Risk attitude and discount rate: crucial factors for planting oil palms by smallholders?

Arieska Sarwosri

Department of Agricultural Economics and Rural Development,
Georg-August-Universität Göttingen

Selected paper presented at the
63rd AARES Annual Conference at Melbourne, Vic from 12-15 February 2019

This paper has been independently reviewed and is published by
The Australasian Agricultural and Resource Economics Society Ltd
on the AgEcon Search website at http://ageconsearch.umn.edu/
University of Minnesota, 1994 Buford Ave
St. Paul MN 55108-6040, USA

Published 2018

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Abstract

Even though oil palm is not a native cash crop in Indonesia, the cultivation of oil palm is rapidly developed by smallholder farmers. This study examines if the adoption of oil palm is reasoned in underlying economic preferences. We utilized an incentivized field experiment to elicit smallholders' risk attitude and discount rate and estimated both preferences jointly. The field experiments included 636 smallholders from Sumatra Island, Indonesia. We compared the risk attitude and discount rate of the oil palm adopters to non-adopters, *i.e.*, rubber smallholders which is the main alternative cash crop of oil palm. We found that adopters are more risk-averse compared to non-adopters. Furthermore, the finding also confirms that risk-averse farmers diversify cultivated crops to mitigate income risks from agriculture. However, we do not find statistically significant differences in the discount rates between the two groups.

Keywords: discount rate, oil palm, portfolio effect, risk attitude, rubber, smallholders' crop selection

1. INTRODUCTION

A number of studies investigated determinant factors of oil palm adoption by smallholders using field survey. Euler *et al.*, (2017) found that different labor requirement is one reason for a household with small member to cultivate oil palm instead rubber, which is the main alternative crop in Indonesia. Furthermore, government policies also accelerate the adoption by minimizing entry barriers including transmigration program and the establishment of oil palm schemes (Feintrenie and Levang, 2009; Hidayat *et al.*, 2015; Rist *et al.*, 2010)[1].

Similar to other decision makers, the smallholders make the decisions under uncertain conditions and hence, their risk-attitude influences the choices. Literature provides the investigation to examine correlations and/or causal relations between decision makers' risk-attitude and adoption of new technology or selection of cash crops (Feder, 1980; Holden and Quiggin, 2017; Ngwira *et al.*, 2013). Moreover, discussions of farmers' discount rate also take part while farmers deal with perennial crops due to the long gap between planting and harvesting (Sauter and Mußhoff, 2018). However, the existing literature investigating oil palm

[1] The schemes are named "nucleus estate and smallholders" (NES) and "Koperasi Kredit Primer untuk Anggota" (KKPA; McCarthy and Cramb, 2009)

adoption by smallholders leaves the discussion of smallholders' risk attitude and discount rate (Clough *et al.*, 2016; Euler *et al.*, 2017; Feintrenie and Levang, 2009; Schwarze *et al.*, 2015).

Thus, this paper aims to investigate the influence of risk attitude and discount rate of smallholders on their crop selection. We examine risk attitude and discount rate of oil palm adopters and non-adopters. Adopters are smallholders who initially cultivated rubber and later planting oil palm (*N* = 199), and since these smallholders cultivate two crops, we call them double-crop smallholders. Non-adopters are smallholders who exclusively cultivate rubber (*N* = 437). In this way, we can compare the results and explain whether the smallholders' risk attitude and discount rate are crucial factors for the adoption. We conducted the study in Jambi Province, Sumatra. This location has a long history of rubber cultivation, in which rubber was broadly cultivated and became family businesses through generations (Feintrenie and Levang, 2009). Although rubber is the cultural cash crop and remains the main cash crop in Jambi, the adoption of oil palm has rapidly occurred (Gatto *et al.*, 2015). Besides, the decision to cultivate both crops demonstrates farmers' effort in mitigating income risk using crop diversification (Heady, 1952). Moreover, poverty may promote smallholder to diversify crops using a plant which has shorter waiting-time for returns (Lawrance, 1991). Therefore, this study is also motivated to examine a relation among crop diversification, farmers' risk attitude and discount rate.

