Tax compliance with strategic auditors: An experimental study

Abstract

The objective of this research is to experimentally verify a theoretical model of tax compliance, assuming a game-theory situation between a taxpayer and an auditor. Specifically, the verification is carried out using experimental data to answer the following three questions: (1) how do the changes of the tax rate affect taxpayers' behavior? (2) What results are brought about by different expectations about the behavior of the other player? (3) What influence does personality have on the tax compliance of taxpayers?

The main findings are shown below. First, with regards to changes to the tax rate and the behavior of each economic agent, contrary to the forecasts of the theoretical model, it was found that if the tax rate is lowered, the extent of the taxpayer's tax compliance increases. This suggests that the more the model forecast, the less the taxpayer is able to anticipate the behavior of the auditor, and thus the taxpayer behaves in a shortsighted manner. Second, regarding the relationship between the different expectations about the behavior of the other player and the taxpayer's tax compliance, it was found that the extent of the taxpayer's tax compliance is higher for the "strategic condition," in which it is reported to that the other party is an actual human being, compared to the "single condition," in which it is reported that the other party is a computer. This suggests that a situation in which the other player is considered an agent who possesses limited rationality and whose actions may deviate from balanced behavior results in tax-declaration behavior with higher compliance.

Keywords:

tax compliance; experiment; strategic condition; single condition

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1. Introduction

The objective of this research is to experimentally verify a theoretical model of tax compliance, assuming a game-theory situation between a taxpayer and an auditor. Specifically, the verification is carried out using experimental data to answer the following three questions: (1) how do the changes of the tax rate affect taxpayers' behavior? (2) What results are brought about by different expectations about the behavior of the other player? (3) What influence does personality have on the tax compliance of taxpayers?

To date, a large amount of research on tax compliance has been conducted. However, first, it cannot be said that the analytical studies as a whole have presented consistent findings; for example, different conclusions have been derived from the single person decision making model and the game theory model. As a result, the task of collecting the appropriate empirical evidence of the models' forecasts becomes vital. Second, many of the experimental studies have simply been an exploration of the facts based on ad hoc settings without any theory-based predictions. In other words, within this prior research, the analytical studies and the experimental studies have not been integrated particularly well, and it can be said that the points under discussion for tax compliance have not yet been sufficiently verified.

Therefore, in this research, we integrate the analytical studies and the experimental studies. Specifically, assuming an analytical model of tax compliance, we constructed within the laboratory a pseudo-society that faithfully expresses the assumptions of the model, and through observing within it the judgments and the decision making of the taxpayer and the auditor, we verified the balance of the theory. In other words, the objective of this research is to conduct a theory-verification and balance-verification experiment in order to present constant experimental evidence for the various points under discussion that as yet remain unresolved.

In this research, the following three questions are considered as the specific points under discussion requiring verification.

First is the question of the effects that changes to the tax rate will have on the

behaviors of each of the economic agents. Currently, various discussions are taking place in Japan about the corporation tax rate, but when a tax rate of a certain level is adopted, it is extremely important to understand what types of behavior each economic agent will engage in as a consequence. In particular, even though the prior research includes many experimental studies that deal with changes to the tax rate, the current situation is that, in actuality, there are still no established findings. Assuming an analytical model concerning this point, we verify the types of effects that changes to the tax rate have on the behavior of taxpayers and auditors.

Second is the question of what kind of effects differences in expectations regarding the behavior of the other player will have on the tax compliance of the taxpayer. Specifically, assuming the theory of the mind and the social brain hypothesis, which are currently hot issues in the field of experimental social sciences, for this question, the differences generated between a "single condition," in which it is reported to the player that the other party is a computer, and a "strategic condition," in which it is reported to the player that the other party is an actual human being, were verified.

Third is the question of the relationship between the personalities of taxpayers and the extent of their tax compliance. While this relationship has been found to exist from the results of studies targeting overseas subjects, no research has been conducted with the prerequisite that the test subjects be Japanese; therefore, in this research, this point was also verified.

The main findings are shown below. First, with regards to changes to the tax rate and the behavior of each economic agent, contrary to the forecasts of the theoretical model, it was found that if the tax rate is lowered, the extent of the taxpayer's tax compliance increases. This suggests that the more the model forecast, the less the taxpayer is able to anticipate the behavior of the auditor, and thus the taxpayer behaves in a shortsighted manner. Second, regarding the relationship between the different expectations about the behavior of the other player and the taxpayer's tax compliance, it was found that the extent of the taxpayer's tax compliance is higher for the "strategic condition," in which it is reported to that the other party is an actual human being, compared to the "single condition," in which it is reported that the other party is a computer. This suggests that a situation in which the other player is considered an agent who possesses limited rationality and whose actions may deviate from balanced behavior results in tax-declaration behavior with higher compliance.

The remainder of the paper is organized as follows. Section 2 discusses related literature. Sections 3 develops the model and section 4 explain our hypotheses and the experimental design. Section 5 presents the experimental results. Section 6 shows our conclusion.

2. A Review of Previous Research

2-1 Analytical model

Allingham and Sandmo (1972) and Yitzhaki (1974) are examples of pioneering research in this field. These studies employed a model of decision-making by an individual based on the probability of a tax audit and the existence of penalties. They confirmed that increases in these variables have positive effects on tax compliance (tax evasion is reduced).

Furthermore, Pencavel (1979), Cowell (1981) and Sandmo (1981) made income endogenous by adding labor supply to the model. They found that with this modification, variables related to tax enforcement—that is, the probability of a tax audit and penalties—no longer necessarily resulted in an increase in tax compliance. While these analyses distinguished among a few forms of tax evasion, they did not explicitly analyze whether these forms could be used to manage the risk of tax evasion by taxpayers. As an exception, Klepper and Nagin (1989) verified compliance by line item and found that substitute relationships existed among various items.

