aggregate data from the five treatments, we can run a Tobit maximum likelihood estimation to investigate the effect of income on compliance. The estimation can also provide us with the effects of the fiscal variables discussed above. Column 1 of Table 3 shows that the effects of income, the tax rate, and the MPCR of the privately provided public good on the compliance rate are all insignificant. By contrast, the effect of the MPCR of the publicly provided public good on the compliance rate is positive and highly significant ($p = 0.002$). The effect of the audit probability is also positive and statistically significant at the conventional levels ($p = 0.074$). These findings are consistent with those from the Mann-Whitney U tests. We now summarize our first main result in Result 1 below:

Result 1: A more preferable publicly provided public good and a higher audit probability can improve tax compliance, but a more valuable privately provided public good and a higher tax rate cannot. Income has no effect on tax compliance, either.

Next let us examine how well our data conform to the theoretical predictions. Equation (1) in Subsection 2.1 says that the individual will fully comply if and only if $(\pi \theta + \pi + m) > 1$, will
evade all taxes if and only if \((\pi\theta + \pi + m) < 1\), and will make a choice in between if and only if \((\pi\theta + \pi + m) = 1\). Equation (1) also implies that the magnitude of \(r\) has no effect on tax compliance. The latter prediction is confirmed by our data and has been shown in Result 1, but the former prediction is not. Given the audit probabilities \((\pi = 0.02 \text{ or } 0.06)\), the fine rate \((\theta = 3)\), and the MPCR of the publicly provided public good \((m = 0.5 \text{ or } 0.7)\) used in the experiments, it is obvious that \((\pi\theta + \pi + m) < 1\) in all treatments. Therefore, we should observe that every subject declares zero income and therefore the average compliance rates in all treatments are zero. However, our experimental evidence shows that the lowest final-round average compliance rate is 21 percent in the BA treatment, which is much higher than zero.

We can test the complete tax evasion hypothesis by looking at the ratios of subjects declaring zero income in various treatments. Figure 2 illustrates these trends. We can see that these ratios start low, generally increase over rounds, and finally reach the maximum at the end of the game. By looking at the final round, the lowest ratio is 22.2 percent \((8/36)\) in HM, followed by 34.1 percent \((15/44)\) in HRT, 37.5 percent \((15/40)\) in HRP, and 55 percent \((22/40)\) in HR. The highest complete tax evasion occurs in the BA treatment, in which as many as 63.6 percent \((28/44)\) of the subjects evade all taxes. All these ratios differ significantly from 1 (two-sided binomial tests, \(p = 0.000\)), thus contradicting the complete tax evasion prediction.

[Figure 2 about here]

The last round of Figure 2 also shows that the HR treatment has a lower level of complete tax evasion as compared with the BA treatment. However, the difference is statistically insignificant (a two-sided binomial test, \(z = -0.81, p = 0.420\)). Furthermore, though a higher tax rate and a higher audit probability seem to have the same effect in curbing complete tax evasion, the latter effect is insignificant (two-sided binomial tests, HRT vs. HR, \(z = -1.97, p = 0.050\)).
A more preferable publicly provided public good is still most powerful in curbing complete tax evasion. A two-sided binomial test shows that the difference between HM and BA is significant ($z = -4.13$, $p = 0.000$), and so is the difference between HM and HR ($z = -3.13$, $p = 0.002$). Therefore, we have our second main result in the following:

Result 2: A more preferable publicly provided public good and a higher tax rate can alleviate complete tax evasion, but a more preferable privately provided public good and a higher audit probability cannot.

3.2. Voluntary Contributions

Figure 3 depicts the average contribution rate per round for various treatments. The contribution rate is defined as the ratio of the contribution to the publicly provided public good divided by the true income. Figure 3 shows that at the beginning of the game, subjects in various treatments contribute an average of 36 to 47 percent of their income to the privately provided public good. Contributions decay smoothly over rounds in all treatments and in the final round the average contributions converge to 13 to 28 percent of subjects’ income. Looking specifically at the average contribution rates of all 12 rounds in row 2 of Table 2, we can see that HM has the least average contribution, which accounts 25 percent of the subjects’ income. Similar levels of contributions are the 27 percent in BA and 28 percent in HRT. Contributions in HR are higher, being about 32 percent of subjects’ income. The highest contribution is observed in HRP, in which subjects’ contribute an average of 41 percent of their income. Figure 3 also reveals that HRP has the highest average contribution rate in every round
of the game.

