Encouraging rainforest preservation by smallholders – an ex-ante policy evaluation

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1. **Introduction**

The high global demand for palm oil and its profitability has accelerated the transformation of rainforest into oil palm plantation in Indonesia (Wilcove and Koh, 2010). On the one hand, the increased production has led to a considerable improvement in the socio-economic conditions of smallholder farmers (Euler *et al.,* 2017; Rist *et al.,* 2010). On the other hand, the consequences in terms of greenhouse gas emissions and the loss of biodiversity are devastating (Gatto *et al.,* 2015; Laurance *et al.,* 2010; Wilcove and Koh, 2010). To reduce the ecological damage and maintain the economic benefits, sustainable palm oil (SPO) certification schemes by international and national agencies have been introduced[1]. Under these schemes, clearance of primary forests is not allowed (RSPO, 2013). However, these palm oil certification agencies have been criticized as a result of their slow response to transform the industry. In particular, enrolment rates of Indonesian smallholder farmers remain low even though they contribute to 40% of the entire oil palm production of Indonesia (Noor *et al.,* 2017; UNDP, 2014). Accordingly, deforestation by smallholders still occurs at a substantial magnitude (Euler *et al.,* 2016).

There are several reasons why smallholders continue to deforest and do not participate in SPO certification. First, profits from rainforest transformation often exceed the profits from certification resulting in prohibitively high opportunity costs of certification (Ruysschaert and Salles, 2014). Second, traditional customs enable smallholders to acquire rainforests for agricultural purposes from the community (Krishna *et al.,* 2017; Resosudarmo *et al.*, 2014). As a result, formal SPO requirements such as official land entitlements are not provided, denying the participation in SPO schemes. Moreover, rainforest transformation is socially acceptable as it improves the households' income (Brandi *et al.,* 2015; Lee *et al.,* 2011; Silva-Castaneda, 2012). To lower opportunity costs, certification agencies pay a price premium for sustainably produced palm oil. In light of low participation rates in certification schemes and high deforestation, the question remains whether the price premium effectively alters the behavior of participants in general and of the targeted smallholder farmers in particular.

While the price premium is already in place and well established, the importance of other policies to increase smallholders' participation have not yet been investigated. One promising approach is to increase the social acceptance of forest preservation. Social acceptance can be triggered either individually or through peer effects. One tool to alter behavior pro-environmentally on an individual level is to provide environmental information, provoking individuals to make a positive contribution to the environment (Steg and Vlek, 2009). Another tool is to use group norms to stimulate the desired behavior. Group members are more likely to follow a norm if the group signals unambiguously that a norm is desired (Steg et al., 2014).

Therefore, policies that aim to strengthen the social desirability of forest preservation also help to increase the participation rates in certification schemes. As the involvement of smallholders in certification schemes has the potential to preserve the rainforest while maintaining the economic benefits of palm oil production, it is critical to determine which policies effectively diminish rainforest clearance of smallholder farmers and stimulate their involvement with SPO certification agencies. We seek to close the research gap which policy measures effectively increase rainforest preservation of Indonesian smallholder farmers. To do so, we first analyze the widely used price premium on its potential to alter the behavior of Indonesian smallholder farmers towards rainforest preservation. Second, we evaluate if deforestation can be reduced by strengthening the social desirability of rainforest conservation. Finally, we assess which household and farm-specific characteristics influence the decision on deforestation.

An experimental approach is appropriate to evaluate policies *ex-ante (e.g.,* Hermann *et al.,* 2017, Moser and Musshoff, 2015). Besides, using a non-standard sample of real decision-makers increases the external validity of the experiment (Harrison and List, 2004). Therefore,

we conducted a social dilemma experiment with smallholder farmers in Jambi Province, Sumatra, Indonesia. The experiment assessed deforestation decisions of smallholder farmers and evaluated three different policies: price premium for certified palm oil, provision of environmental information and contributor recognition by a group. Instead of using convenience samples such as students, we involve smallholders as the real decision makers to test the effect of the policies. Moreover, we utilized realistic framing and incentivized experimental methods to ensure that the participants made rational decisions (Musshoff and Hirschauer, 2014). These two attempts are meant to enhance the external validity of the experiment (Harrison and List, 2004), and hence the results of the study will hold to the extent that can be implemented in other situations, such as in a real decision context. Jambi Province was chosen as it is one of many provinces in Indonesia where an oil palm boom has occurring. Gatto et al. (2015) found an indirect correlation between oil palm expansion and rainforest devastation, because the ongoing establishment of plantations takes place in deforested rainforest. This indicates that future policies to mitigate deforestation remain relevant for implementation.

In doing so, this is the first paper that links rainforest preservation policies to SPO certification using an experimental approach. Our findings are intended to assist policymakers and certification agencies to increase the participation of smallholders in the certification programs and hence, increase the production of sustainable palm oil production.

2. Development of Hypotheses

2.1. Price premium

The price of fresh fruit bunches (FFBs) of oil palm on farm gate fluctuates and results in uncertain farm incomes (Rist *et al.,* 2010). Due to the relatively higher costs of establishing and maintaining certified plantations, smallholders might not participate when a price premium is not offered. Even if compensation for sustainable farming practices is paid, the premium still needs to be high enough to cover additional costs and efforts of certification (Engel and Palmer, 2008; Wunder *et al.,* 2008). However, Ruysschaert and Salles (2014) found that the premium fee is often too low and thus, it is not appealing for smallholders to participate.

If the price premium is high enough to compensate for additional costs of certification, more smallholders will involve in certification programs. As the SPO agencies do not allow for primary rainforest transformation, it results in the decrease of deforestation. However, price incentives are not useful if smallholder farmers pursue other objectives, for example maintaining local farming traditions. We evaluate the effect price premium has on policy deforestation and formulate Hypothesis 1 as follows:

Hypothesis 1 "Price premium" *A price premium for certified palm oil decreases deforestation activities if it covers additional costs of certification.*

2.2. Environmental information

If basic strategies such as the provision of a price premium are insufficient or not possible, the provision of environmental information may engage individuals in pro-environmental behavior. The additional knowledge can change their attitude which results in an alteration of behavior (Maibach, 1993; Steg and Vlek, 2009). However, this mechanism does not always work. Individuals do not alter their behavior if the knowledge of the problem and the awareness of one's actions are not linked (Abrahamse *et al*., 2005; Bamberg and Möser, 2006). A good understanding of environmental issues and a strong commitment to preserving

the environment increases the likelihood that environmental information alters the behavior (Hines *et al*., 1986-1987). As a consequence, this policy measure is implemented merely in more developed countries because the environmental awareness tends to be higher in these countries (*e.g.,* Owens, 2000; Pikett-Baker and Ozaki, 2008).

