KIER DISCUSSION PAPER SERIES

KYOTO INSTITUTE
OF
ECONOMIC RESEARCH

Discussion Paper No.958

“Who is audited? Experimental study on rule-based tax auditing schemes”

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January 2017

KYOTO UNIVERSITY

KYOTO, JAPAN

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January 2017

Abstract

In this study, we employ a game-theoretic framework to formulate and analyze a number of tax audit schemes. We then test the theoretical predictions in a laboratory experiment. We compare audit schemes based on three audit rules: the random rule, cut-off rule, and lowest income reporter audited rule. While the cut-off rule is known to be optimal in theory, it has not thus far been examined in a controlled laboratory experimental setting. Contrary to the theory, the lowest income reporter audited rule yielded higher compliance behavior than the optimal cut-off rule in the experiment, even after controlling for social norms regarding tax payment perceived by the subjects. This empirical finding is practically important because the tax authorities in most countries assign higher priority to enhancing tax compliance.

Keywords: audit scheme; tax evasion; laboratory experiment; cut-off rule; lowest income reporter audited rule

JEL Classification: C91; C92; D81; H26

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Acknowledgments Yoshio Kamijo is grateful for the financial support received from JSPS Grant-in Aid for Exploratory Research and Grant-in-Aid for Scientific Research (B). Takehito Masuda thanks the discussant Kan Takeuchi, the participants at the 2015 Spring Japanese Economic Association Meeting, and the workshop participants at the Center for Experimental Economics, Kansai University, 2015.

1. Introduction

Securing government tax revenues is a persistent and fundamental problem globally (Webber and Wildavsky 1986). The incentive for individuals and companies to avoid excessive tax payments is high, which leads to tax avoidance, tax evasion, and payment delays. The results of a well-known audit program—the National Research Program conducted by the US Internal Revenue Service—estimated the tax gap (i.e., tax due but not paid in a voluntary or timely manner) to be $450 billion in 2006; this amount represented approximately 3.2% of the nominal GDP for that year (Alm et al. 2015). Although analyses of the tax gaps in other countries are limited for several reasons (such as resource constraints and the non-publication of survey results), the gaps are estimated or speculated to be considerable (see Slemrod 2007). Thus, research on policy devices to enhance tax compliance has become increasingly significant. Based on this background, the present study aims to analyze three rule-based audit schemes: the random rule, cut-off rule, and lowest income reporter audited (LIRA) rule.

A basic theoretical model of tax evasion is presented by Allingham and Sandmo (1972) and Yitzhaki (1974). Following the criminal decision model of Becker (1968), these prior studies assume that a taxpayer chooses the extent of tax evasion by comparing the expected benefit from evasion with the expected cost. An implication of the findings of these studies is that the audit probability, tax rate, and penalty rate affect tax compliance. These findings are supported by the results of both empirical research (Clotfelter 1983; Kleven et al. 2011; Slemrod et al. 2001) and laboratory experiments (Beck et al. 1991; Collins and Plumlee 1991; Gërxhani and Schram 2006).[1] Although tax compliance could be improved by increasing the audit probability and penalty rate, most governments face severe budget restrictions related to auditing, and changing the penalty rate would be controversial. Thus, an audit rule whose introduction incurred little additional cost and did not change the penalty rate would be worth considering for actual use. Indeed, a more sophisticated auditing approach would be to consider the auditor to be the principal who designs the audit rules to enhance taxpayers' (agents') compliance under the prevailing audit resource constraints.

In this study, we analyze three rule-based audit schemes. Under the first and most often used audit rule, a taxpayer is randomly chosen and inspected irrespective of his/her reported income. This is the most common rule used in experiments to examine the canonical tax evasion model of Allingham and Sandmo (1972) and Yitzhaki (1974) and to measure behavioral aspects of tax evasion (Baldry 1986; Kastlunger et al. 2009).

[1] For a survey of experimental research, see Alm (1991, 2012).

The second audit rule examined herein is the cut-off rule under which the probability of inspection is high for taxpayers whose income is below a certain threshold; by contrast, taxpayers whose income is above the threshold are never inspected. Based on their working experience with the federal tax authority and several state tax authorities in the United States, Andreoni et al. (1998) report that "many tax agencies apparently do establish cut-off points and focus their audit resources on returns falling below the cut-offs" (p. 832). Based on principal–agent theory, Reinganum and Wilde (1986) and Sánchez and Sobel (1993) show that the cut-off rule enhances tax compliance and increases net tax revenue. Although Alm et al. (1993) and Dwenger et al. (2016) examine the usefulness of this rule empirically, such research on the cut-off rule is limited and no study has thus far investigated the cut-off rule based on the optimal audit probability and threshold.

Finally, under the third rule, lower reported incomes have a higher probability of being audited. Given the restriction that an auditor can inspect only one reported income, this rule becomes the LIRA rule, where among a category of similar taxpayers, the auditor investigates the taxpayer whose reported income is the lowest. One justification for implementing the LIRA rule is that in the United States, the Internal Revenue Service calculates a discriminant inventory function score for each return, on which it determines the tax returns to audit. Alm and McKee (2004) model an audit rule based on the discriminant inventory function score such that the most downward deviating income from the average of the reported incomes is inspected (i.e., the LIRA rule). Specifically, they analyze the LIRA rule theoretically and experimentally in a complete information setting with identical taxpayer incomes. Collins and Plumlee (1991) and Coricelli et al. (2010) also experimentally examine the LIRA rule in an incomplete information setting with multiple types of taxpayer incomes; however, these studies do not theoretically investigate the LIRA rule.

In this study, we compare these three audit rules theoretically and experimentally. Our approach significantly differs from the extant literature on these rules in three ways. First, we compare the rules in the same environment and with the same restriction, while prior studies typically investigate these rules one by one. We compare them in the setting of an incomplete information game with a continuous type of taxpayer. Additionally, we impose the restriction that the expected number of audited taxpayers in equilibrium is the same across the three rules. Second, we choose the optimal parameters (audit probability and threshold) for the cut-off rule that would maximize basic tax revenue (i.e., tax collected based on voluntary reporting). Moreover, we examine the cut-off rule with different parameters to validate the robustness of the rule. The third difference from the extant literature is that we derive the equilibrium strategy of a taxpayer under the LIRA rule in an incomplete information game. This allows us to compare the experimental data with the theoretical prediction.

In our experiment, four players with different taxable incomes simultaneously and privately report their incomes; based on their reports, tax proportionate to the reported incomes is levied. The true income of each taxpayer is private information. Each player has an incentive to under-report his/her true income to reduce his/her tax burden. Following their reporting decisions, some taxpayers may be inspected by the auditor based on the three rules. If an inspected taxpayer is found to have concealed income, the tax for this concealed income is levied, multiplied by the penalty rate.

The presented theoretical analysis shows that the cut-off rule with an optimal choice of threshold dominates the other rules in terms of increasing the compliance rate (the ratio of reported income to true income), minimizing evaded income, and maximizing tax revenue. The LIRA rule yields a higher compliance rate and less evaded income than the random rule does; however, the random rule yields higher penalties and total tax revenue than the LIRA rule does.

The regression analyses, including controlling for subjects' characteristics, present contrasting results, however. These analyses show that the LIRA rule yields a significantly higher compliance rate compared with the optimal cut-off and random rules. Nevertheless, there is no significant difference in the compliance rate between the LIRA and suboptimal cut-off rules. We also find that the impact of social norms regarding tax payment perceived by the subjects is easily interpreted. More precisely, tax awareness and subjects' need for tax audit are positively correlated with the compliance rate, while aggressiveness toward tax evasion is negatively correlated.[2]

The remainder of this paper is organized as follows. Section 2 presents the basic theory of tax evasion decision-making; subsequently, we present our theoretical predictions related to the three tax audit schemes. Section 3 describes our experimental design and procedure. Section 4 reports the results of our experiment and statistically analyzes them. Section 5 concludes.

