The determinants of compliance with environmental tax: Behavioural study motivated by the case of Indonesia

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Abstract

Motivated by the case of Indonesia, this behavioural study applies theoretical and experimental approaches to observe the determinants of compliance with environmental tax. The study is expected to contribute to the environmental policy literature by examining the impact of financial reward and bribery in combination, beside other conventional enforcement factors such as tax rate, audits and fines. While theoretical analysis finds that compliance will decrease with tax rate and increase with audit, fine, financial reward and the price of a bribe, the results of the experiment indicate that the impact of each factor varies according to the presence of bribery. Despite the differences, both approaches show that bribery encourages evasion as the tax rate increases and curbs the positive impact of financial reward in enhancing compliance.

Key words: environmental tax; compliance; theoretical approach; laboratory experiment

1. Introduction

The role of environmental tax in Indonesia gained recognition with the provisions of the Environmental Management and Protection Act, No 32/2009, which provides a legal basis for the government to levy taxes for environmental purposes. However, the compliance behaviour[1] of the polluting firms is not fully observable by the government and the problem of tax evasion should be taken into account.

Tax evasion is an illegal action designed to lessen tax liability, particularly by underreporting the taxed objects. In the case of environmental tax, where the collected taxes are based on the amount of discharged emissions, evasion could be translated into underreporting the actual size of emissions to reduce the tax payment. Due to imperfect monitoring, the accuracy of submitted emission reports is difficult to assess. The problem of taxation is complicated further by the presence of bribery in the tax office, which is still listed among the top corrupting governmental agencies in Indonesia (Transparency International Indonesia 2014). Motivated by the case of Indonesia, this behavioural

[1] Compliance is indicated by the willingness to comply with tax regulations, i.e. paying the tax according to the real tax liability. In a self-reporting system, being compliant requires that the polluting firms should first report the volume of emissions accurately.

study applies theoretical and experimental approaches to examine the determinants of compliance with environmental tax.

Theoretical studies on environmental regulation and enforcement followed from the studies on optimal penalties in law and economics. The seminal work of Harford (1978) is the first theoretical study on environmental tax compliance. Harford extended the influential work of Becker (1968) on crime and punishment to examine the compliance behaviour of firms under imperfectly enforceable pollution taxes. His theoretical results indicate that increasing the fine and the intensity of the audit will lead to more tax compliance, while increasing the tax rate will decrease the reported emissions, thus suggesting an increase in tax evasion.

The later theoretical studies of Heyes (2001), Bontems and Bourgeon (2005) and Macho-Stadler and Perez-Castrillo (2006) examine optimal environmental taxation and enforcement strategies. They found that the audit and fines have a deterrence impact on the practice of underreporting emissions. Their analyses also suggest that the polluting firms tend to evade environmental tax, unless a high probability of audit (that requires a large monitoring budget) could be established.

Bribery may influence the level of compliance, since it reflects the payment by the polluting firms to the governmental agency for avoiding the consequences of environmental policies. The studies of Damania (2002) and Wilson and Damania (2005) are among a few theoretical studies on the interplay between bribery and environmental tax. Although the presence of bribery changes the conditions for the optimal tax rate, their results are in line with the findings of other studies. The increase in the environmental tax rate induces emission underreporting, and a higher probability of audit and larger fines could deter the incidences of evasion.

Most of the theoretical literature on environmental tax focuses on the role of audit and fines to impose compliance. The impact of financial reward for reporting the true amount of emissions has scarcely been investigated. Swierzbinski (1994) introduced financial reward as an additional instrument in deterrence policies in environmental taxation. The findings of his study indicate that the optimal scheme will be similar to a deposit-refund system, where the firms are charged with environmental tax and a reward for accurate reporting is given afterwards, following the auditing process.