Nevertheless, environmental information can also be successfully implemented in developing countries because the success of environmental information depends on many more factors such as values, local beliefs, personal opinions and the style of the environmental information (Arbuthnot, 1977; Corraliza and Berenguer, 2000; Pichert *et al.*, 2008; Price *et al.,* 2014). If environmental information fits local situations and is easy to understand, it tends to have a positive effect on behavior towards the environment. Therefore, we expect a positive effect of the provision of environmental information on rainforest conservation. Therefore, Hypothesis 2 can be formulated as follows:

Hypothesis 2 "Environmental information" *Environmental information which fits the local environmental circumstances increases rainforest preservation of smallholders*.

2.3. Contributor recognition

Engaging in pro-environmental activities is often motivated by normative reasons such as social approval. Using group or peer dynamics which stimulate social acceptance is a useful tool to encourage pro-environmental behavior (Andreoni and Petrie, 2004; Lacetera and Macis, 2010). When Andreoni and Petrie (2004) experimented to investigate the group effect of public goods contribution, they found that revealing each member's contribution increased the total contribution, although the magnitude of the effect was moderate. Samek and Sheremeta (2014) confirmed this finding. Therefore, we expect that the revelation of contributors to rainforest preservation has a positive effect on every member in the group. Accordingly, we formulate the Hypothesis 3 as follows:

Hypothesis 3 "Contributor recognition" *Contributor recognition increases rainforest conservation.*

3. Experimental Design

To test the hypotheses, a framed field experiment with smallholder farmers was carried out in Jambi Province, Indonesia. The experiment consisted of two parts. In the first part, we interviewed the smallholders to obtain household and farm-specific information. Simultaneously, we carried out a Holt and Laury task to elicit risk attitudes (HL-task; Holt and Laury, 2002). In the second part, we conducted a social dilemma experiment with a group of smallholder farmers to investigate the effect of policies on rainforest conservation. The survey and HL-task took place in the smallholders' residences. Afterward, they were invited to participate in the group experiment which took place in the village hall or the house of the village head. In the following, the HL-task and the experimental design of the social dilemma problem are described in detail.

3.1. Holt and Laury task

The HL-task is considered as the gold standard to elicit risk attitudes (Andersen *et al*., 2008). In the HL-task, there are ten series of paired lotteries (Holt and Laury, 2002; see Appendix A). Each series consists of two options: A and B. Each option has a high and a low lottery payoff. The high and low payoffs in option A are 4,000 Indonesian Rupiah (IDR) and 3,200 IDR, respectively, while the payoffs for option B are 7,600 IDR and 200 IDR, respectively. In

option A, the difference between the two gains is less compared to the difference between the two payoffs in option B. Thus, option A is called the 'safe option' and option B the 'risky option'. In each series the chance of gaining the high payoff increases by 10% starting with a 10% chance of winning the high payoff in series one.

For practical reasons, we adopted Ihli *et al*. (2016) to explain the task since they visualized the HL-task. Images of balls with four different colors inside two closed bags depicted the possible payoffs of the two options: red and yellow representing the high and low payoffs in the safe-option while green and blue the same for the risky-option. In each series, the proportions of colored balls change according to the probabilities (see Appendix A for an example of the questionnaire sheet; see Holt and Laury (2002) for complete instructions of the HL-task).

During the task, the smallholders wrote their answer for each series on a questionnaire sheet. We categorized smallholders' risk attitudes by the number of safe-option choices in the HL-task. Risk takers choose up to three, risk-neutral four, and the risk-averse more than five safe-options. To encourage sensible and realistic decisions of the HL-task, we informed the smallholders about the real payoffs (Hertwig and Ortman, 2001). The payoffs were not given cash, but in the form of a shopping voucher for groceries[2].

3.2. Social dilemma experiment design

To examine the effect of policies on deforestation actives, we carried out a social dilemma experiment. This type of experiment illustrates the conflict between short-term individual interests and long-term collective interests (Cardenas, 2016; Dawes, 1980; Steg *et al.,* 2014). Framing the experiment as a rainforest transformation problem makes it possible to analyze the major obstacle for smallholders to be certified. Deforestation is restricted on the principles and requirements for certifications[3], but smallholders still clear forests for agricultural purposes (Euler *et al.,* 2016; Krishna *et al.,* 2017).

We followed the negative framing design by Andreoni (1995). In Andreoni's design, the participants of the experiment are grouped. Within the group, each participant can make a private purchase or a group investment. Any decision determines the payoffs of all participants within the group. If one participant makes the private purchase, he/she increases his/her payoff but reduces the payoffs of all other participants in the group. If the participant makes the group investment, they reduce nothing from other participants' payoff within the group but receive less for themselves directly. This design of the experiment is appropriate to model the real conditions of rainforest deforestation for oil palm plantations. Rainforests are open access resources and transforming them into plantations generates individual benefits. Negative effects of rainforest exploitation regarding environmental damages are imposed on everybody in society and thus, make the society worse-off (Tietenberg and Lewis, 2012). In the experimental setting, each smallholder has 10 hectares of oil palm plantation called 'initial plantation.' These are located next to a rainforest which is reachable for three other smallholders in the vicinity. Each smallholder has the opportunity to either expand his/her plantation into the rainforest by up to 10 hectares (option A, private purchase) or preserve the rainforest (option B, group investment). Depending on the deforestation decision, the payoff of each smallholder (π_i) is determined by:

$$\pi_i = I + e_i p \; - \sum_{j \neq i} e_j p \frac{1}{2} + (10 - e_i) \frac{1}{2} p \qquad (1)$$

The payoff function consists of different terms and will be explained in the following:

1. The payoff from initial plantations
   Each hectare of the initial plantation generates 15,000 kilograms of FFBs. The price of FFBs per kilogram is 1,000 IDR (0.08 US$) (Euler *et al.,* 2015). Thus, the initial plantation generates 150 million IDR. This income is called 'initial income' (*I*).
2. Payoff from expansion
   If the smallholder decides to expand his/her plantation, each additional hectare (*e*) generates profit *p* with the value of five million IDR. The expansion generates less income as newly established oil palm plantations generate less yield.
3. Payoff-reduction from the expansion of others
   For every hectare of transformed rainforest, the smallholder reduces the payoff of every other member in the group by ½ *p*.
4. Return from forest kept
   The smallholder receives a 'return' for every hectare of kept rainforest. As the rainforest transformation may not exceed 10 hectares, the additional profits are given by $(10 - e)\ ½p$.