2. Theory of tax audit rules

2.1. Basic model

This section summarizes the canonical model of taxpayer decision-making proposed by Allingham and Sandmo (1972) and Yitzhaki (1974). A taxpayer decides whether and to

[2] The result found for subjects' norm is in accordance with prior studies such as Kirchler (2007).

what extent to evade taxes in the same way that an individual would weigh a risky gambling decision. The taxpayer (an individual or a firm) has a true taxable income of Y, where $Y > 0$; the true taxable income is private information. Let t be the basic tax rate. The taxpayer pays tY as tax if (s)he reports his/her true income. However, if income is under-reported, the taxpayer should pay tR, where R represents the under-reported income ($R \le Y$), and $Y - R$ represents the amount of evaded or concealed income.[3] However, detailed auditing is randomly executed at probability p, where tax evasion is detected. In our model, tax evasion is revealed if the tax authority inspects the under-reporting taxpayer. In the event of an inspection, the individual must pay $tq(Y - R)$, as a penalty for the tax evasion, where q represents the penalty rate for the illegal activity ($q > 1$). Thus, the penalty is proportional to the concealed income.

The expected utility for an individual reporting his/her income as R (where $0 \le R \le Y$) is $EU = (1-p)U(Y - tR) + pU\left(Y - tR - tq(Y - R)\right)$, where U is a utility function with $U(Y) > 0$ and $U'(Y) > 0$ for any $Y > 0$. By differentiating EU by R and evaluating it at $R = Y$, we obtain $\frac{\partial EU}{\partial R}|_{R=Y} = t(pq-1)U'((1-t)Y)$. Thus, tax evasion occurs when $pq < 1$ or $p < 1/q$.

While the evasion decision depends on neither basic tax rate t nor true income Y, the extent of evasion may depend on these variables.[4] However, if we assume risk neutrality, the taxpayer fully evades his/her tax liability (i.e., reports zero income) whenever (s)he decides to evade taxes. In the discussion that follows, we assume risk neutrality for taxpayers. A comprehensive review of the theory is presented in Andreoni et al. (1998).

The canonical model does not address how the detection probability (p) is determined. Alm and McKee (2004) report that p is determined from the strategic interdependence between auditors and taxpayers. Thus, the detection probability seems to vary with reported income (Reinganum and Wilde 1986; Sánchez and Sobel 1993), past experience of cheating or auditing (Clark et al. 2004; Friesen 2003; Greenberg 1984; Harrington 1988), and relative positions of the reported income (Alm and McKee

[3] Other types of reporting decisions exist such as non-filing and the late payment of taxes owed. However, according to the 2001 Internal Revenue Service estimate of the tax gap, under-reporting represents approximately 82% of the gap and non-filing and late payment represent 8% and 10% of the gap, respectively (see Slemrod 2007). Thus, the major source of the tax gap is under-reporting.
[4] Yitzhaki (1974) shows that under the assumption of decreasing absolute risk aversion, the extent of evasion decreases as the basic tax rate increases and the extent of evasion increases as income increases.

2004; Collins and Plumlee 1991). To ensure strategic interdependence among taxpayers, we assume that there are n taxpayers. In Sections 2.2–2.4, we describe the three audit rules (random rule, cut-off rule, LIRA rule) and theoretically show how taxpayers' decisions differ when adopting them.

To improve our understanding, we explain the three audit rules by using the following parameters: $n = 4$, $t = 0.2$, and $q = 3$. To compare these audit rules in a fair manner, we propose the condition that the (expected) number of investigated taxpayers in equilibrium is one because of the resource constraints of the audit authority. We assume that the true income of each player is selected independently from an identical uniform distribution of [0, 1000]. For each taxpayer i ($i \in \{1,2,3,4\}$), Y_i and R_i denote i's true income and reported income, respectively.

2.2. Random rule

Under the random rule, the auditor chooses one of the four taxpayers at random irrespective of their reported incomes. The chosen taxpayer is inspected. In our setting, the probability of detection (p) is $1/n = 1/4$ and the penalty rate q is 3. Thus, $p < 1/q$ holds true, indicating that the optimal strategy for each taxpayer is to report zero income. Thus, the random rule does not incentivize taxpayers to report their true income.

2.3. Cut-off rule

Under the cut-off rule, the detection probability varies according to the reported income. In particular, we choose a cut-off rule, where the reported income less than 750 is inspected with probability 1/3 and the reported income above or equal to 750 is never inspected. According to our selected parameters, the detection probability of 1/3 is the lowest probability for a taxpayer to report his/her income truthfully. The range of [0, 750] is determined by the restriction that the expected number of inspections is one out of four taxpayers $((1/3)\times(750/1000) = 1/4)$. An optimal strategy for a taxpayer under the cut-off rule is to report his/her income truthfully when his/her income is below or equal to 750 and report the threshold when his/her income is above 750. Thus, under this audit rule, a taxpayer with a higher income evades the tax burden. It is theoretically known that the cut-off rule discussed here is a tax-revenue maximizing audit rule (Sánchez and Sobel 1993); hence, for the experimental treatment, we denote it Cut-off O. Note that participants of Cut-off O with income not above 750 are indifferent among all the possible reporting alternatives. That is, revenue maximizing mitigates the incentive for truthful reporting.

Next, we consider the suboptimal cut-off rule (denoted Cut-off S), which gives participants a sufficient incentive for truthful reporting at the cost of maximizing tax revenue. In the Cut-off S, the reported income less than 500 is inspected with probability 1/2 and the reported income above or equal to 500 is never inspected.

2.4. LIRA rule

Under the LIRA rule, the auditor investigates the lowest income among the four reported incomes. Thus, strategic interdependence exists among taxpayers. Since the true income of each taxpayer is private information, this rule involves incomplete information (Harsanyi 1967).

Under the LIRA rule, the lower the reported income is, the more likely income is to be inspected. Therefore, the optimal strategy for taxpayers is to report their income truthfully if their true income is below some critical value c^* and to cheat otherwise. Critical value c^* is calculated as follows. Assume that the four players follow the same strategy; thus, they report the true income when their income is below c^*. Consider a taxpayer whose true income is $c \le c^*$. The probability of detection when (s)he reports c is $(1-c/1000)^3$, and this probability decreases in c. According to our selected parameters, a detection probability greater than or equal to 1/3 (= $1/q$) is needed to truthfully report income (see Section 2.1). Since income c^* is the marginal value between reporting the true income and cheating, $(1-c^*/1000)^3$ must be equal to $1/q = 1/3$. Thus, we have $c^* = 1000 \times (1-(1/q)^{1/3}) \approx 306$. In fact (as shown in the Appendix), under the LIRA rule, the equilibrium strategy of each i becomes the one where a participant truthfully reports his/her income ($R_i = Y_i$) if $Y_i < c^*$, while (s)he cheats by $e(Y_i)$ ($R_i = Y_i - e(Y_i)$) if $Y_i \ge c^*$, where e represents the extent of cheating with $e(c^*) = 0$, $e(Y_i) > 0$ for $Y_i > c^*$, and $e'(Y_i) > 0$ for $Y_i \ge c^*$.

By comparing the equilibrium strategies under the cut-off and LIRA rules, the income range of those who truthfully report their income is larger under the cut-off rule than under the LIRA rule. Moreover, for any income $Y > c^*$, a taxpayer of type Y reports more income under the cut-off rule than under the LIRA rule (see Figure 1). Thus, the cut-off rule theoretically dominates the LIRA rule.

2.5. Summary of theoretical predictions under our parameter selection

Figure 1 summarizes the equilibrium tax-reporting behaviors under these audit rules. The left panel of Figure 1 shows the prediction of taxpayers' reporting strategies under each audit rule. We see that the cut-off rule dominates the other rules and the LIRA rule dominates the random rule. Further, he predicted strategies under the LIRA rule and the two cut-off rules have kinks at $Y = 306.6, 500 \text{ and } 750,$ respectively.[5]

Figure 1 here

The right panel of Figure 1 illustrates the predicted compliance rate, $r = R / Y$, a measure for the degree of truthful reporting. For example, if a player with income of 500 reports 220, the corresponding compliance rate is $r = 220 / 500 = 44.0\%$.[6] Suppose that the compliance rate is sufficiently close to one (e.g., 90%) and the tax is almost correctly levied; we can then say that such an audit rule works. Moreover, the ranking among the mechanisms is preserved when converting the reporting strategy into the induced compliance rate. Hence, this normalization is useful for the following analysis.