Additionally, Landskroner et al. (1990) analyzed tax evasion under uncertainty using a portfolio approach. In other words, with the understanding that whether to evade tax is part of an individual's portfolio decision making, the model considered not only the uncertainty of a tax audit but also asset risk. Furthermore, Cremer and Gahvari (1994) analyzed tax evasion from the point of view of the most suitable income tax and demonstrated that tax evasion may strengthen or weaken the degree of progressivity of the tax system.

The use of equilibrium-solution benchmarks for reference in this study is drawn from previous studies based on game theory. Graetz et al. (1986) found that modeling a game between a strategic taxpayer and a tax auditor led to different conclusions than when modeling the taxpayer as a sole decision maker. Reinganum and Wilde (1986) modeled

taxpayer type (by actual income) in a continuous distribution and found that, in equilibrium, high-income taxpayers evaded taxes less. Finally, Erard and Feinstein (1994) used a model of continuously distributed income to show that honest taxpayers played an important role.

2-2. experimental research

Next, in this subsection, we survey experimental researches that have been carried out on tax compliance, of which there are many. By referring to Fonseca and Myles (2012), a survey that collated previous research experiments on tax compliance, we see three major characteristics, which provide an overall picture of this body of work.

First, rather than being based on economics, many of the experiments were based on psychology. In particular, a major characteristic is the large number of "fact finding" experiments. In other words, currently, experiments are conducted based not on some sort of theoretical expectation, but rather on ad hoc settings. However, even though these fact finding experiments are being carried out in these sorts of ad hoc settings, there are major doubts about whether they will result in the discovery of systematic facts. Therefore, it seems that what is required is to conduct experiments that verify theories and hypotheses to construct a balanced model.

The second characteristic is that a large number of experiments focus on the personalities of individuals. Specifically, there is an extremely large number of research experiments that collect data on personality via questionnaire, such as the individual's age and gender, and then aim to verify if there is some sort of correlation between the degree of tax compliance and the data on personality. The reason for this focus is that previous research primarily asked "which kinds of people evade taxes and which do not?" and assumed elements such as actual tax evasion behavior. In particular, this body of research has clarified that the older the individual and the higher their years of work experience, the more honestly they report their taxes. As this research targeted overseas subjects, there is a need to verify whether the same results would apply to Japanese subjects. However, the relationship between personality and tax compliance is nothing more than an analysis based on individuals and, ultimately, ought merely to be a supplementary issue. This is because, in the final analysis, the important point is not which type of person evades tax, but what kind of system and regulations increase tax compliance. Therefore, even if we consider personality, what is ultimately required is an

analysis of its relationship to the system.

The third characteristic is that there are no established views on the relationship between changes to the tax rate and tax compliance. Changes to the tax rate are an important issue for policymakers and such changes are expected to significantly change the behavior of economic actors as well. However, in the research experiments, no particular agreement has been reached on the relationship between changes to the tax rate and changes to the behavior of economic actors. One reason for this is that, as noted above in the first point, it is thought that research experiments tend to be carried out in ad hoc form. Whatever the reason, the effects that the important policy variable of tax rate has on the behavior of economic actors require an analysis that provides some sort of robust experimental evidence.

3. The model

3-1 The model

This section describes the model in Reinganum and Wilde (1986) that is used as a benchmark in this research. This game comprises a risk-neutral taxpayer and a similarly risk-neutral tax examiner.

The taxpayer's actual income is his or her private information that cannot be observed by the examiner. Based on actual income, the taxpayer reports income to the examiner. As the examiner does not know the actual income, he or she estimates it from the reported income and decides on a level of effort to employ for the tax examination. The examiner's level of effort determines the probability of discovering the actual income through the tax examination; the higher the level of effort, the greater is the probability that the actual income will be discovered.

The taxpayer's actual income I is a random variable and, in the range of $I \in [\underline{I}, \overline{I}] (\underline{I} < \overline{I} < \infty)$. It is distributed by the distribution function $F(\cdot)$. In the game, after observing his or her actual income, the taxpayer, selects to report an income of $x = r(I)$. If the taxpayer is not audited, he or she will pay a tax of tx based on a proportionate tax rate of t. If the taxpayer is audited and the actual income is discovered, the tax is levied on the actual income and, in addition, the taxpayer is subject to a fixed penalty according to the difference between their actual income and reported income. Therefore, the amount paid by the taxpayer in this instance becomes $tI + t\pi(I\text{-}x)$. According to Yitzhaki (1974), assumptions about these penalties are considered to conform to the tax laws of both the

United States and Japan.

After observing the taxpayer's reported income x, the auditor chooses the level of effort. Costs are incurred for this effort, and in reality, even if the taxpayer's under-reporting is discovered, it is assumed that these costs will still be incurred. In other words, for example, even for reported income $\underline{I}$ that is clearly a case of under-reporting, in the event that the tax auditing costs are high, it is possible that the effort for the auditing will not be made. When the probability of discovery through the auditing (subsequently, the auditing cost) is set as ρ, it is assumed that the auditor multiplies the auditing probability by the cost and then selects what to do. The auditor's strategy is as follows.

$$\rho = p(x), p: (-\infty, \infty) \to [0.1]$$

In this formulation, the auditing probability is unrelated to the size of the under-reporting. In addition, it assumes that the auditing probability is not a consequence of whether the examination succeeds or fails (it does not say whether some partial information will be clarified). For simplification purposes, the auditing cost is assumed to be $c\rho$. The auditing cost is considered to be an increasing function of the examination probability[1].

The auditor's utility function U_A is expressed as follows.

$$U_A = \rho\big(tE[I|x] + \pi t(E[I|x] - x)\big) + (1-\rho)tx - c\rho \qquad (1)$$

$E[I|x]$ is the examiner's expected value for the actual income, based on his or her observation of the reported income. Conversely, the taxpayer's expected utility function U_P is expressed as follows.

$$U_P = p(x)(I - tI - \pi t(I - x)) + \big(1 - p(x)\big)(I - tx) \qquad (2)$$

Therefore, if $r(I)$ traces a monotonic increase, the equilibrium that meets the following requirements becomes the separating equilibrium.