The experiment was repeated six times. After the completion of one round, all values were set back to the initial values. Each group consisted of four members but the group composition remained unknown to the participants. Decisions were made simultaneously. The payoff of each repetition was noted down in a sheet and given back to the participant. Similar to the HL-task, real payoffs were given to encourage sensible and realistic decision during the experiment (Hertwig and Ortman, 2001; the English translation of the instructions and the explanation about the incentive are provided in Appendix B).

3.3.The implementation of policies

To analyze the effects of policies on deforestation, we randomly assigned villages to four different policy treatments. The sampling process is explained in section 3.4. After three repetitions of the experiment, the following policies were introduced:

1. Control
   The experiment as described in section 3.2 was repeated over all six periods.
2. Policy 1 – price premium
   Feintrenie *et al.* (2010) state that 1,500 IDR (0.11 US$) is considered as 'good/high price' for FFBs per kilogram by local smallholders in Jambi Province. Therefore, certified palm oil receives a 50% markup raising price from 1,000 IDR to 1,500 IDR. This price was only paid if smallholders chose not to expand their plantations. The initial income for those who did not expand now yielded:
   10 ha x 15,000 kilogram FFBs x 1,500 IDR per kilogram FFBs = 225 million IDR
3. Policy 2 – environmental information
   To design the policy of environmental information, we provided two colored land use maps of Jambi Province in 1990 and 2010 (see Appendix C). On both maps, circles of areas with massive land use change from rainforest to oil palm plantations were drawn. However, no further information about negative effects of deforestation was given to avoid potential conflict during the experiment, because local smallholders consider rainforest for oil palm to support their financial conditions as genuine (Rist *et al.,* 2010).
4. Policy 3 – contributor recognition
   As already mentioned, the group composition remained unknown to the participants. To investigate the effect of each group, we revealed the members of the group. We only informed the groups' members while the amount of deforested area and payoffs of each member remained confidential.

3.4. Study region, sample selection, and descriptive statistics

The data collection was conducted in Jambi Province, Sumatra, Indonesia. Jambi province was a government's target area to increase rubber production since the 1920s (Fearnside, 1997). Accordingly, rubber was the main non-food crop which was cultivated over generations in Jambi Province (Gouyon *et al.*, 1993; Miyamoto, 2006). Moreover, similar to other provinces in Sumatra, Jambi was also a destination for the transmigration program. Together with the transmigration program, oil palm has been cultivated there. Within the last three decades, oil palm plantations have been quadrupled while rubber plantations have increased by 25%. Resulting from this, the number of rainforests has decreased. In 2013, 55% of the rainforest area was already converted into agricultural land (Drescher *et al.,* 2016; Gatto *et al.,* 2015).

We are focusing on regions where rainforest deforestations have massively and rapidly occurred. Two sites of lowland rainforest have been identified (Drescher *et al.,* 2016): Bukit Duabelas National Park and Harapan Rainforest. From those two sites, we selected five regencies[4], namely: Batanghari, Bungo, Muara Jambi, Sarolangun, and Tebo. Among those regencies, 40 villages were randomly selected. The number of participants per village varied based on the total number of smallholders in each village. In total 636 smallholders who manage oil palm, rubber, or both were selected. We included rubber smallholders because they are likely to switch to oil palm in the future. The literature reveals that a great number of rubber smallholders have converted into palm oil producers, and/or established oil palm plantations together with rubber (Gatto *et al.,* 2015; Rist *et al.,* 2010). The data collection lasted from October 2016 to January 2017.

Table I shows the descriptive statistics of household and farm-specific variables. Most of the participants are full time and middle-aged farmers. The majority are male farmers with an average of eight years of formal education, indicating that they have completed elementary school[5]. The average duration of rubber farming is much longer than oil palm farming. Around 8% of our sample farmers/participants know about SPO-certification programs. This number is low but not surprising. The literature also mentions that smallholders have insufficient knowledge about certification programs (Brandi *et al.,* 2015; Lee *et al.,* 2011; Silva-Castaneda, 2012).

Table 1. Descriptive statistics[a]

Variables	*Description (unit)*	*Mean / share (%)*[c]	*SD*[d]
Socio-demographic information			
Age	Age of smallholder (years)	46.58	10.47
Both-crops farmer	= 1, if smallholder manages rubber and then, palm oil	27.36 (%)	-
Dependents	Number of non-productive household members	2.26	1.407
Experiences oil palm	Duration of palm oil farming (years)	4.69	6.887
Experiences rubber	Duration of palm rubber (years)	15.49	10.76
Education	Formal education (years)	8.28	3.61
Full time smallholders	= 1, if ≥ of income generated by farming	86.48 (%)	-
Knowledge of certification	= 1, if smallholder knows SPO certification	8.49 (%)	-
Male smallholders	= 1, if smallholder is male	96.86 (%)	-
Oil palm smallholders	= 1, if smallholder only cultivate oil palm	13.52 (%)	-
Risk attitude[b]	Number of safe choice in Holt and Laury task	4.85	2.38
Economic information: assets, credit and saving			
Car	= 1, if smallholder owns a / some cars	12.11(%)	-
Loan	= 1, if smallholder owns loan within a year	52.98 (%)	-
Motorbike	= 1, if smallholder owns one / some motorbikes	98.43(%)	-
Saving	= 1, if smallholder owns saving within a year	33.96 (%)	-
Truck	= 1, if smallholder owns a / some trucks	2.36 (%)	-

Source: Field survey
Notes:
[a]N = 636 small-scale smallholders;
[b]Risk attitude variable indicating the number of safe-options in the HL–task: 1-3 risk-taker, 4 risk-neutral, 5-10 risk-averse
[c]The variables which are coded 1 / 0 is presented in percentage which indicates the share
[d]SD = Standard deviation

4. Approach to Data Analysis and results

4.1. Estimation method

Figure 1 depicts the average of oil palm expansion in round 1–6 for the control and the three policy groups. The dashed-vertical line in figure 1 indicates the moment when the policies are implemented. We expect that oil palm expansions in the first three rounds are not statistically significantly different between all groups. The p-value of the Kruskal Wallis rank sum test is 0.46. Hence, we fail to reject the Null hypothesis that there is a statistically significantly difference between all groups.