Table 1 presents the expected tax revenue per taxpayer under these four treatments, broken down into the tax revenue from reported income, the penalty, and their total. Consistent with reporting behaviors, tax revenue from reported income is the highest in Cut-off O followed by Cut-off S, LIRA, and Random. However, for revenue from penalties, this order is reversed. Overall, total tax revenue is the highest in Cut-off O, second highest in Cut-off S and Random, and lowest in LIRA.[7]

[Table 1 here]

3. **Experimental design**

Each of the four treatments (Random, Cut-off O, Cut-off S, LIRA), has two sessions. We conducted all sessions at Kochi University of Technology's Experimental Social Design Lab in July 2014 and April 2015. Each session lasted 90 minutes. We used the experimental software z-Tree (Fischbacher 2007). We recruited 140 student subjects from Kochi University of Technology through campus-wide advertisements. The number of subjects for each treatment was 24 for Random, 36 for Cut-off O, 40 for Cut-off S, and 40 for LIRA. No subject participated in more than one session. Moreover, none of them had prior experience of a similar type of experiment. Subjects were seated at individually partitioned computer terminals assigned randomly. We did not allow any communication among subjects.

Each subject received a copy of the instructions (see the Online Supplementary

[5] Incorporating risk aversion into our model does not change the ranking of the compliance rate.
[6] Note that the definition of the compliance rate in Alm et al. (2009) is (tax paid)/(tax owed); however, under the proportional tax model, this reduces to r.
[7] The penalty revenue depends on penalty rate q, and thus so does total revenue. Hence, we focus on tax collected from reported income.

Information). Additionally, the instructions were read aloud by an experimenter. Subsequently, subjects answered a quiz about the audit rule in which they participated. Following the quiz, an experimenter publicly announced the answers of the quiz. Subjects then proceeded to 20 payment periods. In each session, we employed the stranger matching protocol so that every group in every period included four subjects. Subjects were informed that they would be randomly re-matched in every period.

Next, we explain the process followed in one period of the four treatments. Once a group is formed, every subject faces the reporting screen. On the reporting screen, (s)he privately receives and confirms his/her income, which is drawn independently from the uniform distribution of [0, 1000] (yen), with an increment of 10. Note that income is newly drawn by period, leading to a one-shot incomplete information environment. Every subject can confirm t = 0.2 and q = 3. Given this information, the subject determines how much income to report and (s)he inputs a number between 0 and his/her income, in increments of 10. Once every subject inputs the reported income and clicks the OK button, subjects proceed to the results screen. The results screen displays (from the top) one's own income (Y), one's reported income (R), one's concealed income ($Y-R$), tax on reported income (tR), penalty ($tq(Y-R)$), and one's payoff in the period. In every period after the second period, the history box appears, where subjects can confirm the information contained in the results screen in all of the previous periods. Once all subjects click the Next button, they proceed to the next period.

After participating in 20 payment periods, subjects complete two questionnaires. The first questionnaire asks social norms, which includes tax payment awareness, acceptable tax rate, aggressiveness toward tax evasion, need for audits, and satisfaction for public service, following Gërxhani (2004) and Lefebvre et al. (2015). Second, all participants complete the questionnaire on the measurement of risk preference. To measure subjects' degree of risk aversion, we set 11 lotteries vs. safe constant cash questions, varying the winning probability of the lottery from 0% to 100% in increments of 10%. After the questionnaires are completed, the subjects are immediately paid in cash, privately. Each subject is paid a participation fee of 800 yen (approximately $7 USD) plus the total earnings over the three periods, which are randomly decided by a lottery. The average reward per subject was approximately $19 USD.

4. Experimental results

4.1. Overview of the compliance rate

This subsection examines the income-reporting behavior of subjects. In what follows, we drop the data when drawn income is zero. Table 2 summarizes the compliance rate for each audit rule. We find that the difference in the mean compliance rate among the audit rules is narrower than that predicted, with Random yielding 51.0%. The mean compliance rate is significantly higher in Cut-off O than in Random, (p<0.001, two-sided Wilcoxon rank sum test). Likewise, both Cut-off S and LIRA significantly improve the compliance rate compared with Random (p<0.001 for both cases, two-sided Wilcoxon rank sum test). Nevertheless, for any pair of audit rules except for Random, the null hypothesis of equivalence in the compliance rate between the two rules cannot be rejected at a conventional level of significance.[8]

[Table 2 here]

Figure 2 illustrates the breakdown of the mean compliance rate by income class. The horizontal axis denotes income class divided into quarters. That is, income class k is the minimum integer that satisfies $Y \le 250k$. The vertical axis denotes the mean compliance rate. Figure 2 suggests that the mean compliance rate does not exceed 0.8 for any audit rule or income class. Notably, only 37.2% (resp. 37.1%) of Cut-off O subjects report truthfully ($R = Y$) when their income is not above 750 (resp. 500), while truthful reporting is predicted. One plausible reason that hinders truthful reporting in Cut-off O is the indifference among all possible reporting alternatives when income does not exceed 750, as noted in Section 2. Moreover, Cut-off S successfully promote compliance behavior relative to Cut-off O: 51.9% (resp. 37.2%) of the data show truthful reporting if income is not above 500 (resp. 750).

[Figure 2 here]

The compliance rate under LIRA exhibits a decreasing tendency in income at a significant level ($\rho = -0.3789$, $p < 0.001$, Spearman rank correlation test using raw observations).[9] This observation is qualitatively consistent with the prediction and intuition that, under LIRA, subjects with higher income are less likely to be audited and hence are tempted to conceal more income.

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[8] We run two-sided Wilcoxon rank sum tests by using all observed compliance rates. Since we did not use a fixed income realization across treatments, running tests with the first period data only for statistical independence does not seem plausible.

[9] Under Cut-off S, there is a significant negative correlation between the compliance rate and income (. $\rho = -0.2883,\ p < 0.001$), while under Cut-off O and Random, there is no such significant correlation ($\rho = 0.0271,\ p = 0.4699$; $\rho = -0.0181,\ p = 0.6937$).

4.2. Compliance rate by subject

Figure 3 shows the histogram of the compliance rate averaged by subject under each audit rule. Given an audit rule, the red reference line indicates the expected compliance rate under equilibrium reporting behavior and the uniformly distributed income used in our experiment. Notice that the mode of observed compliance rates is within distance of 0.1 from the predicted one excepted for Random. However, arriving at a consistent explanation of the upward shift in the random treatment and downward shift in the cut-off treatments is difficult. For example, to explain why the compliance rate in Random is higher than expected, assume that a fixed proportion of subjects is the honest type (i.e., they unconditionally report their true income). In this case, the curve of the observed strategy would be pushed up in every treatment, which contradicts the fact that Cut-off O subjects under-report their income. A similar argument holds if we consider the tendency to obey the tax authority (i.e., the experimenters in this setting).

[Figure 3 here]

4.3. Regression results

The regression analysis in this subsection clarifies whether these audit rules induce tax compliance. By using multiple regression analyses, we confirm that audit scheme, income, and social norm on tax payments all affect the tax evasion decision. Alm and Torgler (2011) argue that taxpayers' attitudes toward tax compliance can be explained at least in part, by recognizing the role of ethics in individual behavior. Also, they point out that taxpayers are often motivated by altruism, fairness, and so on. The aggregation of these variables results in the motivation for taxpayers to behave honestly. Indeed, the aggregation of subjective constructs and socially shared beliefs and evaluations is related to motivational forces (Braithwaite 2003).

The total number of observations is 2,800 (140 subjects × 20 times). From these, five subjects (100 observations) were excluded from the analyses since they did not reply to the questions after the experiment. Further, six observations for which we were unable to calculate the decision time and 28 observations for which the compliance rate cannot be defined due to zero income are excluded. Thus, 2,666 observations were used as the sample in our statistical analysis.

In our regression model, the standard error is adjusted for 135 clusters in subjects. The dependent variable is the compliance rate. The independent variables include each income category (the low-income category being the omitted reference category), each tax scheme (LIRA being the omitted reference scheme), social norm divided into five variables, and the risk appetite of each subject. Moreover, the model includes gender (1 if male), the time spent reporting income, and previous audit and penalty (Alm 1988; Coricelli et al. 2010; Kastlunger et al. 2009). Table 3 defines the variables used for the regression model.