Despite the different objectives, the environmental tax could be considered similar to other taxes in experimental studies. A meta-study by Blackwell (2007), based on twenty laboratory experimental studies, examines the impacts of traditional economic determinants of tax compliance: the tax rate, the penalty rate, and the probability of audit. The study finds strong evidence that increasing the penalty rate and audit probability positively affects tax compliance. However, the study fails to find statistical significance of the tax rate on compliance behaviour. Alm *et al*. (1992), Torgler (2002), Feld *et al*. (2006) and Bazart and Pickhardt (2011) conducted experiments in which financial rewards were offered for a completely accurate report. The results showed that the financial reward has a positive impact on compliance. The experiment of Bilotkach (2006) examined the issue of tax evasion under bribery settings. The results reveal that, once it becomes known that the supervising officials would agree to accept bribes, the subjects offer bribes more aggressively and the magnitude of underreporting increases.

Alm (2012) reviewed existing theoretical, experimental and empirical studies on tax compliance. He concludes that the fine and probability of audit have a deterrence effect on tax evasion, while the impact of tax rate is unclear. He also argues that, aside from enforcement factors, positive rewards could increase compliance more effectively than punishment.

This study observed the previous determinants of compliance, such as tax rate, fines, financial rewards for compliance, probability of audit and bribery. In particular, this study was expected to contribute to the environmental tax literature by examining the effect of financial reward on compliance in the presence of bribery. Given the wide array of literature on environmental regulations and tax compliance, it is surprising that the effect of financial reward and bribery in combination is rarely investigated.

2. Theoretical analysis

Theoretical analysis uses mathematical models to analyse the optimal choice of the polluting firms regarding their decision to report their emission levels. The analysis is developed upon the assumption that the polluting firms will act rationally to maximise their benefit. The models are calibrated for the case of Indonesia, which applies the self-assessment reporting procedure in its taxation system.

In our models, the Ministry of Finance (MoF) provides the polluting firms with the right to assess and report the emission size independently, and to pay tax according to the reported emissions. Simultaneously, the MoF delegates administrative authority to the officials for collecting the tax, conducting the audit and delivering the fine (or the reward) to the rightful firms.

The firms may cheat by reporting an emission size below the actual level. MoF charges the cheating firms a fine to encourage their compliance. The fine is levied proportionally to the amount of evaded tax. To provide a greater incentive for the polluting firms, the MoF may offer a financial reward to report the true level of emissions. The reward is given proportionally to the amount of the tax payment.

The fine and reward can only be decided after the level of emission is examined through an audit, which takes place after the emission report is submitted. However, due to limitations in the MoF's resources, the firms can only be audited with a certain probability. In the presence of bribery, the officials may extract the bribe from cheating firms instead of executing the fine. The price of the bribe is proportional to the amount of the fine, and is determined by the officials who are prepared to take a bribe.

2.1 The optimal behaviour of firms without financial reward for compliance in the absence of bribery

The MoF relies on fines and audits to deter evasion. The MoF announces the environmental tax rate (t) and fine rate for evasion (s). The firms are aware that the probability of being audited (ρ) is determined by the audit budget of the MoF ($\tilde{a}$) and the reported emissions (r). The probability that the firms could be audited is characterised by $\rho[\tilde{a}+r]$, where $\rho'[\tilde{a}]$, $\rho'[r] < 0$ and $\rho''[r] > 0$. These conditions suggest that the probability of being audited is lower (higher) when the budget allocated by the MoF to audit increases (decreases) and the reported emissions are higher (lower), while the marginal audit probability is greater at the low level of reported emissions than at the high level. These conditions are consistent with the existing literature, which demonstrates that the optimal audit frequency decreases with what is reported (see, for example, Heyes 2001; Damania 2002; Wilson & Damania 2005).

The firms make a decision regarding the optimal reported emission (r) given the announced tax rate, fine rate and the audit probability. The MoF also announces the available budget for the purpose of auditing. The profit from discharging emissions is expressed by $\pi[e]$, where e is the actual level of emission, with $\pi'[e] > 0$ and $\pi''[e] < 0$. It is assumed that one unit output linearly correlates with one unit of emission; therefore, e may reflect the level of output.