The risk attitude and discount rate are often elicited using a laboratory experiment, where students play roles as real decision makers (Wang *et al.*, 2016). However, to mitigate the disadvantages of laboratory experiment such as too abstract decision situations, we carried out field experiment which involved the group of interest, *i.e.*, smallholders farmers (Levitt and List, 2009; Harrison and List, 2004). To estimate the risk attitude and discount rate, we conducted incentivized experiment of Holt and Laury (HL-task) to elicit the risk attitude, and experiment of Coller and William (CW-task) to measure the discount rate (Holt and Laury, 2002; Coller and Williams, 1999). The HL-task and CW-task have been used in many studies involving rural people and smallholders particularly (Holden and Quiggin, 2017; Ihli *et al.*, 2016; Tanaka *et al.*, 2010). The experiments were incentivized to encourage sensible and realistic decisions during the experiment (Hertwig and Ortman, 2001). We followed Andersen *et al.* (2008) to estimate the risk attitude and discount rate simultaneously, so-called joint-estimation method.

Regarding the findings and the method used, the contribution of our study to the body of literature is twofold. First, this study explains oil palm adoption by smallholders using the investigation of risk attitude and discount rate. In doing so, this study enriches the existing literature examining the determinant factors of oil palm adoption by smallholders (Euler *et al.*, 2017; Feintrenie and Levang, 2009; Rist *et al.*, 2010). Moreover, even though literature investigates risk attitude and discount rate of Indonesian smallholders, this is the first study which utilizes the joint-estimation method (Clough *et al.*, 2016; Schwarze *et al.*, 2015; Skidmore *et al.*, 2014). Second, to the best of our knowledge, this study is the first study investigating relations of farmers' risk attitude, discount rate and crop diversification using Asian context backgrounds (Bezabih and Sarr, 2012; Chavas and Di Falco., 2012; Dercon, 1996).

2. DERIVATION OF HYPOTHESES

The productions of palm oil outnumber other plants per production area, and palm oil contributes to more than one-third of the world's vegetable oil production. Currently, Indonesia leads the productions and exports of palm oil (Carter *et al.*, 2007; Corley and Tinker, 2016; Wilove and Koh, 2010). In Indonesia, the target area of palm oil production was Sumatra Island and lately, also expanded to other islands such as Borneo and Papua (Casson and Obidzinski, 2002; Feintrenie and Levang, 2009). The government of Indonesia together with private companies initiated the establishment of oil palm plantations and factories (Euler *et al.*, 2016). Following them, smallholder farmers also cultivated oil palm. Even though oil palm was a relatively new cash crop, the adoptions of oil palm by smallholders occurred relatively rapid, and in a substantial number, *i.e.*, 40% of Indonesian palm oil production is from smallholders (Euler *et al.*, 2016).

Rubber crop has been introduced in Sumatra Island and Jambi, in particular, at the beginning of the 19th century and became the most important crop after several decades (Feintrenie and Levang, 2009). Broadly cultivated by sufficient numbers of household, rubber cultivation became family businesses which were inherited to the following generations. The earliest cultivation method of rubber is called rubber-agroforest, in which rubber is cultivated together with other cash and non-cash crops (Rembold *et al.*, 2017). Gradually, rubber monocultures were established replacing the rubber-agroforest (Feintrenie and Levang, 2009). Started in the 1980s, the transmigration reshaped land use in Jambi province. The farmlands were cultivated more intensively, and new cash crop was introduced, *i.e.*, oil palm (Gatto *et al.*, 2015). To establish the oil palm plantations, large scales of rainforest were transformed, and a considerable amount of rubber plantations were converted (Drescher *et al.*, 2016; Gatto *et al.*, 2017).