(1) With the forecast of actual income $E[I|x]$ assumed as a given, the examiner selects the examination probability (verification policy) $p\,(x)$ that maximizes U_A.

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1 As was touched on in Reinganum and Wilde (1986), the cost function, when twice continuously differentiable, must meet the following requirement. For a linear cost function, one part of the abovementioned process is not satisfied, but there exists a unique equilibrium solution.

(2) With the examination probability $p(x)$ as a given, the reporting $x=r$ (I) that maximizes U_P is selected.
(3) The actual income $E[I|x]$ assumed is consistent with the actual income I.

To calculate the equilibrium, it is solved backwards. When solving the auditor's optimization problem, the first order condition is as follows.

$$\frac{\partial U_A}{\partial \rho} = t(1+\pi)(E[I|x]-x) - c \qquad (3)$$

If this expression is positive, the examiner selects $\rho = 1$, and if it is negative, he or she selects $\rho = 0$. In addition, when the expression is exactly equal to 0, the examiner selects an arbitrary ρ.

Next, we consider the problem for the taxpayer. With the examination probability as a given, the taxpayer solves a utility maximization problem, but solving this problem incorporates the effects that his or her own reported income has on the examination probability. In other words, the following first order condition is to be obtained.

$$\frac{\partial U_P}{\partial x} = p'(x)[-t(1+\pi)(I-x)] + p(x)t\pi - t(1-p(x)) \qquad (4)$$

Below, we focus on the inner solution. In other words, based on the condition that (3) and (4) equal 0, the first order condition of p and x is solved and the following equilibrium condition is obtained.

1: The equilibrium examination probability is as follows.

$$p(x) = \begin{cases} 0 & x \geq \bar{x} \\ \frac{1}{1+\pi}\left(1-\exp\left\{\frac{-t(1+\pi)}{c}(\bar{x}-x)\right\}\right) & x \in [\underline{x}, \bar{x}] \\ 1 & x < \underline{x} \end{cases} \qquad (5)$$

2: The equilibrium reported income is as follows.

$$x = I - \frac{c}{t(1+\pi)}, for\ I \in [\underline{I}, \bar{I}]$$

3: The equilibrium assumed income by the examiner is as follows.

$$E[I|x] = \begin{cases} \bar{I} & x \geq \bar{x} \\ x = I - c/t(1+\pi) & x \in [\underline{x}, \bar{x}] \\ \underline{I} & x < \underline{x} \end{cases} \qquad (6)$$

The interpretation of this equilibrium can be described as follows. First, from actual income in equilibrium condition 2, we understand that the taxpayer's reported income I is smaller than I in the equilibrium. This is because the taxpayer's reporting incorporates the fact that costs are incurred for the tax auditing. This reported income increases with regard to actual income, decreases with regard to the (limit of the) tax auditing cost c, and increases with regard to the tax rate and penalties.

Next, we examine the probability (verification probability) that the equilibrium examination probability from equilibrium condition 1 is 0 when the reported income exceeds its upper limit, 1 when the reported income falls below its lower limit, and between 0 and 1 when the reported income falls in between.

3-2. Example using numerical values

The numerical values of the parameters used in this research are assumed to be $\bar{I} = 130, \underline{I} = 90, c = 8, \pi = 1.5$ and $t = 0.4, 0.3$.

In this instance, the upper and lower limits for the reported income in the model when the tax rate is 40% becomes $\bar{x} = 80, \underline{x} = 40$. In addition, when the tax rate is 30%, the limits become $\bar{x} = 63.3, \underline{x} = 23.3$.

The equilibrium solutions based on these parameter settings are shown together in the table 1 and 2.

Insert Table 1 and 2 about here.

First, if we look at taxpayers' reported income based on the same tax rate, we see that the higher the actual income, the higher is the reported income. This is because taxpayers with high actual incomes obtain a large benefit from the decrease in the tax auditing probability that results from the increase in reported income. On the other hand, we can see that the equilibrium auditing probability declines, because the higher the actual income, the higher is the reported income.

Next, we consider the effects of changes to the tax rate. By reducing the tax rate from 40% to 30%, the benefit that the auditor obtains from the tax auditing declines, and therefore, the equilibrium auditing probability also declines. Once this tax rate change has been incorporated, the taxpayer decides to report a lower level of income. As a result, we understand that the gains expected by the taxpayer increase when the tax rate

is low.

4. Hypothesis

4-1. The needs for experimental verification

There are two broad requirements to be met by economic experiments.

First, through the experiment, it is possible to directly verify the model. In other words, in order to verify an economic model, it is necessary to collect and analyze data on people's judgments and decision making based on an information set in accordance with the model and in an environment in line with the model. However, it is considered extremely difficult to do so via an empirical analysis using archival data. In contrast, through an experiment, the experimenters can to a certain degree freely create an environment that corresponds to the timeline of the model and the information set. In addition, they can directly observe people's behavior within it and collect behavioral and psychological data. For example, reported income appears in the model. Using archival data, it is difficult to accurately ascertain in which situations and to what degree "real income" deviates from reported income, but this becomes possible in the environment created by an experiment. Thus, the important point is that, through the experiment, it becomes possible to directly verify the model.

The second requirement is that the experiment possesses the quality of prior verification. For example, in an archival analysis, only data based on the system in actual existence can be collected. In contrast, in an experiment, a pseudo-environment that does not exist in the actual system can be created and the behavior of economic actors within it can be ascertained. Therefore, before implementing the actual system, it is possible to verify the economic consequences that would result from such a system by assessing whether they are in accordance with the model's predictions, and to ascertain in advance the unintended consequences that the model cannot predict. Through this, it is possible to make various proposals for the design of the system prior to actually creating the system. For the model used in this type of research, comparative statistics are conducted for the relationship between changes to the tax rate and economic actors, and a major strength of an experiment is that it is easily possible to make tax rates the subject of analysis, even those that have not actually been adopted.