[Table 3 here]

Table 4 presents the results of the regression analysis. The main result (Panel A) is that Random and Cut-off O are negatively correlated with the compliance rate (Random: $z = -4.20$, $p < 0.001$; Cut-off O: $z = -2.52$, $p = 0.012$).[10] This finding suggests that after controlling for subjects' attitudes toward tax compliance, LIRA still leads to an increase in the compliance rate relative to Cut-off O and Random. Moreover, Random has a negative correlation with the compliance rate in all income categories (Panels B–E). On the contrary, although Cut-Off O is negatively correlated with the compliance rate in the Q1 and Q2 income categories, it is positively correlated with the compliance rate in the Q4 income category. These intuitive results are in accordance with Figure 2. That is, LIRA enhances compliance rates more than does Cut-off O when income is in the lower half of the interval. However, LIRA subjects with income in Q4, expecting that other group members are more likely to have income lower than themselves, are tempted to conceal their income more. On the contrary, Cut-off O subjects with income in Q4 are more likely to say 750, which ensures non-auditing.

[Table 4 here]

Our results also indicate that social norm affects the compliance rate (Panel A). In particular, tax awareness and the need to audit the tax affairs of subjects both have positive correlations with the compliance rate (Tax awareness: $z = 1.77$, $p = 0.084$; Need for audit: $z = 2.27$, $p = 0.023$), whereas subjects' aggressiveness toward tax evasion has a negative correlation with the compliance rate (Aggressiveness: $z = -2.18$, $p = 0.039$). These results support those of many previous studies of tax compliance (e.g., Porcano 1988; Ahmed 2004; Alm 2012; Cadsby et al. 2006; Kirchler 2007). Moreover, we find that male taxpayers tend to evade taxes (Male: $z = -2.11$, $p = 0.035$), which supports the

[10] We performed an additional analysis to ensure robustness by using average of the compliance rate of any subject as the dependent variable. The result indicates that Random is negatively correlated with the average compliance rate ($t = -2.92$, $p = 0.004$).

results of Lefebvre et al. (2015).

Whether audits and fines actually deter evasion is often debated (Kastlunger et al. 2009). Penalties are frequently assumed to be useful measures for prohibiting undesired behavior (Landsberger and Meilijson 1982). However, the results of prior studies of the effects of fines on tax compliance are mixed.[11] Our result shows that the previous penalty has a negative correlation with the subsequent compliance rate (penalty (t-1): z = -4.87, p < 0.001).

5. Conclusion

In this study, we employed a game-theoretic framework to analyze three audit rules, namely the random rule, cut-off rule, and LIRA rule, and test the theoretical predictions in a laboratory experiment. The contributions of this study can be stated as follows. First, we compared representative three audit rules using incomplete information game with a continuous type of taxpayer, given the auditor's resource constraint. In particular, we derived a symmetric equilibrium strategy under the LIRA rule as a Bayesian game for the first time to the best of our knowledge. Secondly and primarily, we showed that the LIRA rule as well as the cut-off rules actually work in a laboratory setting. In particular, the LIRA and suboptimal cut-off rules promote tax compliance among subjects to a greater extent than the optimal cut-off rule. Although the ranking of enhancement of compliance behavior among the three audit rules depends on income range, all these three audit rules perform better than random auditing.

The experimental result that the LIRA rule has a higher compliance rate than the optimal cut-off rule has some practical importance because the tax authorities in most countries assign higher priority to the enhancement of tax compliance. While the optimal cut-off also showed high tax compliance and enhanced tax revenue, determining the optimal parameter for a real-world population could be difficult. By contrast, the LIRA rule works without information on the other parameters because it uses the profile of reported incomes to determine whom to audit.

From the results of the regression analysis, which controlled for subjects' social norm and risk attitude, we further found that tax awareness and subjects' need for a tax audit are positively correlated with the compliance rate, while aggressiveness toward

[11] For example, Friedland et al. (1978) find that higher punishment seems to be slightly more efficient at preventing evasion compared with higher audit rates. By contrast, Weck-Hannemann and Pommerehne (1989) find no significant effect of punishment. There are many explanations as to why fines do not have the predicted high effect on tax compliance. Kirchler (2007) suggests that taxpayers try to avoid taxes when the benefits that they could gain are uncertain. Halperin and Tzur (1990) show that the proportion of evaders is an insufficient reason to explain the low penalty rate.

tax evasion has a negative correlation. These results are in line with prior experimental findings on the behavioral aspects of tax reporting decisions, which state that tax awareness, the moral cost of tax evasion, other-regarding preferences, tendency to overestimate a small probability, and asymmetry between loss and gain (Alm 2012) may affect the performance of audit rules.

Finally, we discuss possible future research directions. Under the audit schemes discussed in this study, the auditor decides the rule based on which the taxpayer is to be inspected. Another interesting experimental setting would be the human audit condition, which is part of our ongoing research. In this setting, after taxpayers make their decisions, the subject who plays the role of the auditor must use his/her own discretion to choose one of the four taxpayers as the target. Moreover, when the auditor has a costly option to inspect multiple taxpayers, even if the option does not pay, the compliance rate of taxpayers may increase because they overestimate the probability of being audited when facing ambiguity, as Tan and Yim (2016) observed.

Appendix. Theoretical analysis of the LIRA rule

Let $N = \{1,2,\ldots,n\}$, with $n \geqq 2$ as the set of taxpayers (individuals or firms) that should report their income to a tax authority. For $i \in N$, true income is denoted by $Y_i \in [Y_\ell, Y_h]$, where Y_ℓ, and Y_h are the lower and upper bounds of income, respectively. In our experiment, these are equal to 0 and 1000, respectively. Each *i* with income Y_i reports $r_i \in [0, Y_i]$ to the tax authority.

In the income-reporting game, taxpayers report their incomes simultaneously. Let $(r_1, r_2, \ldots, r_n) \in [0,1000]^n$ be the profile of the reported incomes. A tax authority observes the profile and inspects the individual with the lowest reported income. If there is a tie, a random selection is made from among the tied members.

We assume that the true income of each individual is a random variable. Thus, we model the income-reporting game with a strategic inspection as a normal-form game with incomplete information (Harsanyi 1967). We assume that the true income Y_i of an individual is identically and independently distributed according to a continuous distribution function F on [0,1000]. Let f be the density function of F. Because the income-reporting game with strategic auditing is a normal-form game with incomplete information, the strategy of player *i* is a function that associates his/her realized true income Y_i with reporting income r_i. Let γ_i be the strategy of player *i*.

We adopt the symmetric Bayesian Nash equilibrium (BNE) $(\gamma, \gamma, \ldots, \gamma)$, where every player uses the same strategy γ as a solution criterion to evaluate strategic auditing. We assume the following differentiability condition.

Assumption 1. A Bayesian equilibrium strategy γ_i is a continuous, differentiable, and increasing function with $\gamma(0)=0$.

We explore the conditions that should be satisfied by γ. Suppose $n-1$ individuals, with the exception of player i with income Y (type Y player), follow strategy γ. The expected payoff of the type Y player reporting $r \le Y$ is

$$U(r,Y) = Y - tr - \left(1-F\left(\gamma^{-1}(r)\right)\right)^{n-1} qt(Y-r). \tag{1}$$

Note that $\left(1-F\left(\gamma^{-1}(r)\right)\right)^{n-1}$ is the probability of r being the lowest reported income among n reported incomes. This is a continuous function in the domain $[0,Y]$ when γ is a continuous function. By differentiating $U(r,Y)$ in r, we obtain

$$\frac{\partial U}{\partial r} = -t-(n-1)\left(1-F\left(\gamma^{-1}(r)\right)\right)^{n-2}\left(-f\left(\gamma^{-1}(r)\right)\right)\frac{qt(Y-r)}{\gamma'\left(\gamma^{-1}(r)\right)} + \left(1-F\left(\gamma^{-1}(r)\right)\right)^{n-1} qt\ . \tag{2}$$