The payoff of generating emissions for the compliant firms is given by $\psi_c^e = \pi - te$. The payoff is simply the difference between the profit of production and the environmental tax payment. The payoff of the cheating firms, which submit the report (r) lower than actual emission (e), is defined by $\psi_c^r = \pi - (t.r + \rho st(e-r))$. The payoff consists of the gap between the profit and the cost of underreporting emission, which consists of a lower tax payment and the expected fine from tax evasion. The gain from underreporting emission and evading tax payment is given by the following equation:

$$\psi_c = t(e-r) - \rho st(e-r) \tag{1}$$

Equation (1) is simply the difference between the payoff of cheating and the payoff of compliance. The polluting firms decide the level of reported emission that maximises the gain. The condition for optimal reported emission is given by the first-order condition (FOC) in equation (1).

$$\frac{\partial \psi_c}{\partial r} = -t + \rho st - \frac{\partial \rho}{\partial r} st(e-r) = 0 \tag{2}$$

Rewriting equation (2) in terms of r,

$$r = e - \left(\frac{\rho st - t}{\frac{\partial \rho}{\partial r} st} \right) \tag{3}$$

where $\frac{\partial \rho}{\partial r} < 0$.

Equation (3) implies that the reported emissions will be lower than the actual size if the marginal benefit of underreporting emission (tax rate) is higher than the marginal cost (the tax rate multiplied by the expected fine rate). The optimal report will be equal to the real emission level less the marginal gain of underreporting emissions. The impact of each enforcement instrument on optimal reported emissions is demonstrated by comparative statics, deriving from equation (2) using implicit differentiation.

$$\frac{\partial r}{\partial t} = -\frac{1 - \left(\rho s - \frac{\partial \rho}{\partial r} s(e-r) \right)}{\frac{\partial^2 \rho}{\partial r^2} st(e-r) - 2\frac{\partial \rho}{\partial r} st} \tag{4}$$

$$\frac{\partial r}{\partial s} = \frac{\rho t - \frac{\partial \rho}{\partial r} t(e-r)}{\frac{\partial^2 \rho}{\partial r^2} st(e-r) - 2\frac{\partial \rho}{\partial r} st} \tag{5}$$

$$\frac{\partial r}{\partial \tilde{a}} = \frac{\frac{\partial \rho}{\partial \tilde{a}} st}{\frac{\partial^2 \rho}{\partial r^2} st(e-r) - 2\frac{\partial \rho}{\partial r} st}, \quad (6)$$

where $\frac{\partial \rho}{\partial r} < 0$.

Equations (4), (5) and (6) show that the optimal report decreases with the tax rate (t) and increases with the fine rate (s) and audit budget ($\tilde{a}$). A higher fine rate for evasion, and a higher audit frequency due to the increase in the budget, will impose more pressure on the firms to increase the reported income.

2.2 The optimal behaviour of the firms with financial reward for compliance in the absence of bribery

When the MoF introduces the financial reward for compliance, the expected payoff from generating emissions to the compliant firms are defined by $\psi_c^e = \pi - te + \rho ite$. Now the firms may expect an additional income in the form of a financial reward for reporting the true level of emissions. Financial reward is conditional upon the probability of audit, since the reward is granted after the accuracy of the report is confirmed through auditing. The payoff from reporting accurately is the sum of profit associated with generating emissions and the expected financial reward, less the cost of tax payment. The payoff to the cheating firms from generating emissions is given by $\psi_c^r = \pi - (tr + \rho st(e-r))$. The payoff is the profit of producing emissions less the sum of lower tax payment, the expected cost of the fine, and the expected loss of financial reward. The gain from underreporting emission is given by the following equation:

$$\psi_c = t(e-r) + \rho(st(e-r) + ite) \quad (7)$$

The condition for optimal reported emissions that gives a maximum payoff to the firms is given by the FOC of equation (7).

$$\frac{\partial \psi_c}{\partial r} = -t + \rho st - \frac{\partial \rho}{\partial r}(st(e-r) + ite) = 0 \quad (8)$$

The optimal reported emissions is obtained by rewriting equation (8) in terms of r.

$$r = e - \left(\frac{\left(\rho st - \frac{\partial \rho}{\partial r} ite \right) - t}{\frac{\partial \rho}{\partial r} st} \right) \quad (9)$$

where $\frac{\partial \rho}{\partial r} < 0$.