4-2. Three hypotheses

The first hypothesis concerns the relationship between changes to tax rates and taxpayer behavior. As debates surrounding corporate tax rates are currently taking place in Japan, it is anticipated that changes to tax rates will affect the behavior of economic actors.

In this study, the following two indicators of tax compliance amongst taxpayers are proposed: (1) the average rate of tax compliance and (2) the degree of safe divergence.

The average rate of compliance is the ratio between each individual's actual income and his or her declared income. The higher this figure becomes (i.e., it approaches a value of 1), the more the taxpayer's behavior can be regarded as being highly compliant.

The degree of safe divergence is the difference between the area assumed to be safe by the taxpayer and their reported income, and it can be assumed that the lower this figure, the higher the rate of compliance.[2]

Adopting these two indicators, we are able to establish the following hypotheses conforming to the equilibrium of the model.

Hypothesis 1 Changes in tax rates and economic consequences

Hypothesis 1-1. Taxpayer's average rate of compliance

When the tax rate is lowered, the average rate of compliance declines.

Hypothesis 1-2. Taxpayer's degree of safe divergence

When the tax rate is lowered, the taxpayer's degree of safe divergence declines.

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[2] In addition to declared income, the reason for using the degree of safe divergence as an indicator of compliance is as follows. While equilibrium declared income within the current research takes into consideration the behaviour of tax investigators, it is possible that individual assumptions about investigator behaviour may vary. In other words, we might interpret an individual who assumes there is a relatively high probability of investigation as actively trying to lower their tax burden, even if they declare a relatively high income. Conversely, an individual who assumes there is a relatively low probability of investigation may be seen as more passive in curtailing their tax burden, even if they declare a relatively low income. Therefore, taking as given each individual's assumptions about the probability of investigation, the indicator of how much declared income is relatively lowered by is defined by the degree of safe divergence.

Second, the point to be verified here is whether there are differences in taxpayers' tax-reporting behavior depending on whether the other party is an actual person or not. Behind this question lies the theory of mind (ToM), which has its origins in the research of Premack and Woodruff (1978). It is a theoretical schema that considers the functions of the mind that are perceived for others by people and other animals. In recent years, it has combined with the problem awareness of understanding society from the perspective of others, as well as the social brain hypothesis, which posits that the human brain significantly evolved from the need to understand the minds of others. ToM has been the subject of considerable attention in the fields of psychology and neuro-economics.

Rilling et al. (2002) is a leading example of research in which ToM and the social brain hypothesis are understood by integrating game theory and neuroscience. Through repeatedly conducting the prisoner's dilemma game theory experiment, Rilling et al. (2002) shows there are major differences in the brain's nerve activity depending on whether the opponent is a human being or a computer. Specifically, he establishes that when one player chooses "cooperation," followed by the other player also choosing "cooperation," the corpus striatum, the anterior cingulate cortex, and the orbitofrontal cortex are activated. Furthermore, the activation of the corpus striatum and the orbitofrontal cortex, which are responsible for producing feelings of pleasure, results in further reciprocal cooperative behavior. Moreover, Rilling et al. (2002) uses functional magnetic resonance imaging (f-MRI) to measure whether brain activity is different when the opponent is a human being and when it is a computer, and the results of these measurements show that although the parts of the brain that became active are the same in both instances, the degree of brain activation is greater when the opponent is a human being. In other words, the person feels greater pleasure from reciprocal cooperative behavior when the other person is an actual human being; moreover, these feelings of pleasure result in their further cooperative behavior. If we consider these points, we can understand them as signifying that for feelings or decision making recalled in relationships with others, there will be major differences in what is recalled for each individual.

Fujiwara et al. (2008) also uses f-MRI to measure the brain activity of test subjects when they take part in a selection problem in which they receive financial rewards or

penalties resulting from their decision making, and finds that the subjects experience absolute profit or loss and relative profit or loss in different parts of the brain. Specifically, their limbic systems are activated for absolute profit and loss; in contrast, their prefrontal areas are activated for relative profit and loss. When we consider this, we can see that for economic decision making also, the outcomes will be different when the subject is a lone individual, compared to when he or she assumes there to be other people, and it is important to comparatively study both.

If we think about the findings described in relation to this research, and we assume the same type of game theory situation, then it is possible, for example, that the behavior of taxpayers will change depending on whether the other party is a computer or a human being.

If we consider this from the perspective of tax policy, then we can see it relates to the ways in which the behavior of taxpayers might change depending on whether the rules are applied and managed mechanically and uniformly, or with some degree of flexibility and uncertainty. In other words, when we expand the abovementioned discussion, it can be connected to a discussion of whether, in actuality, in order to increase tax compliance, it is better to manage the rules mechanically and uniformly (when the taxpayer behaves on the assumption that the other party has a "device" that reflects behavior in a mechanical and uniform manner on balance) or alternatively, whether it is better to manage the rules to some degree flexibly and with an element of uncertainty (when the taxpayer behaves on the assumption that the other party will act flexibly and with an element of uncertainty and will not reflect behavior in a uniform manner on balance). It can be argued that this question is an important one in terms of policymaking, and one that requires some analysis.

Hypothesis 2: There is no statistically significant difference in the taxpayer's tax reporting behavior in a "single condition," in which the player is notified that "the other player is a computer," and in a "strategic condition," in which the player is notified that "the other player is a human being" (null hypothesis).

Third, there is the matter of whether the personality of the taxpayer results in differences in their reporting of taxable income, and additionally, what the precise personality factors are that might bring about differences in the degree of tax

compliance. With regard to these questions, previous research conducted with overseas subjects has demonstrated that factors such as age, years of working experience, and gender are significantly correlated to the degree of tax compliance. It is necessary to verify whether these factors also correlate to the degree of tax compliance amongst Japanese subjects. This leads to the following hypotheses.