2.1. Discount rate of the smallholders

Per hectare of rubber plantation generates more profits compared to oil palm plantation, *i.e.*, rubber plantation generates 26% higher profits (Rist *et al.*, 2010). However, rubber requires more labor incentives because rubber should be harvested daily (Drescher *et al.*, 2016). The high labor intensive may affect the household income in two possible mechanisms. First, it prevents the household members to participate in other economic activities, while palm oil harvesting is fortnightly, which enable the household members to do off-farms activities and generate additional incomes for the household (Euler *et al.*, 2017). Second, same size of rubber plantation needs more labors compared to oil palm plantation. Indeed, per head of labor working in oil palm plantation generates more returns (Feintrenie *et al.*, 2010; Rist *et al.*, 2010).

Regarding time, palm oil and rubber are different in two circumstances, waiting time for first harvest and the duration of productive years. Rubber has a longer production period, which is up to 30 – 35 years, while the average production period of oil palm tree is 25 years (Schwarze *et al.*, 2015; Woittiez *et al.*, 2017). Parallel to the optimum growth of trunk and leaves, the first harvest of palm oil starts on the 4^{th} year after planting, even though the tree generates bunches in its early year after planting (year 2 – 3) with low yield (Woittiez *et al.*, 2017). The first harvest of rubber is in the 7^{th} year after planting (Schwarze *et al.*, 2015). Therefore, palm oil is more beneficial for shorter waiting time of first harvest. However, oil palm plantation generates earlier income but the average returns to land on a full cycle of rubber plantation are higher (Feintrenie *et al.*, 2010). However, impatience smallholders might prefer to receive less profitable crop as long as the profits are given in earlier time (Coller and Williams, 1999). Therefore, the more impatient rubber smallholders are more likely to cultivate oil palm in addition to their existing rubber plantation rather than establish additional rubber plantations. Therefore, Hypothesis 2 can be formulated as ***Hypothesis 1.*** *The double-crops smallholders are more impatient compared to rubber smallholders*.

2.2. Risk attitude of the smallholders using portfolio effect

Literature designates weather as a risk factor in agriculture (Lien and Hardaker, 2001). Weather challenges, such as drought and extreme weather, influence crops portfolio and choices of whole farm management (Buchholz and Musshoff, 2014; Holden and Quiggin, 2017). Weather influences latex production in two mechanisms. First, rubber harvesting depends on precipitation. To harvest latex, farmers must remove the bark and let latex flowing down along the tree trunk to be collected in a cup every morning. Rain reduces and/or circumvents yield because the latex leaks out from the cups (Feintrenie *et al.*, 2010). Second, air humidity influences latex production. During the low humidity weather (within July – September) latex production decreases (Miyamoto, 2006). Compared to rubber, the production of palm oil depends less on weather and hence, the harvest can be conducted full year (Rist *et al.*, 2010).

There are different procedures to define palm oil and rubber price in farmers' gate. The price of palm oil is determined by a weekly meeting of the Ministry of Agriculture at province level, and private companies (Hidayat *et al.*, 2015). Rubber price is daily assigned depending on the world price (Feintrenie and Levang, 2009; Marimin *et al.*, 2014). Regarding the palm oil and rubber price, we obtained dataset of for the year 2013 – 2015[2] and present the price fluctuation in Figure 1. Following Gilbert and Morgan (2010), the estimated price volatility of palm oil is 21.28%, which is higher than the price volatility of rubber (15.76%). Therefore, oil palm is more risky compared to rubber in terms of price fluctuation.