When the financial reward was available, the optimal reported emissions were higher than the previous report without the reward. After the introduction of a financial reward, the marginal cost of

underreporting emissions was higher and led to a decrease in marginal gain of evasion for each unit change of reported emissions.

The impact of each enforcement instrument on optimal reported emissions is demonstrated by comparative statics below, using implicit differentiation on equation (8).

$$\frac{\partial r}{\partial t} = -\frac{1-\left(\rho s - \frac{\partial \rho}{\partial r}\left(s(e-r)+ie\right)\right)}{\frac{\partial^2 \rho}{\partial r^2}\left(st(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}st} \tag{10}$$

$$\frac{\partial r}{\partial s} = \frac{\rho t - \frac{\partial \rho}{\partial r}t(e-r)}{\frac{\partial^2 \rho}{\partial r^2}\left(st(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}st} \tag{11}$$

$$\frac{\partial r}{\partial \tilde{a}} = \frac{\frac{\partial \rho}{\partial \tilde{a}}st}{\frac{\partial^2 \rho}{\partial r^2}\left(st(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}st} \tag{12}$$

$$\frac{\partial r}{\partial i} = \frac{-\frac{\partial \rho}{\partial r}te}{\frac{\partial^2 \rho}{\partial r^2}\left(st(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}st} \tag{13}$$

where $\frac{\partial \rho}{\partial r} < 0$.

Comparative statistics show that optimal reported emissions decrease with the tax rate (t) and increase with the available audit budget (ã), fine rate (s) and financial reward rate (i). A comparison of the instruments' impact on reported emissions before and after the introduction of financial reward shows that the negative impact of the tax rate on reported emissions is lower when a financial reward is provided. However, the same case also applies to the positive impact of the fine rate and the budget for audit. It shows that the insertion of financial reward pushes out the impact of other enforcement instruments.

The comparison of the impact of fines and financial reward on the reported emissions yields an ambiguous conclusion. The impact of financial reward is higher than the impact of the fine if the optimal reported emission, as expressed in equation (9), is close to the actual level. On the other hand, the impact of the fine will be superior to the financial reward if the optimal reported emissions are much lower than the actual emissions.

A financial reward is only given to the firms that report their emission levels truthfully. Although the firms increase the reported emissions, the reward will not be granted if the requirement to state the actual level of emissions is not met. Shifting from cheating to compliant behaviour is less favourable for the firms if the expected gain from cheating is much higher. Therefore, the financial reward is

only attractive for the firms if the gap between the optimal report and the actual level of emissions is close.

On the other hand, the intensity of fine is defined by the degree of evasion – the gap between the reported and actual levels of emission. A fine allows the polluting firms to adjust their behaviour according to their tolerated level of expected loss. If the fine is more severe as the fine rate increases, the firms may lower the expected cost by increasing the reported emissions. Following this logic, the impact of a fine will be more considerable than a financial reward when the gap between the optimal report and the actual emissions level is wide. However, the fine does not necessarily induce the firms to declare the real emissions level.

2.3 The optimal behaviour of the firms with financial reward for compliance in the presence of bribery[2]

When the MoF offers a financial reward for compliance despite the prevalence of bribery, the payoff of generating emissions for the compliant firms in the presence of bribery is described by $\psi_c^e = \pi - te + \rho ite$. The payoff is the gain from generating emissions and the expected financial reward, less the cost of the environmental tax payment. The payoff for the cheating firms is given by $\psi_c^r = \pi - \left(tr + \rho bst(e-r)\right)$ – the profit of generating emissions less the sum of underpaid tax payments and the expected bribe. The gain from underreporting emissions is given by the following equation:

$$\psi_c = t(e-r) - \left(\rho\left(bst(e-r) + ite\right)\right) \tag{14}$$

The gain consists of the tax saving resulting from underreporting the emissions less the expected bribe cost and the loss of financial reward for reporting emissions truthfully. The FOC of equation (14) is the following:

$$\frac{\partial \psi_c}{\partial r} = -t + \rho bst - \frac{\partial \rho}{\partial r}\left(bst(e-r) + ite\right) = 0 \tag{15}$$

The optimal reported emissions (r) can be obtained by rewriting equation (15) in terms of r:

$$r = e - \left(\frac{\left(\rho bst - \frac{\partial \rho}{\partial r} ite \right) - t}{\frac{\partial \rho}{\partial r} bst} \right) \tag{16}$$

where $\frac{\partial \rho}{\partial r} < 0$.