Hypothesis 3 : There is a statistically significant correlation between taxpayer personality and taxpayer behavior.
Hypothesis 3-1. The higher the age of the taxpayer, the higher is the indicator of tax compliance.
Hypothesis 3-2. Female taxpayers have higher indicators of compliance than male taxpayers.
Hypothesis 3-3. Individuals with higher confidence in the other players have higher indicators of compliance.
Hypothesis 3-4. Individuals with lower levels of strategic reciprocal relationships have higher indicators of compliance.

Hypotheses 3-1 and 3-2 are conclusions partially derived from and verified in prior research, which shows that higher rates of tax compliance are associated with higher ages of taxpayers and being female. Hypothesis 3-3 posits that more trusting individuals demonstrate higher compliance. This is based on the assumption that more trusting individuals are likely to envisage larger benefits from paying taxes. Furthermore, with regard to Hypothesis 3-4, strategic reciprocal relationships are not seen to be purely altruistic, but rather as indicators of a type of "cunning." They are, thus, assumed to work toward lowering compliance, although it is possible that such relationships will be purely altruistic, depending on the individual. In order to test these assumptions, in this research, a regression analysis is carried out using the tax compliance indicators, with various tax rates as the explained variables.
The average rate of compliance and the degree of safe convergence are used as the indicators of tax compliance. The regression model to be tested is as follows:

$$Y_i = \alpha + \beta_1 AGE_i + \beta_2 GEN_i + \beta_3 TRUST_i + \beta_4 MB_i + \beta_5 SIN\_D + \varepsilon_i \qquad (7)$$

Y_i is the average rate of compliance ($Comp_i$) or the degree of safe divergence ($SAFE_i$). In addition, these explained variables are tested for correspondence with tax rates of 30% and 40%, respectively.

Individual contextual data are used for the explanatory variables. Specifically, *AGE* indicates taxpayer age; *GEN* is a dummy variable in which 1 = female and 0 = male; *TRUST* expresses levels of trust derived from the results of a questionnaire in a trust game; while *MB* indicates levels of strategic altruism derived from the results of an ultimatum game questionnaire. Furthermore, the model recognizes differences between single and strategic compliance indicators, and introduces a dummy variable to control for this, where 1 = single condition and 0 = strategic condition.

For signs to be consistent with the hypotheses, positive and negative signs are reversed for the explained variables. When the explained variable is the average rate of compliance (or the degree of safe divergence) then, for the signs to be consistent with the hypotheses, β_1 is positive (or negative), β_2 is positive (negative), β_3 is positive (negative), β_4 is negative (positive), and β_5 is negative (positive).

4-3. Experimental design

In our experiment, the key concepts are *type of auditors* and *tax rate*. With regard to type of auditors, the following two sets of conditions are created:

"Single condition": Subjects play only the role of the taxpayer, and the role of the auditor is played by the computer.

"Strategic condition": Subjects are divided into those who play the role of the taxpayer and those who play the role of the auditor.

The experiment uses tax rates of 40% and 30%. These tax rates are commonly used in previous studies and were set with current Japanese tax rates in mind.

An overview of the experiment is illustrated in the table 3.

Insert table 3 about here.

The experiment sessions were conducted in 2014 at Keio Business School. The subjects

of the experiment were all graduate students undergoing an MBA program. There were 42 experimental subjects across all sessions in total and each subject participated in only one session (Between-subject design). The allocation of subjects to sessions was completely random. In each session, decision-making data were collected using a within-subject design for both the 40% and 30% tax rates based on the two abovementioned sets of conditions.

We collected behavioral data from the subjects using the strategy method. This method involves: 1) having subjects make decisions on all possible situations they could encounter in their roles (each subject submits a strategy profile for dealing with each situation) and 2) randomly matching subjects, randomly selecting certain situations, and determining the outcome of the game in one shot based on all strategy profiles submitted by the subjects (Casari and Cason 2009). By having subjects submit strategy profiles for dealing with all situations based on their individual roles (as in step 1), this method allows large volumes of data to be collected. Unlike experiments that require subjects to make decisions in sequential play, this method elicits more careful decisions. In addition, providing compensation based on the outcome from step 2 gives the subjects financial incentives, which also increases internal validity. In this way, the strategy method is advantageous as it maintains a certain level of internal validity while securing a large volume of data and eliciting more careful decisions.

The details of the actual experiment conducted are as follows. First, the subjects gathered in a classroom with an internet connection and computer facilities, were randomly divided into two groups (“taxpayer” and “auditor”), and were randomly assigned identity (ID) numbers. No subject was allowed to know the ID number or role of any other subject. The subjects were also forbidden from communicating with each other. Then, the experimenter gave the instructions to the subjects and conducted a simple test to assess their level of understanding. The content of the instructions was kept to a minimum to avoid interfering with subjects’ comprehension. Subsequently, each subject used a PC to access the website designated to their assigned role and responded to each situation in the strategy profile on the website within the time limit. During the task, each subject was able to download an online spreadsheet to assist in decision making. This spreadsheet provided a simple simulation for ascertaining the benefits, to the subject and the other participant, of making a particular decision at a specific tax rate. After submitting the strategy profiles, the subjects responded to a

post-experiment questionnaire. The post-experiment questionnaire asked subjects their age, years of work experience, and gender as well as their level of risk aversion, altruism, and reciprocity. While the subjects answered these questions, experimenters carried out the matching of subjects and conditions to determine each subject's compensation. All compensation was paid in cash on the day of the experiment. In order to increase the incentives for the subjects, a participation payment of 1,000 yen was supplemented with an amount that varied based on the number of points won in the game. The variable amount was calculated as 15 yen per point for those who played as taxpayers and 25 yen per point for those who played as auditors. This was based on the expected payoff at the equilibrium of the model in order to ensure that there would be no significant difference in compensation paid for each session.

One experiment session lasted for approximately 45 minutes on average, including instructions.

The following outlines details of the data collected from the subjects.

