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Which are More Effective to Stop Burning Land: Subsidies or Taxes? Evidences from Laboratory Experiment

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ABSTRACT

The amount of losses incurred by smog encourages all parties to participate in risk mitigation efforts. Law enforcement is one step that is often taken by the authority to reduce the number of entrepreneurs who open plantations by burning land. In addition to the punitive policy, efforts to prevent the burning of land are also required, for example, by providing subsidies for the planters. By utilizing laboratory experiments, this research aims to determine the effect of some treatments that might reduce the proportion of the population who burn the land and increase the proportion who perform manual land clearing, which is environmentally friendly. The treatments given are subsidizing, taxing, and the combined provision of subsidies and taxation. The results from the test of the population differences showed that there is no difference in behavior between the participants working as civil servants and non-civil servants in terms of choosing the investment method. Another finding of this study is that only the provision of subsidies was able to increase the proportion of entrepreneurs who choose environmentally friendly investment activities.

Keywords: taxes, subsidies, land burning, laboratory experiment

INTRODUCTION

Indonesia is a country with a vast forest; about 57 percent of its land area, equating to 108,573,300 hectares. However, this forest is gradually being exhausted by the granting of concessions to entrepreneurs. It is granted to anyone – entrepreneurs – regardless of their civil service or non-civil servant status as long as they have a large budget; hence, they are able to exploit the forest indefinitely without returning the forest function properly (Otoritas Semu, 2016). It is estimated that after another 35 years of deforestation, Indonesia's forests will measure only 57 million hectares (Iskandar, 2000). During this time the concession system that supports the conglomeration of forestry entrepreneurs will have caused the destruction of forests in Indonesia and threatened the sustainability of forests and forest products.

In general, employers always want to minimize the cost of production or investment to obtain a given profit. Therefore when entrepreneurs choose the investment method, they consider it based only on the minimal cost option without considering the cost of environmental damage caused by their production activities. One of the environmentally damaging production activities is land clearing for palm oil plantations by burning land. Many entrepreneurs choose to open plantation land by burning, rather than choosing to open land using manual methods. Burning land is the cheapest way to clear the land if it does not take into account the additional costs resulting from the smog from the burning (Potter & Lee, 1999). The smoke haze that occurs in some areas has a tremendous impact on all of us. Even the air quality in Pekanbaru, Province of

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Riau Island, reaches 984 PSI when exposed to smog from forest burning, which is far above the air pollution standard index that ranges from 300 to 500 PSI (National Geographic, 2015). Smog can lead to outbreaks of respiratory disease, which, if contracted by children and toddlers, can result in death, as well as disruption of economic activities as a result of flight delays and traffic jams because of the extremely limited visibility (Detiknews, several editions, 2013).

So high are the losses due to haze that even the victims are willing to provide subsidies for employers so that they no longer use the burning method when they open land. The amount of the contribution from the victims is measured by their willingness to pay (Restiatun & Suratman, 2015). People's willingness to provide subsidies for employers is likely to be driven by the sense that expending some funds to prevent haze is better than spending the same for the purposes of treatment due to pain caused by haze, particularly as illness causes disutility (Zweifel & Breyer, 1997). Hence, it can be said that the sickness is a direct shock to the utility (Viscussi & Evans, 1990) or health cost (Ryan & Vaithianathan, 2003). As health care costs are required to restore health status, these costs can be treated as health expenses.

There are several studies that state the importance of environmental regulation (see Brock & Evans, 1985; Dean & Brown, 1995; Dean et al., 2000). Theoretically, taxes or subsidies are elements that can reduce environmental pollution activities, such as forest burning. Of the aforementioned studies have not seen how the effect of these regulations on changes in the behavior of entrepreneurs causing pollution.

A lump sum subsidy from the society and the government would lower the cost borne by the planters to clear the land manually. This is in line with the statement that incentives for the prevention of unlawful acts by potential lawbreakers would reduce the number of offenders (Pradiptyo, 2006). This intervention type is referred to as the initiation of crime prevention. Given these subsidies, the profit accepted by employers will be greater than with no subsidy. But even though the subsidy lowers the cost of clearing land manually, supervision and law enforcement remain necessary to guard against moral hazard, i.e., the unlawful burning of land by employers who have received subsidies. Law enforcement can be administered through the Pigou tax for entrepreneurs through which their action of burning land or forests can be audited.