For $(\gamma,\gamma,\ldots,\gamma)$ to constitute a BNE, there must be a local maximum at $r=\gamma(Y)$. Thus, the following first-order condition should be satisfied:

$$\frac{\partial U}{\partial r}(\gamma(Y),Y)\begin{cases} \ge 0 & \text{if } \gamma(Y)=Y \\ =0 & \text{if } 0<\gamma(Y)<Y \\ \le 0 & \text{if } \gamma(Y)=0 \end{cases}$$

$$\Leftrightarrow \frac{\left(\frac{1}{q}-\left(1-F(Y)\right)^{n-1}\right)}{(n-1)\left(1-F(Y)\right)^{n-2} f(Y)}\gamma'(Y)\begin{cases} \le Y-\gamma(Y) & \text{if } \gamma(Y)=Y \\ =Y-\gamma(Y) & \text{if } 0<\gamma(Y)<Y \\ \ge Y-\gamma(Y) & \text{if } \gamma(Y)=0 \end{cases}$$

Let Y^* be defined as follows:

$$Y^* = F^{-1}\left(1-\left(\frac{1}{q}\right)^{1/(n-1)}\right). \tag{3}$$

For $Y<Y^*$, $\frac{1}{q}-\left(1-F(Y)\right)^{n-1}<0$. $\gamma'>0$ from Assumption A1 and $Y-\gamma(Y)\geqq 0$, $Y=\gamma(Y)$ must hold for $Y<Y^*$. Therefore, a type Y taxpayer for $Y \le Y^*$ truthfully reports his/her income.

Next, consider Y that satisfies $Y>Y^*$. The differential equation can be reduced to

$$\gamma'(Y)+A(Y)\gamma(Y)=A(Y)Y$$

where

$$A(Y)=\frac{(n-1)(1-F(Y))^{n-2}f(Y)}{\left(\frac{1}{q}-(1-F(Y))^{n-1}\right)}$$

and $A(Y)>0$ for $Y>Y^*$. A general solution of the above differential equation is

$$\gamma(Y)=e^{-\int A(Y)dY}\left(\int A(Y)Ye^{\int A(Y)dY}dY+C\right)$$

with an initial condition $A(Y)=Y^*$. By using partial integration,

$$\begin{aligned}\gamma(Y)&=e^{-\int A(Y)dY}\left(Ye^{\int A(Y)dY}-\int e^{\int A(Y)dY}dY+C\right)\\&=Y-e^{-\int A(Y)dY}\left(\int e^{\int A(Y)dY}dY-C\right).\end{aligned}$$

Let $a(Y)=\int A(Y)dY$, that is, an indefinite integral of $A(Y)$. Consider the initial condition:

$$\gamma(Y)=Y-\int_{Y^*}^{Y}e^{a(z)}dz\,/\,e^{a(Y)}=Y-\int_{Y^*}^{Y}e^{a(z)-a(Y)}dz \text{ for } Y>Y^*.$$

Therefore, we have a candidate for an equilibrium strategy as follows:

$$\gamma(Y)=\begin{cases}Y & \text{for } Y\leqq Y^*\\ Y-\int_{Y^*}^{Y}e^{a(z)-a(Y)}dz & \text{for } Y>Y^*.\end{cases} \tag{4}$$

The next proposition states that γ constitutes a BNE.

Proposition 1. *Let γ be defined in (4). Strategy profile $(\gamma,\gamma,\ldots,\gamma)$ is a BNE.*

Proof. The payoff of type Y reporting r is given by (1) and is reduced to

$$U(r,Y)=(1-t)Y+t(Y-r)\left(1-q\left(1-F\left(\gamma^{-1}(r)\right)\right)^{n-1}\right) \tag{5}$$

We consider the following cases separately: (i) $Y<Y^*$ and (ii) $Y\geq Y^*$.

Case (i) $Y<Y^*$. Because $r\leq Y<Y^*$ and $\gamma(r)=r$, the payoff described by (5) is rewritten as follows:

$$(1-t)Y+t(Y-r)\left(1-q(1-F(r))^{n-1}\right). \tag{6}$$

Since $r\leq Y<Y^*$ and Y^* satisfies (3), $1-q(1-F(r))^{n-1}$ is negative. Therefore, the taxpayer payoff is maximized at $r=Y$.

Case (ii) $Y \geq Y^*$. When $r \leq Y^*$, the payoff is given by (6) and is maximized at $r = Y^*$ in the domain $[0, Y^*]$. Next, suppose $r > Y^*$. The first derivative of $U(r,Y)$ given by (2) is rewritten as follows:

$$\frac{\partial U}{\partial r} = -t + (n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right)\frac{qt\left(\gamma^{-1}(r) - r\right)}{\gamma'\left(\gamma^{-1}(r)\right)}$$

$$+\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-1} qt + (n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right)\frac{qt\left(Y - \gamma^{-1}(r)\right)}{\gamma'\left(\gamma^{-1}(r)\right)}.$$

Because $Y^* < \gamma^{-1}(r) < r$ and from (3), γ must satisfy the following:

$$\frac{\left(\frac{1}{q} - \left(1 - F(Y)\right)^{n-1}\right)}{(n-1)\left(1 - F(Y)\right)^{n-2} f(Y)} = \frac{Y - \gamma(Y)}{\gamma'(Y)}.$$

By using this, the first derivative is reduced to

$$\frac{\partial U}{\partial r} = -t + (n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right) t \left(\frac{\left(1 - q\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-1}\right)}{(n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right)}\right)$$

$$+\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-1} qt + (n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right)\frac{qt\left(Y - \gamma^{-1}(r)\right)}{\gamma'\left(\gamma^{-1}(r)\right)}$$

$$= -t + t\left(1 - q\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-1}\right) + \left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-1} qt$$

$$+(n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right)\frac{qt\left(Y - \gamma^{-1}(r)\right)}{\gamma'\left(\gamma^{-1}(r)\right)}$$

$$= (n-1)\left(1 - F\left(\gamma^{-1}(r)\right)\right)^{n-2} f\left(\gamma^{-1}(r)\right)\frac{qt\left(Y - \gamma^{-1}(r)\right)}{\gamma'\left(\gamma^{-1}(r)\right)}.$$

This is positive for $r \in [Y^*, \gamma(Y))$, negative for $r \in (\gamma(Y), Y]$, and zero if $r = \gamma(Y)$. Thus, U is maximized at $r = \gamma(Y)$. Therefore, the proof ends.

The following intuition can be gained from the preceding discussion. Because the lowest reporter is audited, the risk of punishment when cheating is high for low-income taxpayers. This implies that truthful reporting is more likely to occur among low-income taxpayers. Assuming that every taxpayer with income below Y truthfully reports his/her true income, the payoff for a taxpayer with income Y when (s)he reports

r is given by (6). Therefore, as long as $1-q\left(1-F\left(r\right)\right)^{n-1}$ is negative, the preferred action is to truthfully report the income. The critical value of reporting income truthfully is obtained when $1-q\left(1-F\left(r\right)\right)^{n-1}=0$ i.e., $Y=Y^*$. For a taxpayer whose income exceeds Y^*, truthful reporting is never a preferred action. The extent of tax evasion is captured by $\int_{Y^*}^{Y} e^{a(z)}dz / e^{a(Y)}$. The slope of γ in the domain $[Y^*, 1000]$ is

$$\gamma'(Y) = 1 - \frac{1}{\left(e^{a(Y)}\right)^2}\left(\left(e^{a(Y)}\right)^2 - e^{a(Y)}A(Y)\int_{Y^*}^{Y} e^{a(z)}dz\right)$$
$$= \frac{A(Y)}{e^{a(Y)}}\int_{Y^*}^{Y} e^{a(z)}dz > 0.$$

Thus, the reported income itself is an increasing function, and Assumption A1 is fulfilled. Figure 1 is obtained by applying the formula in (4) to our experimental setting with the numerical calculation of the integral.