With regard to taxpayers, this study collected data on: a) declared income based on actual income, b) the threshold of declared income when the audit rate is 0%, and c) the threshold of declared income when the audit rate is 100%. There are two reasons for investigating b) and c) along with a). The first reason is to elicit judgments and decisions that are closer to the equilibrium of the model. In other words, the equilibrium of the model begins with identifying the *risk area* and *safe area*, and can then be defined by these areas where the probability of being audited ranges from 0–100%. Therefore, it is important for taxpayers to first become aware of the risk area and safe area, predict the likelihood of being audited in between these two areas, and determine the level of income they would declare. The second reason is to elicit more careful judgments and decisions from the subjects, with a greater awareness of other participants' decision making as a secondary factor.

On the other hand, regarding auditors, this study collected data on: d) the probability of being audited at a given declared income and e) the actual income estimated by auditors in each relevant situation. The reason for collecting data on e) along with d) is, as with taxpayers, to elicit more careful judgments and decisions based on awareness of the equilibrium of the model and increased awareness of the personal information (actual income) of the taxpayers.

The subjects' basic data for each session are summarized in the table 4.

Insert table 4 about here.

As the table 4 shows, because the experiment subjects were all graduate MBA students, their average age and years of work experience were high. The average compensation given was 2,253 yen under the single condition, 2,069 yen under the strategic condition, 2,317 yen for taxpayers, 1,857 yen for auditors, and 2,137 yen for the overall experiment.

5. Experimental results and interpretations

5-1. Hypothesis 1: The economic consequences of changes in tax rates

The differences in reporting income in the 40% and 30% tax rates are compiled in the table 5 and 6.

Insert table 5 and 6 about here.

Table 5 shows the mean value of reporting income for the entire sample, with actual income from 130 to 90 for each tax rate. The table 6 also shows the data delineated by the single condition and the strategic condition. These tables indicate that the average income reported by the taxpayers tends to increase slightly in general when the tax rate drops from 40% to 30%, even though no statistically significant difference is found. This is an outcome antithetical to our theoretical prediction. Theoretically, the probability of being investigated by an auditor diminishes as tax rates fall, and taxpayers who foresee this lower their declared income. In other words, in theory the degree of tax compliance is expected to decline when tax rates fall. However, in reality, we see the degree of tax compliance increasing further when tax rates drop.

Next, this study attempts to confirm the change in the average compliance ratio (the amount of declared income per unit of actual income) based on changes in tax rates. The differences between average compliance ratios for the 40% tax rate and those for the 30% tax rate are shown in the table 7, 8 and 9.

Insert table 7, 8 and 9 about here.

In addition, an overall trend can be observed from these tables in which the average compliance ratio increases slightly when the tax rate drops, even though there is no statistically significant difference.

In other words, with regard to Hypothesis 1-1 (the relationship between tax rates and average compliance ratios), although no statistically significant difference is found, as an overall trend, the results contradict the hypothesis. In other words, when tax rates fall, the test subjects display the behavior of declaring their taxes as if they intended to increase their degree of tax compliance.

Furthermore, the degree of safe divergence is compiled in the table 10. [3]

Insert table 10 about here.

When the tax rate drops from 40% to 30%, the degree of safe divergence as a whole drops, and a statistically significant drop (the Wilcoxon matched-pairs signed-rank test. $p < 0.05$) is found for the entire sample and the strategic condition. Therefore, it is clear that the degree of taxpayer compliance becomes greater when the tax rate falls. This trend is an outcome antithetical to the predictions of our theory.

In other words, Hypothesis 1-2 (the relationship between tax rates and the degree of safe divergence) is also in opposition to our results, which show that when tax rates fall, the test subjects display the behavior of reporting their taxes as if they intended to increase their degree of tax compliance.

As described above, the data collected from the experiment lead to results that contradict our hypothesis, a reason for which may be the myopic behavior of taxpayers. Our hypothesis is that, in theory, taxpayers' degree of tax compliance drops when the tax rate falls because they foresee that the probability of being investigated by an auditor declines due to the decreased tax rate and then reduce their declared income accordingly (the degree of tax compliance decreases).

[3] The sign of '*' in the table is the statistical significance at 5 % level by the Wilcoxon matched-pairs signed-rank test.

However, instead of modifying their behavior by predicting auditors' behavior, taxpayers make their decisions myopically, based solely on the changed tax rate and their own interest. In other words, if the tax rate falls, the rate of tax obligations for taxpayers drops. For example, even if their declared income is the same at 100, the amount of tax paid simply decreases if the tax rate falls. Thus, it could be said that there is no need for taxpayers to reduce their declared income by taking the risk of being audited. As a result, it could be considered that taxpayers' degree of tax compliance increases even further.

When applying these results to policymaking, it may be possible to encourage more honest taxpayer behavior by lowering the tax rate, which contrasts with our theoretical predictions. Certainly, a more thorough analysis is required to understand the extent to which tax revenue rises as a result of taxpayer behavior due to reduced tax rate.

5-2. Hypothesis 2: Single vs. Strategic condition

The average reported income with different assumed tax rates is summarized in the table 11 and 12.[4]

Insert table 11 and 12 about here.

Table 11 shows that, based on a tax rate of 40%, declared reported income in the strategic condition is on the whole higher than reported income in the single condition. Moreover, apart from when actual income is 90%, there is a statistically significant difference in every instance (ANOVA. $p < 0.01$ and $p < 0.05$). Table 12 shows that, based on a tax rate of 30%, reported income in the strategic condition is on the whole higher than reported income in the single condition. Moreover, apart from when actual income is 90%, there is a statistically significant difference in every instance (ANOVA. $p < 0.01$).

From the abovementioned results, the hypothesis is statistically rejected. This suggests that when the other player is an actor of bounded rationality who may possibly diverge from balanced behavior, the taxpayer's tax reporting behavior will be more compliant.

[4] The sign of '*' in the table is the statistical significance at 5 % level and that of '**' in the table is the statistical significance at 1% level by the ANOVA.