[Figure 3 about here]

In testing the differences between two relevant treatments by using the final-round contribution rates, we find that the differences are significant between HM and BA (a two-sided Mann-Whitney U test, \( z = 2.557, p = 0.011 \)) and between HR and BA (\( z = 2.367, p = 0.018 \)). However, the differences between HM and HR, HR and HRT, and HR and HRP are all insignificant.

Using the final-round aggregate data from the five treatments and running a Tobit maximum likelihood estimation, row 2 of Table 3 reveals that increases in the MPCRs of the publicly and privately provided public goods lead to higher contribution rates. However, the effects of income, the tax rate, and audit probability are all statistically insignificant. We now report our third main result below:

Result 3: More preferable publicly and privately provided public goods can induce more voluntary contributions, but changes in the tax rate, audit probability, and income cannot.

[Figure 4 about here]

Next let us check whether the dominant strategy Nash equilibrium of contributing nothing to the privately provided public good holds. Figure 4 depicts the ratios of subjects making zero contribution across rounds in various treatments. Notice first that at the beginning of the game, the ratios of the subjects giving zero are 20 percent in the HR treatment, 18.2 percent in the BA treatment, and only 6 or 2 percent in the other three treatments. These ratios generally increase over rounds, especially in later rounds, and finally reach the maximum in the final round.
Specifically, there are eventually as many as 68.2 percent (30/44) of the subjects giving zero in the BA treatment, followed by 42.5 percent (17/40) in the HR treatment and 36.1 percent (13/36) in the HM treatment. Less than 30 percent of the subjects in the HRT and HRP treatments give zero. Since all these ratios differ significantly from 1 (two-sided binomial tests, \( p = 0.000 \)), the dominant strategy Nash equilibrium that players give nothing to the privately provided public good cannot be confirmed by our data.

Looking at the final-round differences between two relevant treatments, a two-sided binomial test shows that there are significantly fewer subjects giving zero in the HM treatment than in the BA treatment (\( z = -3.01, p = 0.003 \)). Similarly, the HR treatment also has less $0-giving than the BA treatment (\( z = -2.44, p = 0.015 \)). The differences between HM and HR, between HRT and HR, and between HRP and HR are all statistically insignificant. We now summarize these findings in Result 4 below:

Result 4: A more preferable publicly or privately provided public good can discourage free riding, but a higher tax rate and a higher audit probability cannot.

3.3. Total Contributions

To sum up the results from Subsections 3.1 and 3.2, we find that a more preferable publicly provided public good has the advantages of both curbing tax evasion and encouraging voluntary contributions, but a more preferable privately provided public good only has the latter effect. These findings seem to suggest that a more preferable publicly, not privately, provided public good is more effective in achieving both goals. However, Figure 1 and Figure 2 also indicate that although the HM treatment has the highest average compliance rate in almost every round, it
has a rather low level of voluntary contributions. Therefore, it is necessary to combine these two effects and to investigate how various fiscal variables affect total contributions, i.e., the sum of the enforced and voluntary contributions.

[Figure 5 about here]

Figure 5 illustrates the average total contribution rates per round for various treatments. The total contribution rate is defined as the sum of the individual’s tax payments and his (her) voluntary contributions divided by his (her) true income. Figure 5 shows that the average total contribution rates in all five treatments start close together, ranging from the lowest 49.6 percent in HR to the highest 61.2 percent in HRP. Except for the BA treatment, the average total contribution rates seem to decay smoothly. In the final round of the game, subjects in the BA treatment make the least total contribution, which only occupies 17.04 percent of their income, and is then followed by 28.2 percent in HM and 30.8 percent in HR. The two highest average total contribution rates are 36.5 percent in HRP and 36.9 percent in HRT. A two-sided Mann-Whitney U test shows that the difference is statistically significant between the HM and BA ($z = 2.799, p = 0.005$) and between the HR and BA treatments ($z = 1.915, p = 0.055$). Comparing HM with HR and comparing HRT and HRP with either HM or HR shows that the differences between any pair of these treatments are insignificant. The results from the Tobit maximum likelihood estimations, which are reported in Column 3 of Table 3, indicate further that income has no effect on the total contribution rates. The estimation results of all fiscal variables are consistent with those from the Mann-Whitney U tests. We summarize these findings in Result 5 below:

Result 5: Providing a more preferable publicly provided public good and a more preferable privately provided public good have the same and statistically significant effect in inducing more
total contributions. Changes in income, the tax rate, and audit probability have no significant effect on total contributions.