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Tables

	Audit Rule			
	Cut-off O	Cut-off S	LIRA	Random
Tax Revenue	93.6	75.0	68.2	0
Penalty Revenue	0	0	2.7	75.0
Total Revenue	93.6	75.0	70.9	75.0

Table 1 Theoretical predictions of tax revenues (including penalty) per taxpayer under the audit rules

		Compliance rate		Test for difference in compliance rate		
Audit rule	Obs.	Mean	Std. Dev.	vs. Cut-off S	vs. LIRA	vs. Random
Cut-off O	713	0.59	0.42	p=0.4661	p=0.4305	p<0.001
Cut-off S	792	0.64	0.35		p=0.1596	p<0.001
LIRA	791	0.66	0.27			p<0.001
Random	476	0.51	0.41			

Table 2 Summary of the compliance rates

Table 3 Definition of the variables

Variable	Definition
IncomeQ1(reference)[a]	equal to 1 if Income is 10 or more and 250 or less, and 0 otherwise
IncomeQ2[a]	equal to 1 if Income is 260 or more and 500 or less, and 0 otherwise
IncomeQ3[a]	equal to 1 if Income is 510 or more and 750 or less, and 0 otherwise
IncomeQ4[a]	equal to 1 if Income is 760 or more and 1000 or less, and 0 otherwise
Random(reference)[a]	equal to 1 if an audit scheme is Random, and 0 otherwise
Cut-off O[a]	equal to 1 if an audit scheme is Cut-off O, and 0 otherwise
Cut-off S[a]	equal to 1 if an audit scheme is Cut-off S, and 0 otherwise
LIRA[a]	equal to 1 if an audit scheme is LIRA, and 0 otherwise
Tax awareness[b]	the tax-payment awareness of a subject
Acceptable tax rate	the acceptable tax rate of a subject on 10,000
Aggressiveness[b]	the aggressiveness of a subject against tax evasion
Needs for audit[b]	the needs for tax audit that a subject feels
Satisfaction for public services[b]	the satisfaction for public services of a subject
Risk appetite[c]	the risk preference of a subject
Male	male of a subject
Decision time	time spent in order that a subject reports income
Audit (t-1)	equal to 1 if a subject was audited at the precious period (t-1), and 0 otherwise
Penalty (t-1)	the amount of penalty (t-1)

Notes: a) The variables are indicator variables. b) Each question is categorized into one of five questionnaire categories: tax awareness, acceptable tax rate, aggressiveness toward tax aversion, need for tax audit, and satisfaction with public services, then we calculated the average score of each category. 10 means that each answer for the questionnaire item of a subject is low, and 100 means that each item is high. For correspondence between each question and questionnaire item, see the online supplementary material. c) We measured each subject's switching point where (s)he begins to prefer the lottery to safe constant cash. A larger number means that the subject is risk-averse. We used the answers for question 4.

Table 4 Determinants of the compliance rate

	DV=Percentage of true income reporting														
	A: Full			B: Income Q1			C: Income Q2			D: Income Q3			E: Income Q4		
Variables	Coef.	Std.Err.	z	Coef.	Std.Err.	z	Coef.	Std.Err.	z	Coef.	Std.Err.	z	Coef.	Std.Err.	z
IncomeQ1 (reference)															
IncomeQ2	0.016	0.017	0.97												
IncomeQ3	0.015	0.017	0.90												
IncomeQ4	-0.068	0.016	-4.06***												
LIRA (reference)															
Random	-0.169	0.040	-4.20***	-0.2	0.063	-3.11**	-0.210	0.058	-3.61***	-0.11	0.052	-2.13**	-0.16	0.056	-2.85**
Cut-off O	-0.085	0.035	-2.52**	-0.163	0.050	-3.24**	-0.09	0.046	-1.87*	-0.02	0.064	-0.37	0.023	0.064	1.74*
Cut-off S	0.036	0.051	0.71	0.027	0.072	0.31	0.056	0.067	0.83	0.082	0.042	1.93*	-0.08	0.046	-1.54
Tax awareness	0.015	0.009	1.77*	0.013	0.013	1.00	0.017	0.012	1.76*	0.027	0.011	2.36**	0.018	0.012	1.55
Acceptable tax rate	-0.013	0.020	-0.65	-0.02	0.030	-0.53	-0.012	0.013	-0.89	-0.01	0.025	-0.53	-0.03	0.027	-0.11
Aggressiveness	-0.010	0.010	-2.18**	-0.01	0.014	-0.19	-0.012	0.013	-0.89	-0.01	0.012	-0.66	-0.010	0.012	-0.78
Needs for audit	0.019	0.008	2.27**	0.020	0.012	1.75*	0.015	0.011	1.78*	0.015	0.010	1.50	0.027	0.013	2.41**
Satisfaction for pulic	-0.016	0.014	-1.45	-0.02	0.016	-1.12	-0.012	0.013	-0.89	-0.029	0.013	-2.11**	-0.035	0.014	-2.40**
Risk appetite	0.001	0.004	0.26	0.009	0.006	0.14	0.008	0.006	0.13	0.003	0.005	0.71	0.001	0.005	0.25
Decision time	0.020	0.018	1.85*	0.010	0.010	1.00	0.013	0.010	1.29	0.014	0.009	1.50	0.005	0.001	0.15
Male	-0.079	0.027	-2.11**	-0.089	0.040	-2.18**	-0.089	0.038	-2.35**	-0.072	0.034	-2.10**	-0.046	0.036	-1.28
Audit (t-1)	-0.020	0.016	-1.24	-0.019	0.015	-1.24	-0.02	0.015	-1.08	-0.03	0.014	-1.72**	-0.03	0.014	-2.00**
Penalty(t-1)	-0.003	0.008	-4.87***	-0.02	0.008	-2.32**	-0.03	0.008	-3.59***	-0.03	0.008	-3.21**	-0	0.007	-2.27**
Constant	0.535	0.097	5.52***	0.589	0.134	4.38***	0.526	0.125	4.21***	0.487	0.113	4.29***	0.521	0.119	4.38***
Number of Observations		2666			656			664			678			668	
wald chi^2		129.89			43.87			56.63			57.08			46.76	
Prob> chi^2		0.000			0.000			0.000			0.000			0.000	
R^2		0.104			0.094			0.102			0.104			0.095	