This is extremely interesting from a policy making. In short, if we consider this in relation to the problem of how to manage the rules, then the two options correspond respectively to "the single condition," in which the rules are applied and managed mechanically and uniformly, and "the strategic condition," in which the rules are managed, to some extent, flexibly and with an element of uncertainty. The findings obtained from the experiment suggest that, in the case of somewhat flexible and uncertain rules (or at the very least, when tax payers perceive the situation to correspond to somewhat flexible and uncertain rules), taxpayers' tax reporting behavior will be more compliant. To state this in its opposite, the findings suggest that it is preferable not to manage the rules in a mechanical and uniform way from the perspective of inducing a higher level of tax compliance from taxpayers.

6-3. Testing Hypothesis 3: Personality and Tax Compliance

The table 13, 14 and 15 show the analysis results of Hypothesis 3.

Insert table 13, 14 and 15 about here.

From left to right of the table 15, the following dependent variables are used: (1) compliance rate when the tax rate is 40%, (2) compliance rate when the tax rate is 30%, (3) deviation from the safety zone when the tax rate is 40%, and (4) deviation from the safety zone when the tax rate is 30%.

(1) shows that, although the parameter estimate of *GEN* (dummy variable where 1 = female) is positive, the result is not significant. *AGE* is negative and significant at the 5% level, indicating that the result is contrary to the hypothesis that the compliance rate becomes lower among older taxpayers. By way of explanation, it is possible that older individuals earn higher salaries thanks to the seniority-based wage system common among Japanese companies and are more conscious of the tax burden.

In addition, the coefficients for *TRUST* (variable for trustworthiness) and *MB* (variable for the level of strategic reciprocity) are significant—positive and significant at the 1% level and negative and significant at the 5% level, respectively—and support the hypothesis. This indicates that under the tax rate of 40%, the compliance rate increases among individuals who are younger, more trustworthy, and have a lower level of strategic reciprocity.

As mentioned in the definitions of the hypotheses, strategic reciprocity has characteristics of altruism and strategy. We interpret this estimation result to suggest strong characteristics of individuals who act strategically to maximize ultimate personal gain rather than acting under altruism.

In addition, estimation (2), which uses the compliance rate under the tax rate of 30% as the dependent variable, shows almost the same results for all variables except *AGE*, although there are slight differences in significance levels. It is interesting that when the tax rate is lowered, *AGE* is no longer significant. Applying the previously described explanation, it is possible that older individuals who are sensitive to the tax burden under the higher tax rate considerably increase their compliance rate in response to the lower tax rate.

Next, we focus on (3) and (4), which are the analysis results when deviation from the safety zone is the dependent variable.

In these models, a smaller value for the dependent variable is interpreted as a higher compliance indicator. According to the estimation results, while not many variables turn out to be significant, *GEN* is negative and significant at the 5% level under both tax rates. Therefore, a result consistent with the previous studies stating that the compliance indicator is higher among women is obtained. *GEN*, which is not significant when the compliance rate is the dependent variable, becomes significant for the deviation from the safety zone. In other words, although no gender difference is observed when only the compliance rate is evaluated, it is inferred that women are more accurate in estimating the probability of tax audits, and their compliance is higher when the probability of tax audits is taken into consideration.

As for the other variable, *MB* is positive and significant at the 5% level under the tax rate of 40%. This result is consistent with the compliance rate and implies that individuals with higher strategic reciprocity are more likely to deviate from the safety zone (i.e., the compliance indicator is lower). However, since there is no significant difference when the tax rate falls to 30%, the difference in compliance due to individual attributes is unlikely to occur under relatively low tax rates.

6. Conclusions

The objective of this research is to experimentally verify a theoretical model of tax

compliance, assuming a game-theory situation between a taxpayer and an auditor. Specifically, the verification is carried out using experimental data to answer the following three questions: (1) how do the changes of the tax rate affect taxpayers' behavior? (2) What results are brought about by different expectations about the behavior of the other player? (3) What influence does personality have on the tax compliance of taxpayers?

The main findings are shown below. First, with regards to changes to the tax rate and the behavior of each economic agent, contrary to the forecasts of the theoretical model, it was found that if the tax rate is lowered, the extent of the taxpayer's tax compliance increases. This suggests that the more the model forecast, the less the taxpayer is able to anticipate the behavior of the auditor, and thus the taxpayer behaves in a shortsighted manner. Second, regarding the relationship between the different expectations about the behavior of the other player and the taxpayer's tax compliance, it was found that the extent of the taxpayer's tax compliance is higher for the "strategic condition," in which it is reported to that the other party is an actual human being, compared to the "single condition," in which it is reported that the other party is a computer. This suggests that a situation in which the other player is considered an agent who possesses limited rationality and whose actions may deviate from balanced behavior results in tax-declaration behavior with higher compliance.

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Table 1. Numerical example of equilibrium at t =0.4

True income	Reporting income	probability of Auditing	Expected payoff for taxpayers	Expected payoff for auditors
130	80	0	98	32
120	70	0.29	77.7	40
110	60	0.37	67.6	39.4
100	50	0.39	60.5	30.4
90	40	0.4	51.1	32.7

Table 2. Numerical example of equilibrium at t =0.3

True income	Reporting income	probability of Auditing	Expected payoff for taxpayers	Expected payoff for auditors
130	63.3	0	111	19
120	53.3	0.24	91.8	26.2
110	43.3	0.34	80.1	27.2
100	33.3	0.38	71.2	25.8
90	23.3	0.39	63.5	23.4

Table 3. Summary of our experiments

No	Date	Place	Condition	N	Tax rate
1	February 2014	Keio business school	Single	15	0.3, 0.4
2	February 2014	Keio business school	strategic	27	0.3, 0.4

Table 4. Summary of subjects of the experiments

No	Condition	N	Male	Female	Average age	Average years of business	Average rewards
1	Single	15	11	4	31.9	6.8	2,253
2	strategic	27	22	5	31.2	7.0	2,069
		42	33	9	31.5	6.9	2,137

Table 5. The changes of tax rate and the average reporting income (all sample)