This research applies lab experiments to test the effects of the treatment in the form of subsidies, taxation, and the combination of the two on the behavior of forest fires. Although the short-term cost of clearing peatland forests is much lower than the cost of clearing it manually, in the long term, the costs of burning peatland forests are much higher. In addition to the accumulation of the negative effects of smog in the short term, in the long run, more severe economic distortions may occur that could result in the cessation of the production of goods and services.

LITERATURE REVIEW

Smog is one of the outputs from clearing land by burning. One tool that can be used to counter the negative impact of burning land is tax collection against the burn land. This tax is known as the Pigou tax; the tax levied on certain activities that generate externalities for which the cost is not internalized in the market prices. The tax is applied as a correction tool for propping-up inefficient markets. The amount of tax would be set equal to the social costs of negative externalities. However, the Pigou tax will only be effective if market prices remain competitive, irrespective of whether the total taxes cover the total damage or not (O'Hagan, 1984).

Several studies have found different things about the company's scale effect on environmental damage (D'Souza & Peretiatko, 2002). Schumacher (1998) believes that, due to the large scale of production, large firms are more intensive polluters than small-scale enterprises. Different results were found by Beckermen (1995) and D'Souza (2001). They argue that environmental regulation is easier to do in large companies than small firms, so small companies are the main contributor to pollution. This finding is supported by the findings of the World Bank (1997). In the case of land burning, the findings are relevant to the case of burning of land by large plantation companies or small plantations, even individual farmers.

Regulation of forest fires is needed to prevent environmental damage. This regulation should be applied to all plantation companies, regardless of the scale of the company. For employers, the Pigou Tax can be perceived as punishment for their actions that cause environmental pollution when audited. Nevertheless, issuing a penalty as an instrument to prevent crime, in this case environmental pollution has long been debated, not only on a theoretical level, but also on the effectiveness of the penalty at the level of empirical and experimental studies. This then encourages economists to analyze the behavior of breaking the law based on the decision

theory and game theory. The decision theory approach was used in the research by Becker (1968), while the game approach was used by Tsebelis (1989) (Pradiptyo, 2006).

Burning land can be categorized as a criminal act. According to economic theory, this action is a rational behavior, because it is intended to minimize production costs. This is also in line with the modern criminal economic theory that is based on the assumption that criminal acts can also be viewed as a corporation, i.e., any criminal activity carried out with the same impetus as economic activity (Meiselman & Tullock, 1973). The decision of an individual to engage in a criminal activity is largely determined by the opportunities available to do so. This opportunity will determine the magnitude of the benefit and the cost ratio of the criminal activity to be performed (Becker, 1968).

The interaction of entrepreneurs in land burning activities would be better if it is analyzed through game theory, on the basis that the probability of being audited and not audited in doing unlawful acts is influenced by the interactions of rational players. The probability of getting audited is not related to the severity of the punishment. This is in line with the results of several studies of Tsebelis (Pradiptyo, 2006); that an increase in the severity of punishment does not reduce the chances of an individual or company performing unlawful activities, namely, the burning of peatlands. An attempt to increase the severity of punishment is counterproductive because it does not affect the behavior of the individuals or the companies. A better influence would be if the authorities heightened the intensity of law enforcement. In the case of burning the land, the intensity of law enforcement can be interpreted as an increase in the probability of being audited.

The decision to commit a criminal act is influenced by a system of justice against crime, economic factors, and demographic factors. This system of justice includes prevention effects (proxied by the probability of being audited) and the amount of the fine (as a proxy for the level of punishment) on the property obtained from the crime (Bodman & Maultby, 1997). The increased probability of being audited will lower the probability of the entrepreneur burning the land. This is in line with the theoretical prevention hypothesis that the probability and/or level of punishment (representing the cost of criminal behavior) will reduce potential criminal participation in illegal activities (Becker, 1968).