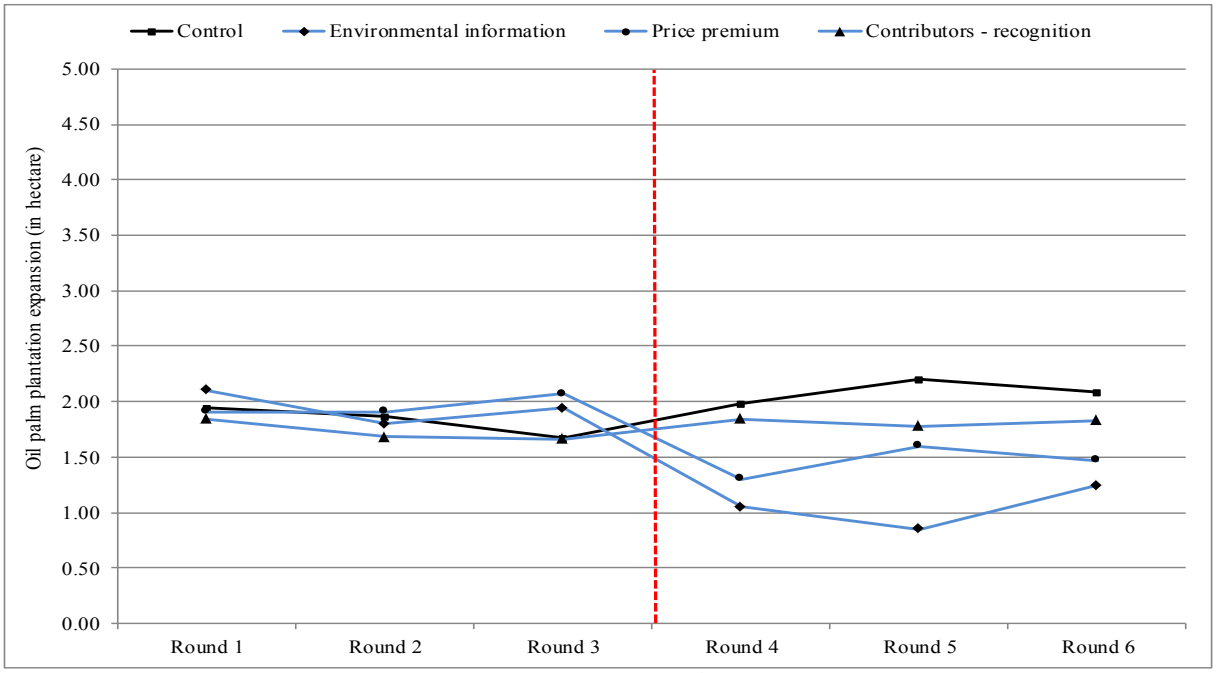
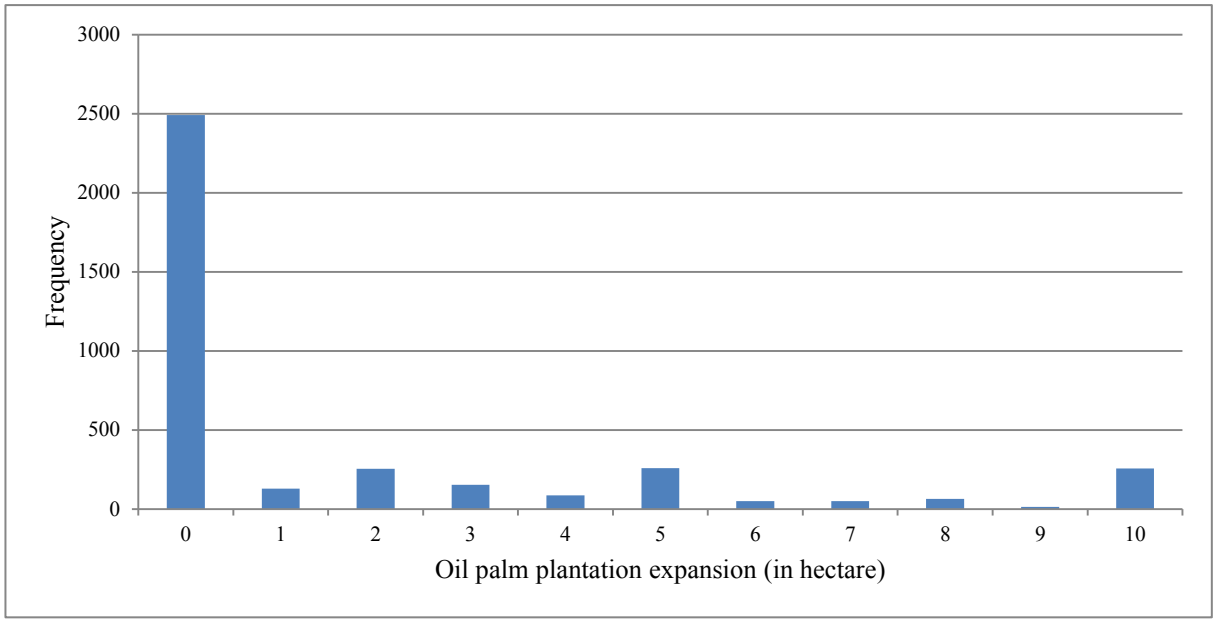


Figure 1: Oil palm expansion over experiment rounds[a]

[a]N = total sample = 636 which consist of 168 farmers for Control, 164 farmer for Environmental Information, 148 farmers for Price Premium and 156 farmers for Contributor recognition

To analyze the deforestation decision making, we set the dependent variable Y_{it}. This variable can take values from zero (no deforestation) to 10 (transformation of 10 ha rainforest). We use panel data estimation techniques as we have repeated *t* observations for all *i* participants. By the design of the experiment, the dependent variable is discrete and non-negative. Therefore, the use of count data models is appropriate. Considering Figure 2 which shows the distribution of oil palm expansion decisions and the fact that the standard deviation (2.98) exceeds the mean (0.13), an assumption can be made that the data set is negative binomial distributed (Cameron and Trivedi, 2010; Winkelmann, 2008).