As shown in Figure 2, the HM treatment has the lowest fraction of subjects declaring zero income in almost every round, but Figure 4 shows that the HRT and HRP treatments have relatively lower fractions of subjects making no voluntary contribution. Therefore, it is also worth investigating how complete free riding occurs in various treatments. We say that a subject completely free rides if he or she declares zero income and makes no voluntary contribution. We can see from Figure 6 that complete free-riding starts low in all treatments: 10 percent of the subjects in the HR treatment give nothing and pay no taxes, and this number is only 2 percent in BA and HRP, and even zero in HM and HRT.

[Figure 6 about here]

Complete free-riding stays low in the early rounds of almost all treatments, but increases sharply in the last two rounds. When the final round arrives, almost half (47.7 percent or 21/44) of the subjects in the BA treatment make absolutely no contribution. Complete free-riding is also high in the HR treatment, in which 32.5 percent (13/40) of the subjects give and pay nothing. The levels of complete free-riding are similar in the remaining three treatments: 19.4 percent (7/36) in HM, 18.2 percent (8/44) in HRT, and 17.5 percent (7/40) in HRP. A two-sided binomial test shows that only the difference between BA and HM is statistically significant ($z = 2.83, p = 0.005$). The differences between BA and HR, HR and HM, HR and HRT, and HR and HRP are all insignificant. We summarize these findings in Result 6 below:

Result 6: Providing a more preferable publicly provided public good significantly curbs complete free-riding. However, a more preferable privately provided public good, a higher tax rate, and a
higher audit probability all have no effect on complete free-riding.

4. CONCLUSION AND DISCUSSION

We conduct experiments and try to explore the effects of changes in the MPCRs of publicly and privately provided public goods on tax compliance and voluntary contributions. The effects of other fiscal variables such as tax rates and audit probabilities are also examined. We find that the increase in the MPCR of the publicly provided public good encourages tax compliance and voluntary contributions, whereas the increase in the MPCR of the privately provided public good has only the latter effect. If we combine the enforced and voluntary contributions, then the effects of the two fiscal changes do not differ significantly, but a more preferable publicly provided public good is still more effective in curbing complete free-riding. Additional findings are that changes in income and tax rates have no significant effect in tax compliance, voluntary contributions, and total contributions. A higher audit probability can only improve tax compliance.

The above findings reveal asymmetric cross effects that are attributable to the increases in the MPCRs of the publicly and privately provided public goods, although the theoretical predictions from a linear payoff function suggest that the cross effects should both be zero. Our evidence shows that an increase in the MPCR (or alternatively, a reduction in the price) of the publicly provided public good induces more voluntary contributions, but a higher MPCR for the privately provided public good has no significant effect on tax compliance.\(^\text{10}\) This suggests that the privately provided public good is complementary to the publicly provided public good, but the inverse does not hold.

\(^{10}\) An increase in the MPCR of the public good implies that the individual can pay the same price for more public good consumption, or alternatively, pay a lower price for the same amount of public good consumption.
The intuition behind this asymmetric outcome is as follows. Individuals see the advantage of cooperation more clearly when the MPCR of the publicly provided public good increases. Since there is an upper bound of the publicly provided public good (20 percent of all individuals’ income), they can only seek more benefits by making more contributions to the privately provided public good. On the contrary, the upper bound of the privately provided public good is all individuals’ income, and therefore when the MPCR of this public good increases, they can simply make more benefits by contributing more to it.

The above results raise some interesting questions, for instance, whether well-performing public education will induce more donations to private schools, and likewise, whether well-operated public dog pounds will encourage more donations to private dog pounds. Since the publicly and privately provided public goods in our experiments are kind of composite goods, without any specific characteristics or features in them, our experimental results are insufficient to answer these questions. Using specific organizations for donations and specific public goods provided by the public sector in the experiments will be an interesting direction for future research.
Table 1  
Experimental Parameters