There are other methods to reduce the number of violations that might prevent individuals from having a career of crime (Pradiptyo, 2006). This type of intervention is referred to as the initiation of crime prevention. In extreme cases, this program can be interpreted as providing a subsidy (or incentive) for individuals not to commit the crime. Theoretically, this intervention is feasible, though, in reality, the initiation of crime prevention is mostly directed at a group of individuals who are most at risk of committing a crime. For the case of burning the land, methods of crime prevention can be introduced by providing subsidies to the planters where data on these entrepreneurs is available. Economically, the subsidies received will reduce the employers' costs incurred in clearing the land manually, which is more expensive than by burning.

When viewed from the perspective of law enforcement, the implementation of the crime prevention initiation shows more visible results compared to the efforts to increase the severity of punishment. One crucial factor that is captured in this analysis is the comparison of the resources needed to implement the policy. The initiation of crime prevention may require more resources than a policy to increase the severity of punishment. If law enforcement has been implemented, the total number of incidents and violations committed by individuals will be identified. In the case of the haze that affected West Kalimantan, Indonesia, the community was willing to provide subsidies to prevent the burning of land, with the assurance that the land would be opened manually. The considerable contribution of this community could be measured by their willingness to pay. Furthermore, the subsidies made by this community would certainly reduce the government expenses to provide subsidies for the planters (Restiatun & Suratman, 2015).

Nonetheless, there is a broader debate as to whether taxes and subsidies can generate outcomes that are symmetrically allocative. The general conclusion shows that the subsidy cannot work or is not efficient in the long term. This is because subsidized payments appear to be a political stigma and will become a fiscal burden (Polinsky, 1979) that will aggravate the pollutant industry in the long term (Burrows, 1979). On the other hand, there is some literature that states that (1) the Pigouvian taxes will generally be optimal in competitive markets without depending on whether the total tax payments are able to cover the total of the damage at the optimum level, and (2), in some circumstances, both subsidies and regulations may be practiced efficiently. To achieve greater efficiency in the management of environmental pollution, it is stated that the pollution tax would be efficient if it is established by fulfilling two requirements: (1) a price equal to the marginal social cost, and (2) each company is taxed at no more than the total amount of the resulting damage (Polinsky, 1979).

MATERIALS AND METHOD

All the games in this experiment were performed using the Z-Tree. Z-Tree stands for "Zurich Toolbox for Ready-made Economic Experiments". It was developed at the University of Zurich by Urs Fischbacher. Z-Tree is designed to enable the conducting of economic experiments without much prior programming experience (Fishbacher, 2007). Hence, it is not too complicated for experimental models to be adopted into Z-Tree. This experiment involves 25 students of the Master Program in Development Economics at Universitas Gadjah Mada. The selection of participants is based on the consideration that entrepreneurs are individuals who take into account the financial returns of each action they will take. Given that the students of the Master Program in Development Economics of Universitas Gadjah Mada are individuals who possess that ability, they may fulfill the role of entrepreneurs in this laboratory experiment. Within the group of selected participants, there are individuals who are civil servants or non-civil servants, so their election as a participant is able to represent the fact that there are forestry entrepreneurs who are civil servants and non-civil servants. Determination of the number of participants and the sum of the rounds is based on the central limit theorem, and the constraints faced.

The experimenters obtained the consent to conduct the experiment from the Board of Directors of the Master Program in Development Economics at the Faculty of Economics and Business, Universitas Gadjah Mada, Indonesia, which acts as the approval for ethical consent. Before starting the game, all the participants received game instructions, either in the form of computer printouts, the display on the computer screen or via oral delivery by the experimenter. In this experiment, each participant was asked to play a plantation owner who would do the clearing. They would be faced with the choice of land clearing by Method 1, by way of clearing and Method 2, namely burning. Clearing land is the most environmentally friendly way, but the cost is high. While by burning forests, although employers can minimize investment costs because it is less expensive, the land burning activity can damage the environment.

The game in this experiment focuses on the choice of land clearing methods made by the participants. Each decision affects the participants by receiving rewards to be taken home. Every point in the final game is Rp100.00. Rp is Rupiah, which is the Indonesian currency. The amount of the reward received by the participants is the accumulation of all the points in the whole scenario. The participants' decision making correlates to the monetary payments that they receive at the end of the experiment. The scenario in this experiment ensures that it retains saliency, an essential element for the validity of the laboratory experiments.