Figure 2: Distribution of oil palm expansion[a]



[a]N = 3,816; 636 smallholder farmers, 6 observations each

To account for time-invariant explanatory variables, we estimate a negative binomial random effects panel model (NBREM) to investigate the effect of policies on deforestation. To account for overdispersion, we assume that $y_{it}|\lambda_{it} \sim Poisson(\lambda_{it})$, where $\lambda_{it}|\delta_i \sim \Gamma(\gamma_{it}, \delta_i)$. This yields the model:

$$Pr(Y_{it} = y_{it}|\boldsymbol{x}_{it}, \delta_i) = \frac{\Gamma(\gamma_{it} + y_{it})}{\Gamma(\gamma_{it})\Gamma(y_{it} + 1)} \left(\frac{\delta_i}{1 + \delta_i}\right)^{\lambda_{it}} \left(\frac{1}{1 + \delta_i}\right)^{y_{it}} \quad (2)$$

With $\gamma_{it} = \exp(\boldsymbol{x}_{it}\boldsymbol{\beta})$. $\boldsymbol{x}_{it}$ is a set of explanatory variables, $\boldsymbol{\beta}$ their coefficients and δ_i is the overdispersion parameter. To vary δ_i across groups, the assumption is needed that $\frac{\delta_i}{1+\delta_i} \sim \mathrm{B}(\mathrm{r}, \mathrm{s})$. Integrating over δ_i yields the joint probability for the i^{th} individual (Hausman *et al.*, 1984; Winkelmann, 2008).

$$\Pr(y_{i1}, y_{i2}, \ldots, y_{iT}|\mathbf{X}_i) = \frac{\Gamma(r+s)\Gamma(r + \sum_{t=1}^{T} \gamma_{it})\Gamma(s + \sum_{t=1}^{T} y_{it})}{\Gamma(r)\Gamma(s)\Gamma(r + s + \sum_{t=1}^{T} \gamma_{it} + \sum_{t=1}^{T} y_{it})} \prod_{t=1}^{T} \frac{\Gamma(\gamma_{it} + y_{it})}{\Gamma(\gamma_{it})\Gamma(y_{it} + 1)} \quad (3)$$

We use STATA 14 to estimate the NBREMs.

4.2. Hypothesis testing

To test our hypotheses, we estimate two NBREMs; the results are presented in Table II. Column (1) controls only for the policy treatment dummies. Column (2) adds household and farm-specific characteristics. Column (3) shows the regression results of a linear random effects model with clustered standard errors at the individual level. The last two columns serve as robustness checks.

Concerning our hypotheses all three models provide similar findings: price premium and environmental information are statistically significantly different from zero with a negative sign[6].

Table 2. Regression results of the negative binomial random effects panel models[a]

Variables	*(1) Coefficient (NBREM without control variables)[b]*	*(2) Coefficient (NBREM with control variables)*	*(3) Coefficient (Linear random effects model)*
Policies			
Price premium (1/0)	-0.73 (0.21)***	-0.83 (0.21)***	-0.73 (0.33)**
Environmental information (1/0)	-0.67 (0.21)***	-0.78 (0.22)***	-1.13 (0.28)***
Contributor – recognition (1/0)	0.09 (0.21)	0.03 (0.21)	-0.45 (0.31)
Socio-demographic information			
Age (years)	-	0.00 (0.01)	0.01 (0.01)
Both-crops farmers	-	-0.06 (0.32)	0.30 (034)
Dependents (number)	-	0.07 (0.06)	0.11 (0.07)
Experiences oil palm (years)	-	0.02 (0.02)	0.00 (0.02)
Experiences rubber (years)	-	0.01 (0.01)	-0.01 (0.01)
Education (years)	-	-0.02 /0.03)	0.02 (0.03)
Full time smallholders (1/ 0)	-	-0.03 (0.25)	0.07 (0.30)
Knowledge of certification (1/ 0)	-	-0.40 (0.30)	-0.07 (0.40)
Male smallholders (1/ 0)	-	-0.85 (0.42)**	-1.26 (0.68)*
Oil palm smallholders (1/ 0)	-	-0.17 (0.36)	-0.47 (0.42)
Risk attitude[c]	-	-0.11 (0.03)***	-0.09 (0.04)**
Economic information: assets, credit and saving			
Car (1/0)	-	0.37 (0.25)	0.37 (0.35)
Loan (1/0)	-	-0.17 (0.16)	-0.02 (0.18)
Motorbike (1/0)	-	-1.08 (0.66)	0.55 (0.50)
Saving (1/0)	-	-0.30 (0.17)*	-0.20(0.22)
Truck (1/0)	-	0.23 (0.51)	0.79 (0.76)
Constant	0.49 (0.17)***	2.85 (0.93)***	2.63 (0.98)***

Notes:
[a]N = 1,908; 636 smallholder farmers, treatment rounds only: 3 observations each
[b]Significance level ***p < 0.01; ** p < 0.05; * p < 0.10
[c]Risk attitude variable indicating the number of safe-options in the HL–task: 1-3 = risk-taker; 4 = risk-neutral; 5-6 = risk-averse

In comparison to the control group, the coefficient for Policy 1 (price premium on certified palm oil) is statistically significantly different from zero at least at the 5% level and has a negative sign on all three models. In our design of the experiment, smallholders only get the price premium on their yield from the initial plantations if they choose not to deforest. The price premium was set to 1,500 IDR/kg of FFB because this price is considered to be fair (Feintrenie *et al.,* 2010).

The certification agencies widely use price premiums as an instrument in their scheme. In Indonesia, the price per kilogram of bunches of fresh fruit is determined weekly, based on a meeting with Dinas Perkebunan (a plantation agency), operating under the Ministry of Agriculture. The price of certified palm oil is not regulated, and hence gives room for companies to freely determine the price of certified palm oil. The price does not often cover additional costs for certification (Hidayat et al., 2015). Our results show that if a fair price premium is given, smallholders will reduce their deforestation activities. In the context of participation in SPO schemes, this finding confirms results of other studies. If certified palm oil provides higher profits than the expected additional income from the newly developed plantation, then producers would stop transforming rainforest areas (Bateman *et al.,* 2010; Corley and Tinker, 2016; Hidayat *et al.,* 2015; Schouten and Glasbergen, 2011). Accordingly, we confirm hypothesis 1 that a price premium on certified palm oil which is considered to be fair has a positive effect on rainforest conservation and therefore on participation rates of smallholder farmers.

In all three regression models, the effect of the second policy (environmental information) is statistically significantly different from zero at the 1% level with a negative sign. The result indicates that the implementation of the second policy mitigates and/or eliminates deforestation. It confirms the finding from the literature that environmental information promotes environmentally friendly behavior (Kollmuss and Agyeman, 2002; Steg and Vlek, 2009). This finding also provides an insight that the depiction of land-use change by maps of Jambi Province is well understood by farmers. Otherwise, it is very unlikely that the provision of additional knowledge would lead to a decrease in deforestation activities. Therefore, we can conclude that environmental information has a curtailing effect on smallholders' decisions over rainforest deforestations. As rainforest deforestation is the main obstacle for smallholders' compliance, the policy might successfully increase smallholders' participation in certification programs. Hence, hypothesis two is supported.