[Insert Figure 1]

Based on the price data, we can estimate the weekly returns obtained by the smallholders and the coefficient correlation of the returns between the two crops. If the coefficient correlation is a positive and less than one, then planting both crops means mitigating the risk return. Crop diversification is a common strategy to create different income sources to overcome uncertainties in agriculture (Dercon, 1996). Hence, the risk-averse farmers have incentives to diversify the crops (Chavas and Di Falco., 2012), and we can formulate the second hypothesis as: ***Hypothesis 2***. *Risk-averse smallholders cultivate both oil palm and rubber.*

3. METHODOLOGY

3.1. Experimental design

In the HL-task, the participants are confronted with ten series of paired lotteries. Each paired lottery consists of two options: option *A* and option *B*. There are two payoffs for every option: high and low payoff. The chances of obtaining high payoff are gradually higher as the

[2] We obtained the palm oil price from the weekly meeting dataset. Since the palm oil price differs depending on the age of the trees, we used the average price palm oil from different ages of tree. The rubber price is daily price of rubber from GAPKINDO. To make the price of both crops is comparable, we used Thursday price of the daily rubber price because the palm oil price is determined every Thursday.

participants moved down to the ten series of the multiple price list (MPL) as presented in Table 1. The two payoffs in option *A* are 4,000 Indonesian Rupiah (IDR; 1$ ≈ 13,440IDR) and 3,200IDR, and the payoff in option *B* are 7,600IDR and 200IDR[3]. In each series, the participants must choose either option *A* or option *B*.

[Insert Table 1]

For the data collection, the experiment of HL-task was visualized based on Ihli *et al.* (2016). In the questionnaire sheet, we pictured images of balls with four different colors inside two closed bags to depict the payoffs of the two options: red and yellow representing the high and low payoffs in option *A*, while green and blue the representing high and low payoffs in option *B*. In each series, the proportions of colored balls change according to the probabilities. For example, in series 1, bag A contains one red ball and nine yellow balls, while bag B contains one green ball and nine blue balls. The experiment of HL-task was incentivized. The incentives were not in cash, and instead, a shopping voucher for daily groceries was handed to each smallholder. There were two steps to determine the incentive of HL-task: first, the smallholders choose one series randomly, to do so they must take one out of 10 numbered-coins in a closed bag. The taken coin tells us the randomly selected series. Second, on the selected series the smallholders can choose randomly one payoff from option A or option B depending on their choice in the particular series.

Coller and Williams (1999) elicited the discount rate by confronting participants with two options of payoffs: option *I*, earlier-smaller payoff, and option *II*, later-higher payoff. In our design, option I is a payoff in a week (seven days) for which the payoff amount is fixed. Option *II* is a payoff in three months (90 days). The value of payoffs in option *II* changed based on the annual interest rate which ranges from 10% to 100%. The matrix payoff of the CW-task is presented in Table 2. Similar with the HL-task, the CW-task is also incentivized. The participant must take one out of out of 10 numbered-coins in a closed bag. The taken coin defines the selected row, where the value of incentive is determined (depending on participants' choices, option *I* or *II*).

[Insert Table 2]

There are two reasons of one-week delay in option *I* include: (1) the delay for both payoffs reduces the temptation to obtain "today" gain and hence, we avoid a present bias and hold the

[3] We followed Moser and Mußhoff (2017) to determine the value of the payoffs in the MPL for the HL-task in Indonesia.

transaction cost for participants is constant (Andersen *et al.*, 2008), (2) to allow the arrangement of shopping vouchers with the local groceries shop.

3.2. Joint-estimation method

Following Andersen *et al.* (2008), the risk attitude and discount rates are estimated using the join-estimation method, where the risk attitude is integrated for the estimation of the discount rate. To conduct the estimation, Andersen *et al.* (2008) utilized the maximum likelihood estimation (MLE). To do so, we began with the assumption of a power risk utility function with constant-relative-risk-aversion (CRRA) (Holt and Laury, 2002) which formulated as:

$$U(X) = (X + \omega)^{1-\theta} \tag{1}$$

Where U is the utility, X are the payoffs in the HL-task, θ is the risk aversion coefficient, and ω is the background consumption. Following Andersen *et al.* (2008), the ω is equal to zero. Let denote the high payoff as *h* with the respective probabilities (p_j), and low payoff as *l* with the respective probabilities as $1 - p_j$. Then the expected utility (EU) of the paired lotteries for option A and B of the HL-task can be formulated as (Sauter and Mußhoff, 2018):