Financial reward increases the marginal cost of underreporting emissions and reduces the marginal gain from the evasion. However, since the bribe replaces the fine and reduces the marginal cost of

[2] We implicitly assume that the probability of the firms being audited by the corrupt officials is either zero (no chance of bribery) or one (complete chance of bribery). This assumption implies that the firms are fully aware of the officials' corrupt behaviour beforehand. This awareness could have developed through past experiences, or have been influenced by commonly shared public information, for instance the news revealing tax bribery as a common practice among businessmen in Indonesia (The Jakarta Post, 2012).

underreporting, this optimal report is still lower than the report induced by financial reward in the absence of bribery, as expressed by equation (9). Comparative statistics derived from the FOC in equation (15) are presented below.

$$\frac{\partial r}{\partial t} = -\frac{1-\left(\rho bs - \frac{\partial \rho}{\partial r}\left(bs(e-r)+ie\right)\right)}{\frac{\partial^2 \rho}{\partial r^2}\left(bst(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}bst} \tag{17}$$

$$\frac{\partial r}{\partial s} = \frac{\rho bt - \frac{\partial \rho}{\partial r}bt(e-r)}{\frac{\partial^2 \rho}{\partial r^2}\left(bst(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}bst} \tag{18}$$

$$\frac{\partial r}{\partial \tilde{a}} = \frac{\frac{\partial \rho}{\partial \tilde{a}}bst}{\frac{\partial^2 \rho}{\partial r^2}\left(bst(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}bst} \tag{19}$$

$$\frac{\partial r}{\partial b} = \frac{\rho st - \frac{\partial \rho}{\partial r}st(e-r)}{\frac{\partial^2 \rho}{\partial r^2}\left(bst(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}bst} \tag{20}$$

$$\frac{\partial r}{\partial i} = \frac{-\frac{\partial \rho}{\partial r}te}{\frac{\partial^2 \rho}{\partial r^2}\left(bst(e-r)+ite\right)-2\frac{\partial \rho}{\partial r}bst} \tag{21}$$

where $\frac{\partial \rho}{\partial r} < 0$.

The optimal reported emissions decreases with the tax rate (t) and increases with the available budget of the MoF allocated on audit ($\tilde{a}$), fine rate (s), bribe rate (b) and financial reward rate (i). The negative impact of tax rate on reported emissions is bigger than the impact when financial reward is offered and bribery is absent.

The impact of bribe rate on the optimal report is higher than the impact of fine rate. For the cheating firms, the actual punishment for underreporting is determined by the bribe rate set by the corrupt official. Therefore, the firms will be influenced more by the bribe rate than by the official fine rate. The impact of financial reward will be higher than the impact of the fine only if the optimal reported emissions, as expresses in equation (16), is close to the actual level, otherwise the impact of the fine will be superior to the impact of financial reward.

The financial reward will have a greater impact on reported emissions than a bribe only if the optimal reported emissions are close to the actual emissions level, and the bribe is so expensive that it is approaching the size of the fine. Bribing to evade the fine is less appealing than the anticipation of financial reward when the size of the requested bribe is almost equal to the fine. Once the gap between

the optimal report and the actual level is narrowed, shifting from evasion to compliant behaviour will be less costly for the firms. However, reporting accurately will create a considerable loss of gain for the cheating firms if this gap is wide and the size of the bribe is considerably smaller than the fine. In this case, the firms will be inclined to underreport the emissions and anticipate the bribe.

Theoretical analysis shows that financial reward is less significant for stimulating the compliance of firms when bribery is not stopped. The bribe nullifies the severity of a fine and thus lessens the marginal cost of evasion. At the end, the presence of the bribe makes the financial reward relatively less attractive to the firms.