The game is played in four scenarios, and each scenario is executed over five rounds. In each scenario, the participants receive different treatments. The flow of the game is explained as follows:

Stage 1: Baseline

The participants receive an endowment of 50 points in each round. With the endowment, the participants have to choose whether to use Method 1 or Method 2. In Method 1 the fee is 25 points, while the cost of Method 2 is 5 points. If the participants choose Method 1, then the returns that the participants receive at the beginning of the period are small but increase in the next period, while for Method 2 it is the opposite. The period is denoted as the stage; five rounds are considered as five periods. The returns from Method 1, respectively, are 5, 7, 10, 15, and 30, while for Method 2 they are 15, 10, 5, 5, and 0, respectively. The participants' points are calculated using the formula (Endowment - Cost) + Return. In this section, there is no randomization.

Stage 2: Subsidies

The participants are given an endowment of 50 points in each round. With the endowment, the participants have to choose whether to use Method 1 or Method 2. In Method 1 the fee is 25 points, while the cost of Method 2 is 5 points. If the participants choose Method 1, then the returns that the participants receive at the beginning of the period are small but increases in the next period, while for the second method it is the opposite. The period is denoted as the stage; five rounds are considered as five periods. The returns from Method 1 are 5, 7, 10, 15, and 30, respectively. The returns from Method 2 are 15, 10, 5, 5, and 0, respectively. However, in this stage, the participants are introduced to the treatment subsidies. If the participants choose Method 1, the participants receive a subsidy of 10 points as a reward because the participants did not destroy the forest. The participants' points are calculated using the formula (Endowment - (Cost - Subsidy)) + Return. In this section, there is no randomization.

Stage 3: Taxes/Pigou Taxes

The participants are given an endowment of 50 points in each round. With the endowment, the participants had to choose whether to use Method 1 or Method 2. In Method 1 the fee is 25 points, while the cost of Method 2 is 5 points. If the participants choose Method 1, then the returns that the participants receive at the beginning of the period are small but increase in subsequent periods, while for Method 2 it is the opposite. The period is denoted as the stage, and five rounds are considered as five periods. The returns from Method 1 are now 5, 7, 10, 15, and 30, respectively, while for Method 2 they are 15, 10, 5, 5, and 0, respectively. However, in this stage, the participants are introduced to the treatment of fines/taxation, and the participants are the object of random audits conducted by computer. The probability of being exposed to audit is 25 percent. If the participants who are exposed to audit are found to have chosen Method 2, they are subjected to fines/taxes for environmental damage. The fines/taxes that apply are progressive in line with the round, hence, in rounds 1-5 the fines/taxes are 30, 30, 40, 45, and 50, respectively. In this section, the randomization is automatically performed by computer program. Participants who are randomly audited that they burned the forest, they will be taxed. The participants' points are calculated using the formula ((Endowment - Cost) – Taxes) + Return.

Stage 4: Subsidies and Taxes (Mixed)

The participants are given an endowment of 50 points in each round. With the endowment, the participants have to choose whether to use Method 1 or Method 2. In Method 1 the fee is 25 points, while the cost of Method 2 is 5 points. If the participants choose Method 1, then the returns that the participants receive at the beginning of the period are small but increase in the next period, while the second method is the opposite. The period is denoted as the stage, five rounds are considered as five periods. The returns in Method 1 are now 5, 7, 10, 15, 30, respectively, and for Method 2 they are 15, 10, 5, 5, and 0. However, in this stage, the participants are given the treatment of subsidies and penalties/tax. If the participants choose Method 1, the participants receive a subsidy of 10 points as a reward because the participants did not destroy the forest. In this stage, the participants are the object of random audits conducted by computer. The probability of being exposed to audit is 25 percent. If the participant exposed to audit chose Method 2, they are subject to fines/taxes for environmental damage. The fines/taxes that apply are progressive in line with the round, so, in round 1-5, the fines/taxes are 40, 40, 50, 60, and 70, respectively. In this section, the randomization is automatically performed by computer program. Participants who are randomly audited that they burned the forest, they will be taxed. The participants' point is calculated using the formula (Endowment - (Cost + Subsidies) – Tax) + Return.