<table>
<thead>
<tr>
<th>Treatment</th>
<th>BA (base audit)</th>
<th>HM (high m)</th>
<th>HR (high r)</th>
<th>HRT (high r and t)</th>
<th>HRP (high r and π)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tax rate</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>(t)</td>
<td>Auditing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Audit</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.06</td>
</tr>
<tr>
<td>probability</td>
<td>(π)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fine rate</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>(θ)</td>
<td>MPCR of Y</td>
<td>0.5</td>
<td>0.7</td>
<td>0.5</td>
<td>0.5</td>
</tr>
<tr>
<td>(m)</td>
<td>MPCR of Z</td>
<td>0.5</td>
<td>0.5</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>(r)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Y is the publicly provided public good and Z the privately provided public good.
Table 2
Results Summary

<table>
<thead>
<tr>
<th>Treatment</th>
<th>BA (base audit)</th>
<th>HM (high m)</th>
<th>HR (high r)</th>
<th>HRT (high r and t)</th>
<th>HRP (high r and π)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average compliance rate (1)</td>
<td>0.490</td>
<td>0.648</td>
<td>0.435</td>
<td>0.468</td>
<td>0.555</td>
</tr>
<tr>
<td></td>
<td>(0.238)</td>
<td>(0.201)</td>
<td>(0.292)</td>
<td>(0.226)</td>
<td>(0.273)</td>
</tr>
<tr>
<td>Average contribution rate (2)</td>
<td>0.272</td>
<td>0.249</td>
<td>0.319</td>
<td>0.284</td>
<td>0.408</td>
</tr>
<tr>
<td></td>
<td>(0.198)</td>
<td>(0.122)</td>
<td>(0.213)</td>
<td>(0.184)</td>
<td>(0.204)</td>
</tr>
<tr>
<td>Average total contribution rate (3)</td>
<td>0.370</td>
<td>0.379</td>
<td>0.406</td>
<td>0.424</td>
<td>0.519</td>
</tr>
<tr>
<td></td>
<td>(0.204)</td>
<td>(0.140)</td>
<td>(0.232)</td>
<td>(0.213)</td>
<td>(0.229)</td>
</tr>
<tr>
<td>Percent of subjects declaring zero income (4)</td>
<td>29.7%</td>
<td>11.6%</td>
<td>35.2%</td>
<td>19.3%</td>
<td>20.6%</td>
</tr>
<tr>
<td></td>
<td>(0.299)</td>
<td>(0.214)</td>
<td>(0.349)</td>
<td>(0.263)</td>
<td>(0.304)</td>
</tr>
<tr>
<td>Percent of subjects making no contribution (5)</td>
<td>36.0%</td>
<td>22.2%</td>
<td>24.4%</td>
<td>16.5%</td>
<td>11.0%</td>
</tr>
<tr>
<td></td>
<td>(0.272)</td>
<td>(0.266)</td>
<td>(0.322)</td>
<td>(0.245)</td>
<td>(0.213)</td>
</tr>
<tr>
<td>Percent of subjects completely free ride (6)</td>
<td>18.2%</td>
<td>9.3%</td>
<td>16.5%</td>
<td>8.9%</td>
<td>6.0%</td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(0.198)</td>
<td>(0.270)</td>
<td>(0.191)</td>
<td>(0.144)</td>
</tr>
<tr>
<td>Percent of subjects fully comply (7)</td>
<td>22.9%</td>
<td>25.2%</td>
<td>11.9%</td>
<td>11.7%</td>
<td>20.6%</td>
</tr>
<tr>
<td></td>
<td>(0.244)</td>
<td>(0.260)</td>
<td>(0.180)</td>
<td>(0.146)</td>
<td>(0.241)</td>
</tr>
<tr>
<td>Average earnings (in NTS) (8)</td>
<td>465</td>
<td>498</td>
<td>545</td>
<td>543</td>
<td>592</td>
</tr>
<tr>
<td></td>
<td>(55.15)</td>
<td>(39.31)</td>
<td>(86.28)</td>
<td>(76.76)</td>
<td>(80.75)</td>
</tr>
</tbody>
</table>

Note: The observations are the individual subjects’ average choices for all 12 rounds. The standard deviations are in parentheses.
Table 3
Tobit Maximum Likelihood Estimation Results Using the Final Round Observations