3. Experimental analysis

When dealing with compliance issues it is necessary to consider the real behaviour of the real economic agents, which may not be driven simply by utility maximisation, as assumed in the theoretical approach. Laboratory experiments can provide the information regarding how people will behave in relation to the particular economic design, thus verify the prediction of the theoretical approach (Roth 2002). In this study, the laboratory experiments were conducted to compensate for the limitation of theoretical analysis, hence closing the gap between theoretical prediction and the real behaviour of the agents in question.

The experiments were carried out in Indonesia with students of Diponegoro University as the experimental subjects, representing decision makers of the firms. The common critique for employing the students in laboratory experiments was that it may raise the issue of population validity, particularly on the topic of whether or not the decisions of the students in the experiment are suggestive of the decision of the real economic agents. However, empirical studies indicate that demographic differences among experimental subjects have no significant impact on experimental results (see Guillen and Veszteg, 2006). The study of Alm *et al*. (2011) on the external validity of laboratory experiment also finds that the behavioural responses of students are similar to the responses of other subjects in the same experimental settings. Students have been employed in various experiments to investigate firms' behaviour. For instance, students were recruited as subjects in the experiments on firms' behaviour in the oligopolistic setting (Le Coq & Orzen 2006; Morgan *et al*. 2006; Orzen 2008).

The recruitment of students is done through open announcement. The students who apply to participate in the experiments are randomly assigned to one of the four available treatments. The experiments offer a real monetary payoff, as the subjects can earn and lose money according to their decisions during the experiments. Any earnings are given to the subjects in cash at the end of the experiment.

3.1 Experimental designs

The experiments were designed to replicate the theoretical models and to test these models in the laboratory setting. In accordance with the theoretical models, the experiments covered three scenarios. The first two scenarios represent the taxation setting without the practice of bribery, while the last scenario indicates the setting afflicted with bribery. Financial reward was introduced in the last two scenarios as an additional determinant of compliance behaviour. For the sake of simplicity, this experiment used the assumption that the income received by polluting firms corresponds linearly with the emitted emissions.

Each scenario consisted of 24 rounds and included 29 subjects (in total, 87 students participated as experimental subjects). In each round, the subjects were given a fixed amount of income in real

monetary value. Given the value of the treatment variables, the subjects had to make a decision regarding the amount of income they were willing to report. The reported income was the base for drawing the experimental tax, which reduced their earning from the experiment. In general, the treatment variables (variables controlled by the experimenter, whose values were changed systematically to examine the response of the subjects) were tax rate, fine rate, price of bribe, financial reward rate, and probability of audit.

Table 1: Values of the determinant variables

Determinant variables	Values
Tax rate	5%, 40%, 80% *(of the reported income)*
Fine rate	105%, 140%, 180% *(of the unpaid tax)*
Reward rate	5%, 40%, 80% *(of the paid tax)*
Probability of audit	5%, 40%, 80%
Price of bribe	5%, 40%, 80% *(of the fine)*

The values of the fine rate are higher than 100%, indicating that the subjects who get the penalty should first pay the unpaid tax, and then pay the amount proportional to the unpaid tax as the punishment. During the experiment, the value of the treatment variables was picked randomly so that the different combinations occur in each round. The gap between the values of the variables was set distinctly wide to make the difference noticeable to the subjects.

The selection of treatment variables was different across scenarios. Scenario 1 was the basic scenario, which simulated the taxation condition in the absence of bribery, while the reward for telling the truth was not available. Given the tax rate, fine rate and probability of audit, the subjects had to decide the amount of income they intended to report. The subjects who were detected to e cheating (reporting income less than the actual amount) would have to pay the fine.

Financial reward, as an additional determinant of compliance behaviour, was introduced in scenario 2. In this scenario, the subjects were not only punished for cheating, but they also were encouraged to report truthfully by being providing the financial reward to do so. The subjects who were selected to be audited with certain probability faced two outcomes. The subject reporting accurate income would get financial reward, while the cheating subjects would be punished.

Scenario 3 replicated the situation characterised by the presence of bribery, and the government tried to encourage compliance by providing financial reward. In this scenario, the experimental subjects were not only obliged to pay the cost of cheating (in terms of fines or bribe costs), but also were eligible to receive the reward once the audit confirmed the accuracy of their reports. The price of the bribe was added as another determinant in this scenario.