$$EU_{Aj} = p_j \cdot U(X_{Ah}) \tag{2}$$

The EU of option B is

$$EU_{Bj} = p_j \cdot U(X_{Bh}) \tag{3}$$

To allow the randomness of the participants' choice during the experiment, Holt and Laury (2002) introduced a noise parameter (μ), so-called Luce's error (Luce, 1959). Let denote the probability to choose option *A* or *B* in series *j* of HL-task as Pr_j^{HL}. Hence, the probability of choosing option *A* is (Holt and Laury, 2002):

$$Pr_j^{HL}(A) = \frac{EU_A^{\frac{1}{\mu}}}{EU_A^{\frac{1}{\mu}} + EU_B^{\frac{1}{\mu}}} \tag{4}$$

The formula for the option *B* can be seen equation (4). The participants' decision to select the options is denoted as y_j. The $y_j = 1$ if the participants chose option A and $y_j = 0$ for the choice of option *B*. The log likelihood of the HL-task (L^{HL}) can be formulated as (Andersen *et al.*, 2008):

$$lnL^{HL}(\theta,\mu;y) = \sum_j ((\ln(Pr_j^{HL}(A)|y_j = 1) + (\ln\left(1 - Pr_j^{HL}(A)\right) | y_j = 0)) \quad (5)$$

Furthermore, following the joint-estimation method of Andersen *et al.* (2008), the risk attitudes of the participants are incorporated for the estimation of the discount rate. To do so, we first integrated the risk attitude on the present value of the two options of the CW-task:

$$PV_I = \left(\frac{1}{1+\delta}\right)^t \cdot \frac{(M_I)^{1-\theta}}{1-\theta} \quad (6)$$

and

$$PV_{II} = \left(\frac{1}{1+\delta}\right)^{t+\tau} \cdot \frac{(M_{II})^{1-\theta}}{1-\theta} \quad (7)$$

The PV_I is the present value of the option *I* of the CW-task and the PV_{II} is the present value of the option *II*. The M_I is the payoff of option *I* in time $t = 7\ days$. The M_{II} is the payoff of option *II*, in time $t + \tau = 90\ days$. Thus, the τ is the time between the early and later payment, *i.e.*, 83 days. The δ indicates the discount rates of the participants. The noise parameter for the estimation of the discount rate is denoted as ϑ. When the probability of the participants choose option *I* or *II* in the row k of CW-task is denoted as Pr_i^{CW}, then the probability of a smallholder chooses the option *I* in row k can be defined as (Andersen *et al.*, 2008):

$$Pr_k^{CW}(I) = \frac{PV_I^{\frac{1}{\vartheta}}}{PV_I^{\frac{1}{\vartheta}} + PV_{II}^{\frac{1}{\vartheta}}} \quad (8)$$

The participants' decision to select the options is denoted as y_k. The $y_k = 1$ if the participants chose option *A* and $y_k = 0$ for the choice of option *B*. With the integration of the risk attitude of the participants for the estimation of the discount rate, the log likelihood of the discount rate estimation is formulated as:

$$\ln L^{CW}(\theta,\delta,\mu,\vartheta;y) = \sum_k ((\ln(Pr_k^{CW}(I)|y_k = 1) + (\ln\left(1 - Pr_k^{CW}(II)\right) | y_k = 0)) \quad (9)$$

3.3. Sample selection and descriptive statistics

Jambi Province is located on the east coast of central Sumatra and the study took place in five regencies: Batanghari, Bungo, Muaro Jambi, Sarolangun, and Tebo. We interviewed 8 – 24 smallholders per village. The number of observations per villages varied depending on the total population of smallholders. In total, we involved 636 smallholders, including 437 rubber smallholders and 199 double-crops smallholders. The data collection was last from October 2016 until January 2017. The data collection consists of three parts: (1) interview for information of household characteristics, (2) CW-task, (3) HL-task.