Notes: $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Figures

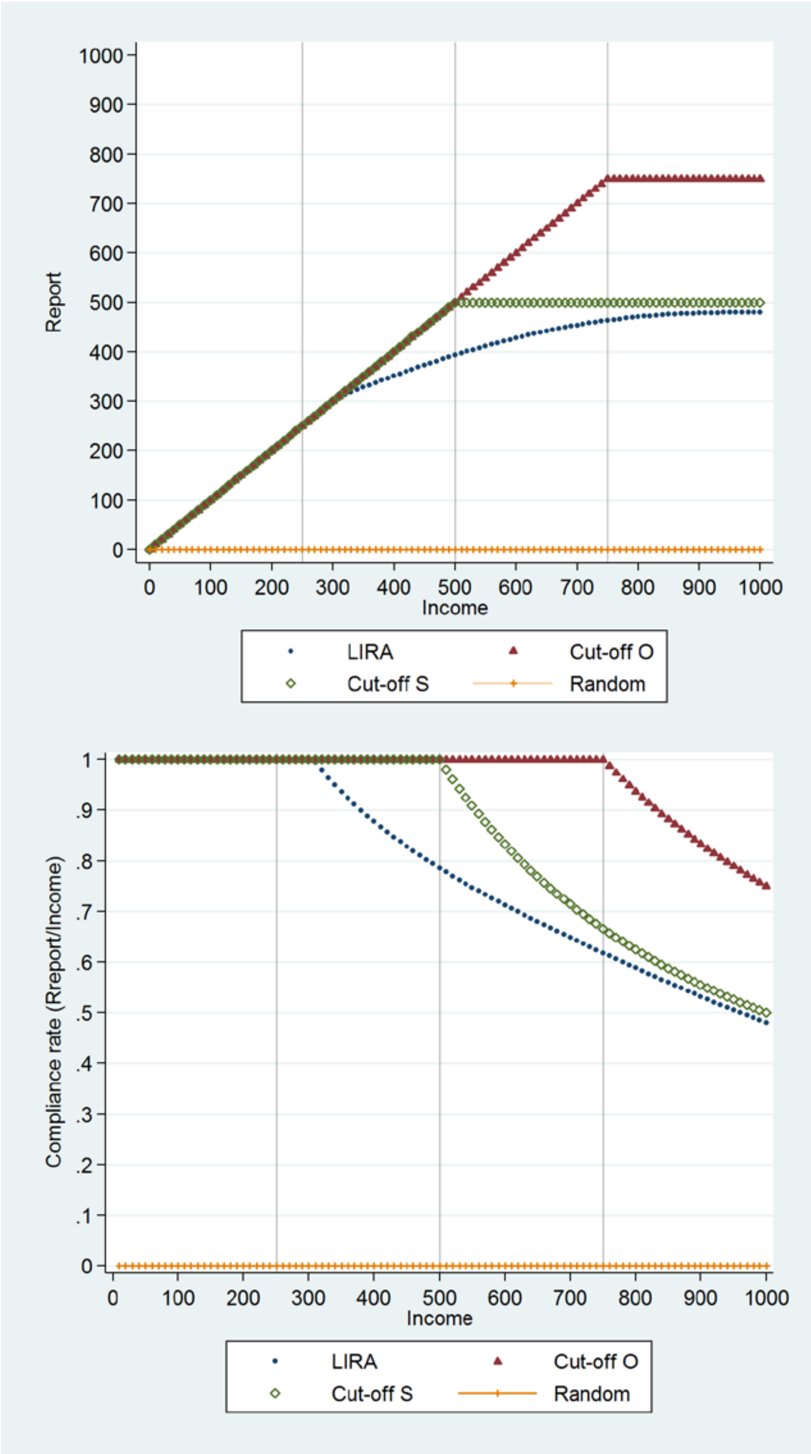

Figure 1 Theoretical predictions of reported incomes under the audit rules

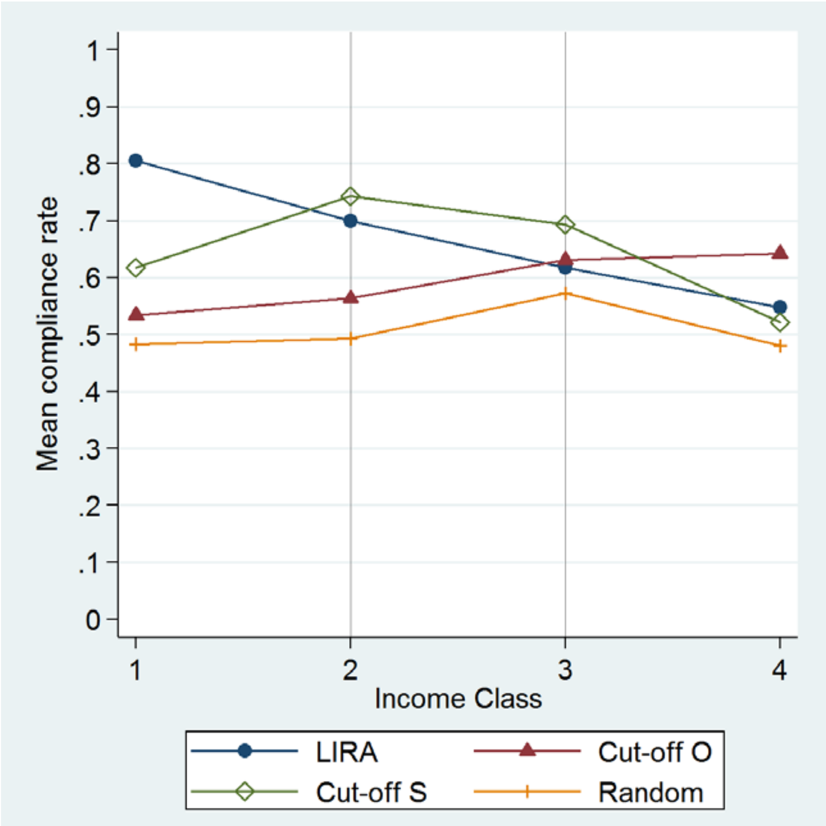

Figure 2 Observed income-reporting strategy

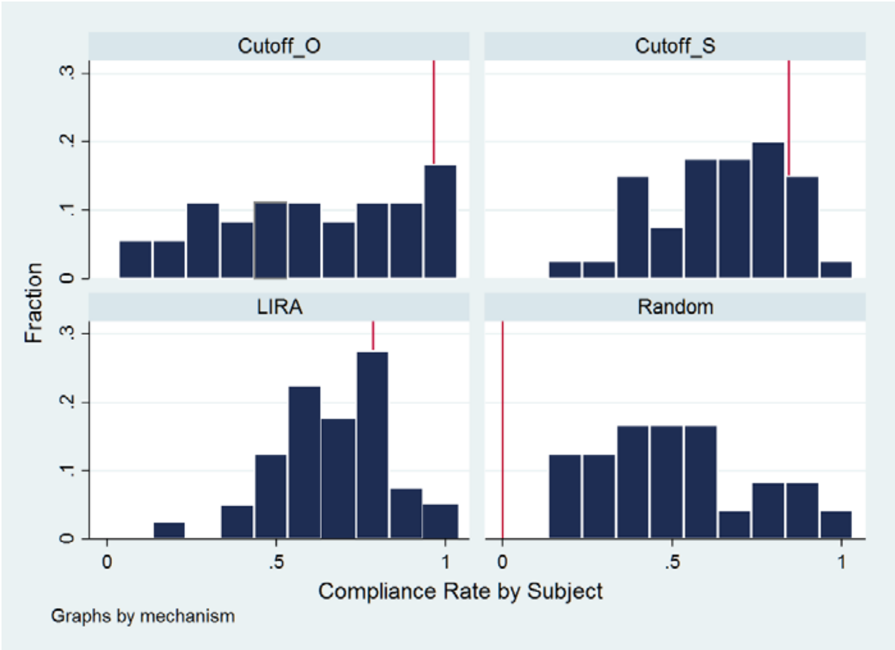

Figure 3 Mean compliance rate by treatment and subject

Supplementary material to “Who is audited? Experimental study of rule-based tax auditing schemes” by Yoshio Kamijo, Takehito Masuda, and Hiroshi Uemura

This document provides the experimental instructions, quiz, post-experimental questionnaires assessing risk preference and tax awareness.

1. Experimental Instructions (English Translation)

The instructions that were used for the experiment are described below based on the ones used for the LIRA condition. The differences between these instructions and those used for other conditions are indicated by inserted paragraphs as necessary. After the experimenter had explained the general cautions to all the subjects, the experimenter read the instructions below aloud to them.

[*Subjects in all treatments read*]

Test Overview Explanation

Everyone will repeatedly perform a decision-making task that I will describe (there will be 20 of these decision-making rounds). Three of the other participants will be your group members. You will have different group members for each decision-making round.

Your PC screen will show you an income amount that you have earned for the current round. This income is determined by a randomized computer algorithm. Only you are able to know your income. After you have seen your income, you will set the amount you want to report (your reported income). Twenty percent of your reported income will be collected as a tax.

For each decision-making round, either you or one of your group members will be designated as the audit recipient, in accordance with the rules I will describe. If you are designated as the audit recipient, you may not refuse to take part in the audit.

Decision-Making Rounds

First, the computer screen will show you your actual income. It will be an amount between 0 and 1,000 (yen) in 10-yen increments. The amount shown is determined by a randomized computer algorithm. Only you are able to know this amount.

After you have seen the amount shown, set the amount that you want to report.

It should be an integer (a multiple of 10 yen) between 0 and your actual income amount. Twenty percent of the amount you report will be collected as a tax. So if you are not audited, the amount you earn will be [Your actual income] – [Your reported income × 0.2]. For example, if your income is 500 yen and the income you report is 300 yen, the amount you earn will be 500 yen – [300 yen × 0.2 = 60 yen] = 440 yen.

[*Subjects in LIRA read*]

Explanation of Audit Process

The audit recipient will be selected by a computer algorithm in accordance with the following rules. Among the group of you and your group members, the participant who reported the lowest income amount will be the audit recipient. No other participant will ever be selected as the audit recipient (they have a zero probability of being the audit recipient). If your reported income is the lowest in your participant group (which consists of you and your group members), you will be the audit recipient. If you are designated as the audit recipient, a tax of 60% of your unreported income (= the difference between your actual income and reported income) will be collected. So if you are designated as the audit recipient, the amount you earn will be [Your actual income] – [Your reported income × 0.2] – [Your unreported income × 0.6]. If the lowest reported income was reported by more than one participant, the audit recipient will be selected by a randomized computer algorithm.