Before the experiment was conducted, the subjects were asked to fill in a simple questionnaire to solicit their risk attitude. The questionnaire referred mainly to the risk characteristic assessment used by financial investment companies. Since the risk attitude of each subject varied, the data of risk attitude might be helpful to explain the individual decisions of the subjects during the estimation of the experimental results.

3.2 Experimental results

Comparisons among the treatment groups revealed that, when financial reward is available, subjects in different bribery settings respond differently. The introduction of financial reward increases the average reported income when bribery is absent (80%). However, when the cheating subjects are

allowed to bribe, the average report is level with the average report in the absence of reward (59% to 58%).

Table 2: Summary statistics of reported income

Scenario	Mean	Standard deviation	Min	Max
Scenario 1	58%	41%	0%	100%
Scenario 2	80%	38%	0%	100%
Scenario 3	59%	44%	0%	100%

To analyse the compliance behaviour of the experimental subjects, the reported incomes as the proxy of compliance were regressed on the treatment variables and risk attitude. The fact that all scenarios had multiple rounds, with each scenario consisting of 24 rounds, provides a big panel dataset (there are 696 observations for each scenario). The Hausman test reveals that the random effect model is statistically preferable than its alternative (fixed effect model) to analyse the data. The random effect model suggests that the error term of the cross-sectional unit is not correlated with the independent variables, therefore allowing time-invariant variables such as risk attitude to be included as explanatory variables.

Table 3: Determinants of the reported income

Determinant	Coefficient (Standard error)		
	Scenario 1	Scenario 2	Scenario 3
Tax rate	0.03 (0.04)	0.03 (0.04)	-0.15** (0.04)
Fine rate	0.09* (0.04)	0.02 (0.04)	0.11** (0.04)
Financial reward rate	n.a.	-0.04 (0.05)	0.07 (0.14)
Price of bribe	n.a.	n.a.	0.10* (0.05)
Audit probability	0.51** (0.04)	0.41** (0.04)	0.53** (0.04)
Risk	-0.02 (0.06)	0.00 (0.05)	-0.04 (0.05)

Note: * significant at 5% significance level, ** significant at 1% significance level. n.a.: not applicable

The coefficients in the table above represent one unit change in reported income (measured as percentage of the amount received) due to one unit change in determinant variables. During all scenarios, the risk characteristic of the subjects does not have a significant impact on their decision on the amount of reported income, although the sign of the coefficient is correct (indicating that the reported income will be lower for the more risk-seeking subjects).

In all scenarios, the probability of audit had the biggest impact (as indicated by the magnitude of the coefficient) at the highest level of significance (constantly at 1% significance level). In scenario 1, the other determinant variable that significantly affected the reported income during the experiment was fine rate. On the other hand, the tax rate did not affect the decision of the subjects to report their income. Meanwhile, aside from audit probability, the rest of the variables did not significantly affect the decision of the subjects in scenario 2, including the financial reward rate, the additional instrument to enhance compliance.

The impact of tax rate in scenario 3, in which bribery was allowed, was significant at the 1% level of significance. The tax rate, which did not have a statistically significant effect on reported income in scenarios 1 and 2, had a negative impact on reported income when bribery was practised. Fine rate and price of bribe, as additions to the conventional determinant of compliance, were also statistically significant. However, the financial reward rate did not statistically affect the reported income.

Since the impact of financial reward is the main topic of interest in this study, it was necessary to see whether the availability of financial reward (as opposed to the size of the reward) would make a difference in the reported income. Therefore, financial reward was translated into the dummy variable consisting of binary values. A value of zero represents the condition without the financial reward, and it is one if the financial reward is available. The financial reward dummy was regressed on reported income, together with other controlled variables.