ESTIMATION RESULTS AND DISCUSSION

Based on the type of work, this experiment was attended by 16 participants with civil servant status, and the rest with non-civil servant status. In general, an individual wants civil servant status due to the low level of risk, where the income received by a civil servant is not depend on his/her work. This is very different from the status of a job as an employee in a private company or as an entrepreneur. The job status as a civil servant with little risk is very likely to influence his or her decision to choose the investment activities with Method 1 or Method 2 in this game. In addition, the civil servant status indicates that the participant is a servant of the state, so he or she would be very likely to choose actions that are not detrimental to the state from the choices of actions available.

Following the distribution of the participants experiment based on the employment status, these research lab experiments were carried out using four scenarios, namely, (1) the baseline condition, (2) the provision of subsidies, (3) Pigou taxation, and (4) a combination of subsidies and taxes. The results of the game using each scenario are summarized below.

BASELINE

In the baseline condition, from as many as five rounds of the game, there were 41 participants (32.8 percent) who decided to choose the investment activity in Method 2, which is burning the land. While the remaining 84 (67.2 percent) chose the activity in Method 1, which is clearing. The more decisions to choose method 1 is likely due to the amount of the proportion of participants whose status was civil servant. **Table 1** below shows the significant testing for the decision of the preferred method based on the employment status.

Table 1. Option Investment Method Based on Job Status

Methods	Civil Servant	Non-Civil Servant	Z Test - the proportion of two-sample test
Method 1	50 (59.5 percent)	34 (40.1 percent)	1.74 (2.58) *
Method 2	30 (73.2 percent)	11 (26.8 percent)	2.97 (2.58) *

* Denote significantly at α = 5 percent

Since the test of the population proportion who chose Method 1 indicates that the value of Z count < Z table, it can be said that there is no difference in the population proportion of participants who chose method 1 based on their status as civil servant or non-civil servant. This suggests that the selection of the first method is not solely caused by the status of a civil servant who is a government agent. However, the opposite was found for the selection method 2, as the calculation of the Z value indicates that there is a significant difference between the population proportion that chose Method 2 between the participants' status as civil servant and non-civil servant. The proportion of the population who chose Method 2 mostly work as civil servants. This indicates that even though they are civil servants, many who considered the minimization of the investment costs lacked any concern about the environmental damage.

SUBSIDIES

The Pigou subsidy provision is expected to encourage the behavior of employers to choose Method 1. This is because the subsidy reduces the investment cost, considering that the investment cost for Method 1 is more expensive than that for Method 2. In this scenario, 101 participants (80.8 percent) chose Method 1, and only 24 (19.2 percent) chose Method 2. **Table 2** below shows the results of the significance test for population proportion that chose Method 1 and Method 2 in the baseline scenario and the scenario of subsidies provision.

Table 2. Changes in the proportion of the population as a response to the subsidies provision

Methods	Baseline	Subsidies	Z Test - the proportion of two sample tests
Method 1	84 (67.2 percent)	101 (80.8 percent)	3.24 (2.58)*
Method 2	41 (22.8 percent)	24 (19.2 percent)	0.96 (2.58)*

* Denote significantly at α = 5 percent

The results of the test above show that there are differences in the population proportion that chose Method 1 after the subsidy scenario is granted. This means that the subsidies will encourage more employers to choose Method 1, which is environmentally friendly.

TAXES/PIGOU TAXES

The Pigou tax is imposed on any employer who is found to select the investment method that is not environmentally friendly. To find out which employers choose Method 2, the government should conduct an audit. In this scenario, the audit process is done automatically by computer. If there are participants who are found to have chosen Method 2, they will be taxed with the higher amount than the cost of investment for Method 1. The audit levels are differently determined for each round. The results of the game with this scenario are as explained in **Table 3** below.