We describe the household characteristics in Table 3. Using the Mann-Whitney test as presented at column (5) of Table 3, dependency-ratio, education and the status of full-time farmers are not statistically significant different between the two groups of smallholders. The dependency ratio is ratio of dependents and total household members. The rubber plantations of the double-crops smallholders were older than the plantations owned by the rubber smallholders. In accordance, the double-crops smallholders were also older people. The size of rubber plantations (productive plantations) of the double-crops smallholders was bigger compared to the plantations owned by the rubber smallholders. More female household heads were found in the double-crops category, even though male were still dominant participants for both types of smallholders.

Furthermore, we captured the information of smallholder economic conditions using several variables such as occupancy of land title, ownership of vehicles as household assets and access to microfinance. In Jambi, there are two types of land title: (1) systematic or official land title; and (2) sporadic or informal land title. Sporadic land title is a land title that recognized by the local government but cannot be used for formal transactions such as collateral (Krishna *et al.*, 2017). Kubitza *et al.* (2018) mentioned that purchasing systematic land title is relatively costly for smallholders. More of double-crop smallholders hold systematic (official) land tittle compared to rubber smallholders. A motorbike was the most common transportation device, but cars and trucks were owned only by wealthier families. Thus, in the interview, we asked a question with binary response whether they own cars or trucks. The double-crops smallholders possessed more vehicles compared to rubber smallholders. Furthermore, the double-crops smallholders have better access to microfinance regarding microcredit and saving.

[Insert Table 3]

4. RESULTS AND DISCUSSIONS

To test the hypothesis, we estimated the risk attitude and discount rate of double-crops and rubber smallholders without controlling for household characteristics, or so-called homogeneous model. Table 4 presents the results, in which panel A shows the estimation for rubber smallholders, and panel B shows the estimations for double-crops smallholders. We can use the 95% confidence interval to see whether the risk attitude and discount rate of the two groups are statistically significantly different. If there is no intersect and/or overlap at the upper and lower boundaries between the double-crops and rubber smallholders, then the two groups are statistically significantly different. When the boundaries intersect or overlap, we evaluate the results using t-test for the two groups.

[Insert Table 4]

4.1. Testing of hypotheses 1

The estimate δ of the rubber smallholders is 2.97, *i.e.*, the estimated discount rate is 297%, and the confidence interval ranges from 2.04 to 3.90. The estimate for the double-crops smallholders is 2.06, *i.e.*, the estimated discount rate is 206%, and the confidence interval ranges from 1.22 to 2.92. Compared to the previous study in, the estimate discount rates of the Indonesian smallholders are extremely high, and thus, they are very impatient (Nguyen, 2011; Tanaka *et al.*, 2010). However, these results are robust, as there is no issue about the range of interest rates that are too broad, in which the annual interest rates which were set in the CW-task were ranging from 10 to 100 percent. Furthermore, the discount rate is high but we applied all methodical approaches estimating true and low discount rates (discount rates and risk preferences estimated jointly as well as low upper boarders of the discount rate ranges in the CW-task). Thus, policy makers and also the smallholders have to deal with these high discount rates which imply wide-ranging impatience causing poverty and a lack of ability to maximize returns from business.

The upper and lower level of 95% confidence interval for the estimated δ of double-crop and rubber smallholders are overlapping as shown in column (4) and (5) of Table 4. We evaluate this using t-test to examine whether the difference of the discount rate from the two groups of smallholders is zero. The result (p-value = 0.16) indicates that the discount rates of double-crops and rubber smallholders are not statistically significantly different. This result contradicts our expectation in hypothesis 1 that double-crops smallholders are more impatient. We found that the discount rates of double-crops and rubber smallholders are not statistically significantly different and hence, we cannot support hypothesis 1.