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Compliance rate (1)</th>
<th>Contribution rate (2)</th>
<th>Total Contribution rate (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-2.6719**</td>
<td>-1.3491**</td>
<td>-1.1158**</td>
</tr>
<tr>
<td>Income</td>
<td>-0.0002</td>
<td>-0.0073</td>
<td>-0.0070</td>
</tr>
<tr>
<td>Tax rate (t)</td>
<td>1.7831 (0.95)</td>
<td>0.6205 (0.60)</td>
<td>1.0263 (1.09)</td>
</tr>
<tr>
<td>Audit probability (π)</td>
<td>8.7250* (1.80)</td>
<td>1.7382 (0.66)</td>
<td>2.3819 (0.99)</td>
</tr>
<tr>
<td>MPCR of Y (m)</td>
<td>3.0754** (3.11)</td>
<td>1.0615* (1.88)</td>
<td>1.0516** (2.13)</td>
</tr>
<tr>
<td>MPCR of Z (r)</td>
<td>0.8460 (0.86)</td>
<td>1.3666** (2.48)</td>
<td>1.0431** (2.15)</td>
</tr>
<tr>
<td>Log-likelihood</td>
<td>-197.0329</td>
<td>-141.2100</td>
<td>-137.6092</td>
</tr>
<tr>
<td>Number of observations</td>
<td>204</td>
<td>204</td>
<td>204</td>
</tr>
</tbody>
</table>

Note: The $t$-statistics are in parentheses. The superscripts ** and * denote 5 and 10 percent significance levels, respectively.
Figure 1. The Average Compliance Rates by Round

Figure 2. The Percentage of Subjects Reporting Zero Income
Figure 3. The Average Contribution Rates by Round

Figure 4. The Percentage of Subjects Making Zero Contribution
Figure 5. The Average Total Contribution Rates by Round

Figure 6. The Percentage of Subjects Who Completely Free Ride
APPENDIX

Subjects’ Instructions for the HM Treatment

Subject ID number: ______

Welcome to the experiment. This is an experiment about individual and group investing behavior. Besides a participation fee of NT$100, if you follow the instructions closely and make your decisions carefully, you may earn an additional sufficient amount of money. All participants will be paid in cash at the end of the experiment. This study is funded by a grant from the National Science Council.

The experiment will last about 75 minutes.

Investment Decisions

In this experiment you will make decisions in each of the 12 rounds. In each round you and the other participants will be randomly assigned to groups of four. The group compositions will never change during the entire 12 rounds, and you will never know who the other three members are in your group.

Your payoff each round depends on your and the other three group members’ decisions. Every participant has three accounts: accounts X, Y, and Z. Everyone has his (her) own X account. At the beginning of each round, we will distribute NT$15, NT$20, NT$25, and NT$30 randomly into each group member’s X account. When a new round begins, the four different amounts of money will be re-deposited randomly in each group member’s X account. You will only know the amount of money deposited into your own X account, and this amount of money may not be the same in each round.

You will make two decisions in each round: First, you will report some or all of the amount
of money deposited into your X account. Twenty percent of your reported amount will be
invested in the Y account automatically. Second, you will decide how much of the remaining
income is to be invested in the Z account. The rest of the money will be retained in your X
account.

In each round you will receive a decision form, which is similar to the following:

<table>
<thead>
<tr>
<th>Subject ID: 256</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 4</td>
</tr>
<tr>
<td>(A) The amount of money in your X account: NT$ 25</td>
</tr>
<tr>
<td>(B) How much of the money in your X account would you like to report? NT$ ______ (B ≥ A and must be an integer.)</td>
</tr>
<tr>
<td>(C) The amount of money you invest in the Y account: NT$ ______ (= 0.2×B)</td>
</tr>
<tr>
<td>(D) Now the remaining money in your X account: NT $ ______ (= A – C)</td>
</tr>
<tr>
<td>(E) How much of the money in (D) would you like to invest in the Z account? NT$ ______</td>
</tr>
</tbody>
</table>

**Auditing the Amount of the Money Originally Deposited into Your X Account**

There are 50 balls in this transparent bag. The numbers 1 through 50 are written on the
balls. In each round after all participants have made their decisions, we will draw one ball from
the bag. The participant whose subject ID number coincides with the number on this ball will
be audited. If the amount of money he (she) reports is less than the original amount of money
deposited into his (her) X account, that is, the amount of money in (B) is less than the amount of
money in (A) in the above table, then 20% of the difference plus three times this difference will
be deducted from his (her) payoff this round. That is,

\[ 4 \times 0.2 \times (\text{the original amount of money in the X account} - \text{the reported amount in the X account}) \]

will be deducted from his (her) payoff this round. His (her) payoff this round will be zero if it
Your Payoff

Now we explain the payoffs resulting from the X, Y, and Z accounts.