The regression results indicate that the coefficient for the third policy (contributor recognition) is not statistically significantly different from zero. This finding is opposite to previous results of Andreoni and Petrie (2004) and Samek and Sheremeta (2014). One explanation is that smallholders have improved their income through high demand for palm oil, and rainforest clearance for oil palm plantations is therefore socially acceptable (Krishna *et al.,* 2017; Resosudarmo *et al.*, 2014 and Rist *et al.,* 2010). Consequently, we cannot support hypothesis three. Hence, recognition of contributors may not be effective in raising participation rates in certification programs. From this finding, we obtain the insight that there is no social approval for rainforest conservation. Furthermore, contributions to forest conservation neither create a spill-over effect nor reinforce normative reasons for environmentally friendly behavior. Our finding shows that rainforest transformation for palm oil production is socially accepted and not punished.

To test the robustness of our experimental results and to analyze other determinants of deforestation, further household, and farm-specific variables were added in Column (2) and (3) of Table II. First, we find that gender matters in the decisions of rainforest deforestation. The dummy for male smallholders is statistically significantly different from zero with a

negative sign. At first sight, this result is counterintuitive as most literature shows that women tend to have higher environmental conciseness (Arcury and Christianson, 1990; Stern *et al.,* 1995; Zelezny *et al.,* 2000). However, Villamor *et al.* (2014) found that women in the Jambi Province are more concerned to make individual profits and would convert natural forest into monoculture farming such as rubber and oil palm much faster than men. Therefore, it is plausible that women in the experiment tend to create oil palm plantation at the cost of rainforests earlier than men.

Second, we found that risk attitude also matters in the decision of deforestation. Risk attitude often influences the choice of preserving the environment (Claassen *et al.,* 2008). In our regression, risk attitude is statistically significantly different from zero with a negative sign, indicating that more risk-averse smallholders deforest less. Starting new farming such as establishing oil palm plantations is considered as a risky step as it consists of uncertainties. According to Djanibekov and Villamor (2017), Sumatran smallholders are very concerned about the uncertainty of future land use returns and would, therefore, opt not to deforest and stick to the safe returns from the initial plantation.

Using two different estimation techniques in column (2) and (3) of Table II provided similar results. The signs of the statistically significant coefficients do not change. This underlines the robustness of the results in column (2). However, the coefficient for savings in column (3) drops out of the 10% significance level. Therefore, we do not draw any conclusion on this variable.

5. Conclusion

The SPO-certification program has been established to mitigate the environmental damages due to rainforest deforestation for oil palm production. However, these programs have been criticized for being unattractive to smallholder farmers. Involving smallholder farmers in the certification program is essentialbecause smallholders generate 40% of Indonesia's palm oil production. This paper analyzes three different policies which tackle deforestation – the major obstacles to getting into a certification program. We investigated price premium for SPO, the provision of environmental information, and contributor's recognition on their potential to engage in pro-environmental behavior which are already in place and which have been proposed in the literature in other contexts.

First, we found that the fair price premium successfully mitigates the rainforest deforestation. This first finding implies that if the policy of price premium is well implemented then, more smallholders will subscribe to an SPO scheme. Second, we found that providing additional knowledge on environmental conditions has a positive effect on the decision behavior of the smallholder farmers on forest conservation. An experimental approach, a method that we used to examine the effects of the policies, has the benefit of the extension of external validity. Hence, the findings of our study might be transferred into real-world policy implementation, by governmental and certification agencies, in three ways: (1) The government of Indonesia and certification agencies should evaluate the current price premiums for certified palm oil, (2) SPO agencies should take the provision of local/explicit environmental information into account when campaigning for their cause, (3) the SPO agencies should be aware that many smallholders need to be addressed as multiplier effects of participants cannot be assumed.

The results of our research are country specific to Indonesia and are specific to local beliefs and needs. Therefore, the results might differ in other countries. In our case, group effects do not alter the behavior of participants. Nevertheless, a combination of providing environmental information which raises the awareness of environmental damages and making individual decisions explicit in the group could be very useful and generate spill-over effects.

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Appendix

During the data collection, we hired five enumerators who spoke the local language and received training to be able to conduct the experiment. In the following, we present the English translation of the instructions for the HL-task in part A and the social dilemma experiment in part B.

A. HOLT AND LAURY TASK

A.1. Experimental design

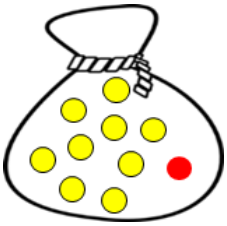
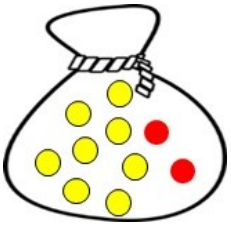
The instructions that were provided for the farmers are:

"There are two bags: bag A and bag B. Inside the bags are 10 colored-balls. The colors of the balls in bag A are: red and yellow. The colors of the balls in Bag B are: blue and green. Each color indicates a monetary value:

- ✓ *(Bag A) Red: 4,000 IDR*
- ✓ *(Bag A) Yellow: 3,200 IDR*
- ✓ *(Bag B) Green: 7,600 IDR*
- ✓ *(Bag B)Blue: 200 IDR*

In this task, there are 10 paired series with different payoffs. In every round, you have to choose between bag A and bag B. Depending on your choice, one ball will be drawn randomly from your chosen bag. This will be your payoff. In series one, Bag A contains one red ball and nine yellow balls, while bag B contains one green ball and nine blue balls. In series two, Bag A contains two red balls and eight yellow balls, while bag B contains two green balls and eight blue balls. This continues on until series 10, according to Table A.1. Please write down your answer on the questionnaire sheet stating whether you prefer bag A or bag B."

Table A.1. Holt and Laury task*

	Bag A	***Option (A or B)***	***Bag B***
1		……	
	1 red ball, 9 yellow balls		1 green ball, 9 blue balls
2		……	
	2 red balls, 8 yellow balls		2 green balls, 8 blue balls

*due to page limitation, we only present the combination 1 and 2. However in the task, we show the smallholders combination 1 – 10

A.2. Incentive for HL-Task

"At the end of the experiment, we will give you a shopping voucher for groceries. The amount of the voucher will be determined as follows:

a. *Please draw one coin of the first bag. Inside the bag are 10 coins which are numbered from 1-10. Please draw one. This will be the number of the series.*
b. *On the selected series, you will get either bag A or bag B depending on your choice as written down in the questionnaire sheet before.*
   Example: You draw coin number three. In your questionnaire sheet, you have selected bag A. Therefore you will draw a second time from Bag A. This bag has three red and seven yellow balls.
c. *From the bag, you draw one ball. The value of your shopping voucher depends on the color of the ball you have drawn.*
   Example: You took red ball, thus your incentive is 4,000 IDR."