True income	N	Reporting at t = 0.4	Reporting at t = 0.3	difference	*p* value
130	28	96.07	97.86	-1.79	0.26
120	28	91.79	94.29	-2.50	0.08
110	28	88.21	89.29	-1.07	0.47
100	28	83.21	85.36	-2.14	0.15
90	28	78.93	78.21	0.71	0.71
Total		87.64	89.60	-1.35	0.33

Table 6. The changes of tax rate and the average reporting income (by condition)

	Single condition					Strategic condition				
True income	N	t = 0.4	t = 0.3	difference	*p* value	N	t = 0.4	t = 0.3	difference	*p* value
130	15	88.67	90.00	-1.33	0.58	13	104.62	106.92	-2.31	0.25
120	15	84.00	86.67	-2.66	0.15	13	100.77	103.08	-2.31	0.32
110	15	80.67	84.00	-3.33	0.16	13	96.92	95.38	1.54	0.41
100	15	78.67	80.67	-2.00	0.25	13	88.46	90.77	-2.38	0.37
90	15	76.67	76.00	0.67	0.73	13	81.54	80.77	0.77	0.78
Total		81.73	83.47	-1.73	0.43		94.46	95.38	-0.92	0.58

Table 7. The changes of tax rate and the rate of compliance (all sample)

True income	N	t = 0.4	t = 0.3	difference	P value
130	28	73.90%	75.27%	-1.37%	0.27
120	28	76.49%	78.57%	-2.08%	0.17
110	28	80.19%	81.17%	-0.97%	0.47
100	28	83.21%	85.36%	-2.14%	0.15
90	28	87.70%	86.90%	0.79%	0.78
total		80.30%	81.46%	-1.16%	0.39

Table 8. The changes of tax rate and the rate of compliance (Single condition)

True income	N	t = 0.4	t = 0.3	difference	P value
130	15	68.21%	69.33%	-1.02%	0.66
120	15	70.00%	72.22%	-2.22	0.13
110	15	73.33%	76.36%	-3.03	0.16
100	15	78.67%	80.67%	-2.00	0.25
90	15	85.19%	84.44%	0.74	0.73
total		75.08%	76.59%	-1.50	0.51

Table 9. The changes of tax rate and the rate of compliance (Strategic condition)

True income	N	t = 0.4	t = 0.3	difference	P value
130	13	80.47%	82.25%	-1.78%	0.25
120	13	83.97%	85.90%	-1.92%	0.59
110	13	88.11%	86.71%	1.40%	0.41
100	13	88.46%	90.77%	-2.31%	0.36
90	13	90.60%	89.74%	0.85%	0.89
Total		86.32%	87.07%	-0.75%	0.72

Table 10. The changes of tax rate and the degree of safe divergence

	Total (N=28)		Single (N=15)		Strategic (N=13)	
	t = 0.4	t = 0.3	t = 0.4	t = 0.3	t = 0.4	t = 0.3
The degree of safe divergence	12.14	5.71	11.33	7.33	13.08	3.85
Difference	6.43		4.00		9.23	
P value	0.017*		0.236		0.021*	

Table 11. The Average reported income (by condition) at t = 0.4

True income	Single condition	Strategic condition	p value
130	88.13	104.62	0.011*
120	83.75	100.77	0.002**
110	80.63	96.92	0.002**
100	78.75	88.46	0.019*
90	76.25	81.54	0.304

Table 12. The Average reported income (by condition) at t = 0.3

True income	Single condition	Strategic condition	p value
130	88.75	106.92	0.008**
120	85.63	103.08	0.003**
110	83.13	95.38	0.003**
100	80.00	90.77	0.009**
90	75.63	80.77	0.193

Table 13. Descriptive statistics

Variable	Average	VAR	Min	Max
COMP_40	0.811	0.122	0.472	1
COMP_30	0.822	0.119	0.647	1
SAFE_40	12.692	21.271	-30	50
SAFE_30	6.154	22.817	-30	50
GEN	0.231	0.43	0	1
AGE	31	5.906	23	50
TRUST	5.154	3.209	0	10
MB	4.308	1.955	0	9
SIN_D	0.538	0.508	0	1
N		26		

Table 14. Correlation coefficient

Variables	COMP_40	COMP_30	SAFE_40	SAFE_30	GEN	AGE	TRUST	MB	SIN_D
COMP_40	1.000								
COMP_30	0.862***	1.000							
SAFE_40	-0.328	-0.269	1.000						
SAFE_30	-0.211	-0.378*	0.805***	1.000					
GEN	0.134	0.113	-0.465**	-0.436**	1.000				
AGE	-0.234	-0.088	0.003	-0.059	-0.221	1.000			
TRUST	0.116	0.189	0.205	0.347	-0.172	0.260	1.000		
MB	-0.128	-0.120	0.489**	0.413**	-0.183	-0.152	0.285	1.000	
SIN_D	-0.520***	-0.483**	-0.065	0.048	0.141	0.040	0.192	-0.173	1.000

Table 15. The result of regression analysis

	(1)	(2)	(3)	(4)
	COMP_40	COMP_30	SAFE_40	SAFE_30
GEN	0.046	0.049	-19.832**	-21.353**
	(0.044)	(0.046)	(9.202)	(9.947)
AGE	-0.007**	-0.004	-0.096	-0.654
	(0.003)	(0.003)	(0.691)	(0.747)
TRUST	0.019***	0.019**	0.073	1.584
	(0.006)	(0.007)	(1.328)	(1.436)
MB	-0.026**	-0.023**	4.564**	3.153
	(0.010)	(0.011)	(2.142)	(2.315)
SIN_D	-0.167***	-0.155***	2.622	5.167
	(0.037)	(0.039)	(7.776)	(8.405)
Constant term	1.137***	1.030***	-1.203	6.838
	(0.121)	(0.128)	(25.273)	(27.317)
N	26	26	26	26
Justified R2	0.471	0.378	0.237	0.225