Table 3. Response to Pigou Taxes

Methods	Baseline	Taxes	Z Test - the proportion of two-sample test
Method 1	84 (67.2 percent)	92 (73.6 percent)	1.52 (2.58)*
Method 2	41 (22.8 percent)	33 (26.4 percent)	0.96 (2.58)*

* Denote significantly at α = 5 percent

A total of 92 decisions (73.6 percent) selected Method 1, and 33 decisions (26.4 percent) chose Method 2. From the calculation of Z, the Z value > the Z table is obtained, so we can say that there is no difference in the proportion of the population who chose Method 1 and Method 2 compared to the baseline scenario and the scenario with tax (audit). This is likely due to the possibility of not being audited so that employers still expect to perform maximum profit with Method 2. Hence, the choice of tax imposition, if audited, does not encourage entrepreneurs to choose an alternative method of investing that is more environmentally friendly.

SUBSIDIES AND TAXES (MIXED)

In this scenario, all the participants receive subsidies that aim to reduce the cost of investment for Method 1. But, on the other hand, despite the existence of subsidies that encourage employers to choose Method 1, it still requires the enforcement of the legislation so that no entrepreneurs invest using methods that can damage the environment. Thus, this stage is introduced as a scenario with a mixture of subsidization and taxation. The tests on the interchangeability of the population proportion in response to this treatment are in three ways, namely:

1. Comparing outcomes from the baseline scenario and the scenario of subsidies and tax provision (mixed)
2. Comparing outcomes from the scenario of subsidy provision and tax charging (mixed)
3. Comparing outcomes from the taxation scenarios and the scenario of subsidy provision and tax charging (mixed)

Table 4 below shows the results from the above scenarios.

Table 4. Comparison of Baseline and Mixed

Methods	Baseline	Taxes+ Subsidies	Z Test - the proportion of two sample tests
Method 1	84 (67.2 percent)	95 (76 percent)	2.58 (2.58)*
Method 2	41 (22.8 percent)	30 (24 percent)	0.96 (2.58)*

* Denote significantly at α = 5 percent

The results of the Z value test above show that there is no change in the proportion of the population using Method 1 or Method 2 between the baseline scenario, and the scenario of providing subsidies and charging taxes together. This is consistent with the findings from the outcome of the tax charging scenario. The possible insignificant subsidization and imposition of tax are due to the effects of taxation.

The outcomes of the subsidy provision scenario are similar to the outcomes of the provision of subsidies and taxation (mixed) scenario, which can be seen in **Table 5** and **Table 6** below.

Table 5. Comparison of Subsidies and Mixed

Methods	Subsidies	Taxes + Subsidies	Z Test - the proportion of two-sample test
Method 1	101 (80.8 percent)	95 (76 percent)	0.68 (2.58)*
Method 2	24 (19.2 percent)	30 (24 percent)	1.36 (2.58)*

* Denote significantly at α = 5 percent

Table 6. Comparison of Tax and Mixed

Methods	Taxes	Taxes + Subsidies	Z Test - the proportion of two-sample test
Method 1	92 (73.6 percent)	95 (76 percent)	0.60 (2.58)*
Method 2	33 (26.4 percent)	30 (24 percent)	0.61 (2.58)*

* Denote significantly at α = 5 percent

The outcomes of the scenario taxation and a mix of subsidization and taxation show that the Z calculated value < Z table value, providing a conclusion that there was no difference in the population proportion who chose Method 1 and Method 2 in the two scenarios.

CONCLUSION

The findings from this study show that there is no difference in behavior between the participants' status as civil servant and non-civil servant in the attitude towards land burning. This may be due to economic factors, such as the cost saving for land clearing, which is a major factor that affects an individual's decision to choose the method of land clearing.

Of the three treatments given, only subsidies providing treatments were able to reduce the number of participants choosing the method of clearing land by burning. These subsidies can be interpreted as a form of policy treatment. On the other hand, the application of subsidies and taxation for polluters does not significantly affect the number of participants who choose the manual land clearing methods. This may be due to the effects of taxing that may encourage individuals or companies to attempt moral hazard because of the possibility of undetectable unlawful conduct. This supports research that contends that the initiation of crime

prevention is more effective to anticipate the unlawful behaviors of individuals or companies than taking punitive actions.

Disclosure statement

No potential conflict of interest was reported by the authors.

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