Tools needed for the HL-task: questionnaire sheet; red, yellow, green, and blue balls; three Bags; 10 coins numbered 1 – 10. The payoff table of the HL-task which was not provided to the smallholders:

Table A2. Matrix payoff of HL-task

Series	*Option A*	*Option B*	*Expected Payoff A*	*Expected Payoff B*	*Difference of expected payoff*
1	10% gain of 4,000IDR or 90% gain of 3,200IDR	10% gain of 7,600IDR or 90% gain of 200IDR	3,280 IDR	940 IDR	2,340 IDR
2	20% gain of 4,000IDR or 80% gain of 3,200IDR	20% gain of 7,600IDR or 80% gain of 200IDR	3,360 IDR	1,680 IDR	1,680 IDR
3	30% gain of 4,000IDR or 70% gain of 3,200IDR	30% gain of 7,600IDR or 70% gain of 200IDR	3,440 IDR	2,420 IDR	1,020 IDR
4	40% gain of 4,000IDR or 60% gain of 3,200IDR	40% gain of 7,600IDR or 60% gain of 200IDR	3,520 IDR	3,160 IDR	p360 IDR
5	50% gain of 4,000IDR or 50% gain of 3,200IDR	50% gain of 7,600IDR or 50% gain of 200IDR	3,600 IDR	3,900 IDR	-300 IDR
6	60% gain of 4,000IDR or 40% gain of 3,200IDR	60% gain of 7,600IDR or 40% gain of 200IDR	3,680 IDR	4,640 IDR	-960 IDR
7	70% gain of 4,000IDR or 30% gain of 3,200IDR	70% gain of 7,600IDR or 30% gain of 200IDR	3,760 IDR	5,380 IDR	-1,620 IDR
8	80% gain of 4,000IDR or 20% gain of 3,200IDR	80% gain of 7,600IDR or 20% gain of 200IDR	3,840 IDR	6,120 IDR	-2,280 IDR
9	90% gain of 4,000IDR or 10% gain of 3,200IDR	90% gain of 7,600IDR or 10% gain of 200IDR	3,920IDR	6,860 IDR	-2,940 IDR
10	100% gain of 4,000IDR or 0% gain of 3,200IDR	100% gain of 7,600IDR or 0% gain of 200IDR	4,000 IDR	7,600 IDR	-3,600 IDR

B. THE EXPERIMENT OF SOCIAL DILEMMA

The social dilemma experiment took place in the head of the village house or village hall. On average, the experiment lasted between one to two hours.

B.1. General Instruction

"Thank you for your participation in this experiment. This is a study of individual decision making regarding palm oil plantation expansion. In this experiment, there will be six rounds of decision making.

At the end of the experiment you can earn a grocery shopping voucher according to your performance in the experiment. Soon, we will distribute a questionnaire sheet where you can write down your answer. Now we will provide instructions for the experiment.

1. ***You are a member of a group***

   You will be placed in a group with three other people. In total, there are four members in one group. These remain the same until the end of the experiment. The members of the groups are confidential and you are not allowed to discuss with other participants.

2. ***Your initial oil palm plantations and income***

   Imagine that you own 10 ha of productive oil palm plantations. We call these 'initial plantations'. Your initial plantations are located near a forest. These plantations yield 15,000 kg of fresh fruit bunches (FFBs) per ha per year and hectare. Suppose that the price of FFBs per kg is 1,000 IDR. The income of the initial plantations is 10 x 15,000 kg x 1,000 IDR /kg = 150 million IDR per year. We call this income the 'initial income'.

3. ***Opportunity to expand the initial oil palm plantations***

   There will be 6 rounds of decision making. These six rounds are equal to six years of individual decision making regarding palm oil plantation expansion. Every year, you receive an opportunity to decide whether you want to expand your 'initial plantations' by cutting down the forest close to your plantations or leave the nearby forest untouched. You can expand 1,2,…, 10 hectares. Every hectare of expansion generates additional profit for you. Let us call this profit 'p'. In Indonesian currency, p is five million IDR. If you decide to expand by one hectare, your additional profit is 1p; two hectares of expansion generate 2p; and finally, 10 hectares of expansion generate 10p. However, for every hectare of expansion, you reduce the income of the other members in your group by ½p per hectare of expansion.

   Example: You expand by six hectares. You will get additional profit = 6 x p = 6 x 5 million IDR = 30 million IDR. From this expansion, the income of each of the three other members in your group is reduced by 6 x ½p = 6 x 2.5 million IDR = 15 million IDR.
   This works also the other way around: if the other members in your group decide to expand, they will reduce your income by ½p per hectare of expansion.

   Example: One other member in your group expands by four hectares. Then he/she will get an additional profit of 4 x p = 4 x 5 million IDR = 20 million IDR. However, it will reduce your income and that of the other members by = 4 x ½p = 4 x 2.5 million IDR = 10 million IDR.

4. ***Return from the forest kept***

   Every year, you have an opportunity to expand up to 10 hectares, but if you decide to expand less than 10 hectares, you will receive 'return' from the forest that you kept. We called this 'return from forest kept'. The value of this 'return' is equal to ½p. The other members in your group are not affected by your decisions of keeping the forest.
   Example: If you expand 6 hectares, it means you keep 10 – 6 = 4 hectares of forest. Your 'return from forest kept' is = 4 x ½p = 4 x 2.5 million IDR = 10 million IDR.
   Example: If you expand 0 hectare, it means you keep the forest = 10 – 0 = 10 hectares. Your return from forest kept is = 10 x ½p = 10 x 2.5 million IDR = 25 million IDR.

5. ***Calculation of income***

   Annual income = initial income (150 million IDR) + additional profit from expansion + return from forest kept – loss from other members expansion

6. ***Writing down your decision***

   You can write down your decision in the questionnaire sheet. If you decide to expand, you have to circle option A. Then, write down how many hectares of you want to expand: 1,2,… or 10 hectares. If you decide not to expand zero, you circle B. If we are in round 1, write down your decision in 'Year 1'. If you are in round two, write it down in 'Year 2'. After each round, we will collect the questionnaire sheet to calculate your income. Afterwards we will give back your questionnaire and you can continue to the next round.