Table 4: Determinants of the reported income with financial reward dummy

Determinant	Coefficient (Standard error)	
	Scenario 1 and 2	Scenario 1 and 3
Tax rate	0.03 (0.03)	0.05* (0.03)
Fine rate	0.07** (0.03)	0.11** (0.03)
Probability of audit	0.46** (0.03)	0.51** (0.03)
Risk	-0.01 (0.04)	-0.03 (0.04)
Bribe dummy	n.a.	(omitted)
Reward dummy	0.22** (0.06)	0.05 (0.06)

Note: * significant at 5% significance level, ** significant at 1% significance level

The results show that the financial reward dummy was statistically significant in influencing the reported income when bribery was not practiced. The presence of the financial reward increased the reported income in the absence of bribery by a wide magnitude. The coefficient indicates that it would increase the reported income by 22% of the received amount. The significance of the financial reward dummy might explain why the financial reward rate does not affect the reported income in scenario 2. Subjects were more motivated by the presence of financial reward, rather than by the size of the reward. Provided that the reward is available, they would be more compliant regardless of the amount. This result may also explain the anomaly in scenario 2, where all variables except the probability of audit failed to influence the reported income. The current result indicates that the availability of reward rules out the impact of other determinants.

However, when the practice of bribery is introduced, financial reward becomes insignificant. These results indicate that the availability of financial reward significantly increases compliance, given that bribery is prevented. Once bribery is practised, the evasion will continue.

4. Discussion and conclusion

The study employed theoretical and experimental approaches. The theoretical analysis used mathematical models to analyse the optimal choice of the polluting firms regarding their decision to report emissions levels. The common criticism of this approach is that the method relies heavily on the assumption that the economic agents are fully rational and driven solely by the motivation to maximise their benefit. The experimental approach could relax the assumption of rationality, allowing

the possibility that economic agents do not necessarily take decisions based on a logical consideration. This approach could fill the gap between the actual economic behaviour and the prediction of the theoretical model.

Theoretical analysis predicts that compliance will decrease with tax rate and increase with audit, fine and financial reward, whereas the findings of the experimental approach indicate that the impact of each determinant varies according to the existence of bribery. The panel analysis revealed that the tax rate did not affect compliance in the absence of bribery. However, tax rate indeed showed a significantly negative impact on compliance in the presence of bribery. The argument for this difference could be that the tax elasticity of the reported income increases in the presence of bribery. The subjects find that the cost of the fine could be evaded all the time by paying the bribe, which was less than the amount of the fine. In this setting, the subjects responded directly to an increase in tax rate by decreasing their report.

Another result that differed between the two approaches was the finding regarding the impact of financial reward. The theoretical study indicated that the impact of financial reward on the compliance of polluting firms would be less than the impact of the fine, in both the absence and the presence of bribery. However, the experimental results showed that the impact of financial reward was superior to the impact of the rest of determinant variables if bribery was fully prevented, while it failed to influence compliance in the presence of bribery.

The theoretical study assumed that economic agents would act optimally to maximise their profit; on the other hand, the experiment allowed the experimental firms to act on emotional consideration besides profit maximisation behaviour. The experimental subjects, who may have considered evading the obligation as an un-ethical attitude, would be more encouraged to comply when the reward to do so was available. However, the presence of bribery reduced the costs of evasion. Bribery created a situation where the net benefit of evasion was more appealing than the net benefit of compliance. In this situation, the economic motivation ruled out the ethical consideration and the subjects ignored the financial reward.

Despite the difference, both approaches indicate that bribery disrupts the effectiveness of enforcement instruments. It augments the negative consequence of tax on compliance by encouraging aggressive tax evasion as the tax rate increases. This condition raises more restrictions for the Ministry of Finance, since the tax rate should be maintained at a low level. Bribery also reduces the positive impact of financial reward on compliance, which is able to enhance the compliance (despite the value of the reward) before the bribery becomes prevalent.

Based on the findings of this study, the recommended environmental tax schemes in the presence of bribery would be a combination of moderate tax rate and moderate financial reward. Considering that the probability of audit and fine has strong impacts on compliance, a high audit intensity and severe fine are necessary. Another important hint from this study regards the influence of bribes. Since the price of a bribe as required by the tax officials demonstrates a significant impact on the compliance decision, enforcement policies directed toward corrupt tax officials who could increase the size of the demanded bribe (to compensate for the risk of being punished for abusing the authority) are strongly recommended.

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