[*Subjects in Random read*]

Explanation of Audit Process

Audits will be done in accordance with the following rules. One audit recipient will be randomly selected by a computer algorithm, regardless of the actual or reported income amounts of you and your group members. If you are designated as the audit recipient, a tax of 60% of your unreported income (= the difference between your actual income and reported income) will be collected. So if you are designated as the audit recipient, the amount you earn will be [Your actual income] – [Your reported income × 0.2] – [Your unreported income × 0.6].

[*Subjects in Cut-off O read*]

Explanation of Audit Process

The audit recipient will be selected by a computer algorithm in accordance with the following rules. If your reported income is less than 750, the probability that you will be selected as the audit recipient is one third. If your reported income is 750 or more, you will never be selected as the audit recipient (you will have a zero probability of being selected as the audit recipient). If you are designated as the audit recipient, a tax of 60% of your unreported income (= the difference between your actual income and reported income) will be collected. So if you are designated as the audit recipient, the amount you earn will be [Your actual income] – [Your reported income × 0.2] – [Your unreported income × 0.6].

[*Subjects in Cut-off S read*]

Explanation of Audit Process

The audit recipient will be selected by a computer algorithm in accordance with the following rules. If your reported income is less than 500, the probability that you will be selected as the audit recipient is one-half. If your reported income is 500 or more, you will never be selected as the audit recipient (you will have a zero probability of being selected as the audit recipient). If you are designated as the audit recipient, a tax of 60% of your unreported income (= the difference between your actual income and reported income) will be collected. So if you are designated as the audit recipient, the amount you earn will be [Your actual income] – [Your reported income × 0.2] – [Your unreported income × 0.6].

[*Subjects in all treatments read*]

Each decision-making round will be carried out as described above. Twenty of decision-making rounds will be performed. You will have different group members for every decision-making round.

Summary of Amounts Earned in Each Round

Amount earned when not audited = Actual income – [Reported income × 0.2]

Amount earned when audited = Actual income – [Reported income × 0.2] – [Unreported income × 0.6]

Method of Calculating Monetary Reward

Your monetary reward will be determined based on the earned amounts.

Monetary reward (yen) = Total of three earned amounts selected by lottery + Remuneration for participation

After the instructions above were read, the screens were explained to the participants. The payment round was then administered following quiz.

2. Quiz (English Translation)

1. Please fill in and circle the correct answer.

A group consists of ____ subjects. The subjects you matched with (1) do not change (2) change every period (3) change every three periods.

2. Suppose that your true income is 800 and you report 600. Then, what is your tax, including penalty? Please circle the correct answer.

A. When you are not audited, your tax is (1) 200 (2) 240 (3) 120.

B. When you are audited, your tax is (1) 200 (2) 240 (3) 120.

3. Suppose that your true income is 820. Then, what is the maximum you can report? (1) 1000 (2) 820 (3) 600

4. How is the audit target chosen? Please circle the correct answer.

(1) The group member whose report is the lowest in the group.

(2) The group member whose report is the highest in the group.

[*subjects in Random read*]

(3) The group member chosen at random by a computer.

[*subjects in LIRA read*]

(3) The group member whose income is the highest in the group.

[*subjects in Cut off O read*]

(3) The group member whose report is less than or equal to 750 chosen with a probability of 1/3 by a computer. ** There was a typo. The word "or equal to" should have been deleted**

[*subjects in Cut off S read*]

(3) The group member whose report is less than 500 chosen with a probability of 1/2 by a computer.

(4) The group member chosen by a subject playing an auditor.

5. Suppose that your true income is 800 and you report 400. Then what is your earning?

When you are not audited	

When you are audited	

3. Post-experimental questionnaires (English Translation)

3.1. Questionnaires assessing tax awareness

Tax-payment awareness

Do you agree with the following statements? Please circle the most appropriate number on the scale.

A.1 Tax-payment is indispensable to the life of the people.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

A.2 Tax-payment is one of the most important national obligations.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

A.3 Paying tax based on one's true income is a matter of course.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

Acceptable Tax Rate

B.1 In your opinion, what is the appropriate percentage of income tax for 100,000 Japanese yen?

%

Aggressiveness for Tax Evasion

Do you agree with the following statements? Please circle the most appropriate number on the scale.

C.1 It is not difficult to hide one's true income.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

Needs for Tax Audit System

Do you agree with the following statements? Please circle the most appropriate number on the scale.

D.1 Tax audit is essential to prevent tax evasion.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

D.2 Many tax evasions are exposed through tax audits.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

Satisfaction with public services

Do you agree with the following statements? Please circle the most appropriate number on the scale.

E.1 A government does not waste national tax.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

E.2 Many social services should be transferred from the private sector to the public

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

sector.

E.3 Public services in Japan are enriching.

Tax Compliance

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

Can you accept the following circumstances? Please circle one of the most appropriate numbers of the scale.

F.1 An individual who hides his/her true income receives public assistance.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

F.2 An individual who evades tax receives sufficient public service.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

F.3 A firm that evades corporate income tax runs its business through the use of subsidies.

10______20______30______40______50______60______70______80______90______100

Absolutely unacceptable Absolutely acceptable

3.2. Questionnaires assessing risk preference

In the following, you choose the lottery and money for sure category you prefer. In each lottery category, you win or lose a certain amount of money based on a certain probability. In each question, the left column shows the lotteries that differ from the other in the winning probability.

Question 1

Lotteries		Money for sure	
-100 yen for sure			0 yen
10% of 300 yen, 90% of -100 yen			0 yen
20% of 300 yen, 80% of -100 yen			0 yen
30% of 300 yen, 70% of -100 yen			0 yen
40% of 300 yen, 60% of -100 yen			0 yen
50% of 300 yen, 50% of -100 yen			0 yen
60% of 300 yen, 40% of -100 yen			0 yen
70% of 300 yen, 30% of -100 yen			0 yen
80% of 300 yen, 20% of -100 yen			0 yen
90% of 300 yen, 10% of -100 yen			0 yen
300 yen for sure			0 yen

Question 2

Lotteries		Money for sure	
-300 yen for sure			0 yen
10% of 300 yen, 90% of -300 yen			0 yen
20% of 300 yen, 80% of -300 yen			0 yen
30% of 300 yen, 70% of -300 yen			0 yen
40% of 300 yen, 60% of -300 yen			0 yen
50% of 300 yen, 50% of -300 yen			0 yen
60% of 300 yen, 40% of -300 yen			0 yen
70% of 300 yen, 30% of -300 yen			0 yen
80% of 300 yen, 20% of -300 yen			0 yen
90% of 300 yen, 10% of -300 yen			0 yen
300 yen for sure			0 yen

Question 3

Lotteries		Money for sure	
3400 yen for sure			3700 yen
10% of 4000 yen, 90% of 3400 yen			3700 yen
20% of 4000 yen, 80% of 3400 yen			3700 yen
30% of 4000 yen, 70% of 3400 yen			3700 yen
40% of 4000 yen, 60% of 3400 yen			3700 yen
50% of 4000 yen, 50% of 3400 yen			3700 yen
60% of 4000 yen, 40% of 3400 yen			3700 yen
70% of 4000 yen, 30% of 3400 yen			3700 yen
80% of 4000 yen, 20% of 3400 yen			3700 yen
90% of 4000 yen, 10% of 3400 yen			3700 yen
4000 yen for sure			3700 yen

Question 4

Lotteries		Money for sure	
3600 yen for sure			3700 yen
10% of 4000 yen, 90% of 3600 yen			3700 yen
20% of 4000 yen, 80% of 3600 yen			3700 yen
30% of 4000 yen, 70% of 3600 yen			3700 yen
40% of 4000 yen, 60% of 3600 yen			3700 yen
50% of 4000 yen, 50% of 3600 yen			3700 yen
60% of 4000 yen, 40% of 3600 yen			3700 yen
70% of 4000 yen, 30% of 3600 yen			3700 yen
80% of 4000 yen, 20% of 3600 yen			3700 yen
90% of 4000 yen, 10% of 3600 yen			3700 yen
4000 yen for sure			3700 yen

<u>Please confirm that you have provided your ID.</u>

Thank you.