Name: ……
<u>Year 1</u>
Option A = ... ha. Your income Year 1 = ……IDR
Option B = 0 ha. Your income Year 1 = ……IDR
<u>Year 2</u>
Option A = ... ha. Your income Year 2 = ……IDR
Option B = 0 ha. Your income Year 2 = ……IDR
<u>Year 3</u>
Option A = ... ha. Your income Year 3 = ……IDR
Option B = 0 ha. Your income Year 3 = ……IDR

Your decisions and annual income are confidential. You are not allowed to announce your decisions nor discuss them with other participants. First, we will make three rounds. After round three, we will have a short break where we will provide additional instruction. Then we proceed to round four, five and, six.

7. ***Payoffs for the social dilemma experiment***

   The incentives are determined in the following way:
   a. *We select randomly one participant per village.*
   b. *We provide a bag with six numbered coins which represent the rounds of the experiment. Afterwards, the selected participant randomly draws one coin. The coin indicates the selected round of the experiment.*
   c. *Third, the payoff of the selected round is divided by a thousand and paid out. For example, if the payoff in the experiment is 175 million IDR, the selected person receives 175,000 IDR (14 US$)."*

B.2. Instruction for policies implementation

In round 4 – 6, we implemented the policies. Four types of instructions were provided:

1. ***Instructions for control villages***

   In the control-village, the instructions for round 4 – 6 are the same than before. Therefore, we only give instruction to the smallholder to continue the experiment with the same rule.

   "Thank you for your participation in the first three rounds of the experiment. Now we would like to invite you to proceed to round 4, 5 and 6. The rules remain same."

2. ***Instructions for Policy 1 villages (Price premium)***

"Thank you for your participation in the first three rounds of the experiment. Before we proceed to round 4, 5 and 6, we would like to inform you that there is one changing in the rule.
The price of FFBs per kg was 1,000 IDR, which generated your initial income of 150 million IDR. This price was given to those who decided to expand (choose option A) and those who decided not to (choose option B).
Now, we apply a new rule. For those who decide not to expand (choose option B), the price per kilogram FFBs is changed to 1,500 IDR. The other rules remain the same."

3. ***Instructions for Policy 2 villages (Environmental information)***

"Thank you for your participation in the first three rounds of the experiment. Before we proceed to round four, five and six, we will distribute two land use maps of Jambi Province. The first map depicts Jambi Province in the year 1990, the second Jambi Province in the year 2010. Primary forest is colored dark green, secondary forest light green and oil palm plantations purple. We have marked land use transformation among primary forest, secondary forest and oil palm plantations by circles. We can see on the map that areas which were previously primary forest are transformed into secondary forest and secondary forest was transformed into palm oil plantations.
Now we would like to invite you to proceed to round four, five and six. The rules remain the same."

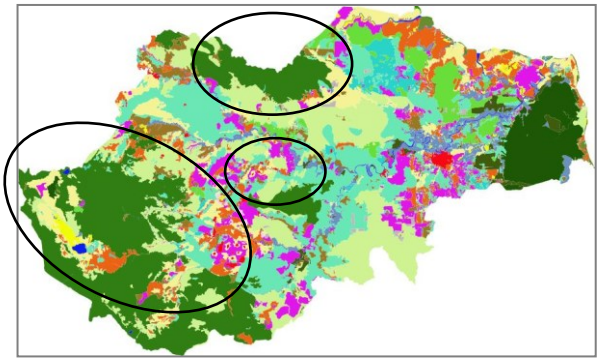


Figure A-2. Jambi land use the Year 1990

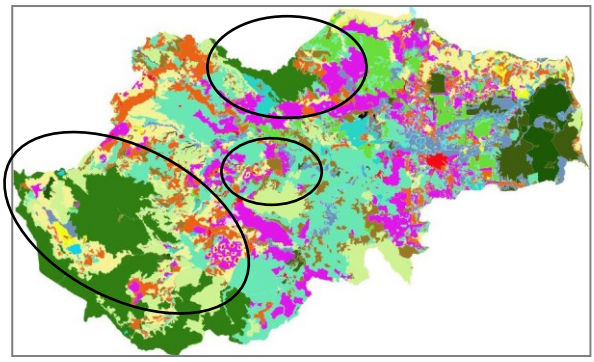


Figure A-2. Jambi land use the Year 2010

4. ***Instructions for Policy 3 villages (Contributor Recognition)***

"Thank you for your participation in the first three rounds of the experiment. In the first three rounds, the members of the groups were confidential. Now we would like to inform all participants who are in each group.
'In group one, the members of the group are: ..., ..., ..., ... In group two, the members of the group are: ..., ..., ..., ...' (and so on).
Although you know the members of your group, the experiment is still an individual task. You are not allowed to discuss with other participants.
Now we would like to invite you to proceed to round 4, 5 and 6 where the offer of the palm oil plantation expansion and the rules remain same."

ENDNOTES

[1] Indonesian Sustainable Palm Oil (ISPO); International Sustainability and Carbon Certification (ISCC); Palm Oil Innovation Group (POIG); Rainforest Alliance (RA)/Sustainable Agriculture Network (SAN); Roundtable on Sustainable Biomaterials (RSB); Roundtable on Sustainable Palm Oil (RSPO); Sustainable Palm Oil Manifesto (SPOM) have SPO certification schemes.

[2] Cash payoffs are associated with bribery in this area.

[3] The seven principles of ISPO include legal plantation business permits; plantation management; protection of primary forest and peatland; environmental management and monitoring; responsibility to workers; social responsibility and community economic empowerment; continuous business improvement. The eight principles of RSPO include: commitment on transparency; compliance with applicable existing laws and regulations; commitment to long term economic and financial viability; use of appropriate best practice by plantation and mills; environment responsibility and conservation of natural resources and biodiversity; responsible consideration of employees and of individuals and communities affected by growers and mills; responsible development of new plantings; commitment to continuous improvement in key areas of activity (Ministry of Agriculture of the Republic of Indonesia, 2015).

[4] In Indonesia, regencies are administrative subdivisions which are one level below the provinces.

[5] In Indonesia elementary school lasts for six years of formal schooling.

[6] Taking the learning effects into account, we also tested for round fixed effects. We found that round fixed effects are not statistically significant. The inclusion of round fixed effects in the regression does not change the outcome of our regression results.