1. X account

The money eventually left in your X account can only be obtained by you alone. We provide several examples in the following:

Example 1. Suppose that NT$8 is eventually left in your X account. Then your payoff from the X account this round is NT$8.

Example 2. Suppose that NT$20 is eventually left in your X account. Then your payoff from the X account this round is NT$20.

Example 3. Suppose that NT$0 is eventually left in your X account. Then your payoff from the X account this round is NT$0.

2. Y account

The payoff you can earn from the Y account depends on the total amount of money that you and the other three group members invest in the Y account. Each dollar invested in the Y account will yield each group member NT$0.7. As was mentioned previously, the total investment in the Y account is equal to 20% of the sum of the four group members’ reported amounts of their X accounts. We provide several examples below to explain how your payoff from the Y account is determined.

Example 1. Suppose that you report that there is originally NT$20 in your X account, and the other three members report a total of NT$60. As a result, your group invests
NT$0.2 \times (20+60) = NT$16 in the Y account. Then you earn NT$11.2 from the Y account, and so does everyone else in your group.

Example 2. Suppose that you report that there is originally NT$23 in your X account, and the other three members report a total of NT$55. As a result, your group invests NT$0.2 \times (23+55) = NT$15.6 in the Y account. Then you earn NT$10.92 from the Y account, and so does everyone else in your group.

3. Z account

What you can earn from the Z account depends on the total amount of money that you and the other three group members invest in the Z account. Each dollar invested in the Z account will yield each group member NT$0.5. We provide several examples below to explain how your payoff from the Z account is determined.

Example 1. Suppose that you invest NT$0 in the Z account, and the other three members invest a total of NT$30 in the Z account. Then you earn NT$15 from the Z account, and so does everyone else in your group.

Example 2. Suppose that you invest NT$13 in the Z account, and the other three members invest a total of NT$18 in the Z account. Therefore, the total investment in the Z account by your group is NT$31. Then you earn NT$15.5 from the Z account, and so does everyone else in your group.

Example 3. Suppose that you invest NT$15 in the Z account, and the other three members invest nothing in the Z account. Therefore, the total investment in the Z account by your group is NT$15. Then you earn NT$7.5 from the Z account, and so does everyone else in your group.
Your Payoff per Round

Your payoff each round is the sum of the earnings from your X account, the Y account, and the Z account minus any deduction if you are audited and found to be underreporting. Let us provide several examples below to explain the calculations.

Example 1. Suppose that at the beginning of some round there is originally NT$25 in your X account. You report NT$20, and thereby you invest NT$4 in the Y account. You invest NT$11 of the remaining NT$21 in the Z account. As a result, the amount of money eventually left in your X account is $10 (= 25 – 4 – 11). Suppose that the other three group members report a total of NT$60 in their X accounts, and therefore they invest NT$12 in the Y account. They invest a further NT$25 in the Z account. Therefore, your group invests a total of NT$16 in the Y account and NT$36 in the Z account. Suppose that you are not audited. Then your earnings this round amount to NT$10 + NT$0.7×16 + NT$0.5×36 = NT$39.2.

Example 2. Suppose that at the beginning of some round there is originally NT$20 in your X account. You report NT$18, and thereby you invest NT$3.6 in the Y account. You invest NT$7.4 of the remaining NT$16.4 in the Z account. As a result, the amount of money eventually left in your X account is $9 (= 20 – 3.6 – 7.4). Suppose that the other three group members report a total of NT$65 in their X accounts, and therefore they invest NT$13 in the Y account. They invest a further NT$30 in the Z account. Therefore, your group invests a total of NT$16.6 in the Y account and NT$37.4 in the Z account. Suppose that you are audited, and therefore there is a deduction of NT$1.6 [= 4×0.2×(20 - 18)] from your earnings. Then your earnings this round amount to NT$9 + NT$0.7×16.6 + NT$0.5×37.4 - NT$1.6 = NT$37.72.
Your Total Earnings from This Experiment

Your total earnings from this experiment will be the sum of the earnings that you earn in each of the 12 rounds plus a participation fee of NT$100.

Please do not talk to each other during the experiment. Your decisions and payoffs will be kept secret both during and after the experiment. There will be no link between your personal identity and the experimental data.

Good luck!
REFERENCES


Consistency of Preferences for Altruism, “Econometrica,” 70, 737-753.