4.2. Testing of hypothesis 2

The risk aversion coefficient θ is 0.03, and the confidence interval ranges from -0.05 to 0.11. To categorize the risk attitude, we refer to the "classification of risk aversion coefficient" by

Holt and Laury (2002) which defines the range of risk aversion -0.15 < θ < 0.15 as risk-neutral individuals. Hence, the rubber smallholders are on average nearly risk-neutral individuals. Panel B provides estimations for the double-crops smallholders. The risk aversion coefficient θ is 0.21, and the confidence interval ranges from 0.11 to 0.31, which indicates that the double-crops smallholders are slightly risk-averse (Holt and Laury, 2002). These results indicate that the risk attitude of double-crops and rubber smallholders are different, *i.e.*, double-crops smallholders are more risk-averse. Column (4) and (5) of Table 4, which is the confidence boundaries of the respective θ confirm the significant difference, *i.e.*, the upper and lower level of the 95% confidence interval are not overlapping. We can conclude that the risk attitude between the two types of smallholders is statistically different and support the hypothesis 2.

The diversification of crops has two sides of consequences (Heady, 1952). In one side, it requires knowledges of two or more crops and their extra work to manage the combinations of capital and input for maximizing the profits. In other side, when uncertainties are unavoidable, minimizing the variation of returns using the crop diversifications should be used. Both option of crops, palm oil and rubber, have different amount of return per hectare area of plantation as well as different types of risks. Rubber is riskier crop in terms of weather dependency. Considering the price fluctuation, palm oil is riskier (see Figure 1). When the coefficient correlation ρ of the palm oil and rubber return is < 1, the combination of both crops reduces the risk of the investment. In this state, we can predict that the smallholders who combine the crops are more risk averse compare to those who cultivate only one crop, as mentioned in hypothesis 2 of this paper. The theory mentioned that crop diversification reduces the risk of investment and our finding proves that the smallholders who combined the crop selections are more risk-averse compared to those who cultivate only one crop, *i.e.*, rubber.

5. CONCLUSION

The efforts of the government in encouraging palm oil productions have been successful to make Indonesia the biggest producer and exporter of palm oil (Casson and Obidzinski, 2002; Feintrenie and Levang, 2009). Various scales of plantations involve to the national production of palm oil including big scale plantations which are owned by the government and private companies as well as small-scale plantations. Even though smallholders are often characterized as slow adopters to the new technologies, the adoption of oil palm by smallholder rapidly occurred and hence, numbers of study investigated determinant factors of the adoption (Euler *et al.*, 2017; Feintrenie *et al.*, 2010; Rist *et al.*, 2010). This study enriches the body of the literature by examining the risk attitude and discount rate of smallholders regarding their decision to adopt oil palm. From the investigations, we obtain two main findings: (1) there is no difference between adopter and non-adopters in terms of the discount rate, (2) the adopters of oil palm are more risk-averse compared to rubber smallholders.

The understanding of smallholders' risk attitude and discount rate are essential insights for the government as the policy makers before implementing structural changes as well as future policies. For example, the Indonesian government requires large palm oil private companies to be certified for more environmentally farming practice, so-called Indonesian sustainable oil palm (ISPO), in which this policy will be also applied for smallholders (Ministry of Agriculture of the Republic of Indonesia, 2015). There are comprehensive regulations to be certified by ISPO or other certification agencies, such as prohibition to deforest, usage of chemical fertilizer and other activities which might harm biodiversity, soil and groundwater supply (RSPO, 2013). The knowledge of the risk attitude and discount rate can be an important insight to assure the success of the policy. Since the smallholders are risk-averse, the government should mitigate the sources of risk such as price premium for certified palm oil, provision of premium, intense assistant as well as guarantee for market access (Engel and Palmer, 2008; Lee *et al.*, 2011; Wunder *et al.*, 2008; Ruysschaert and Salles, 2014).

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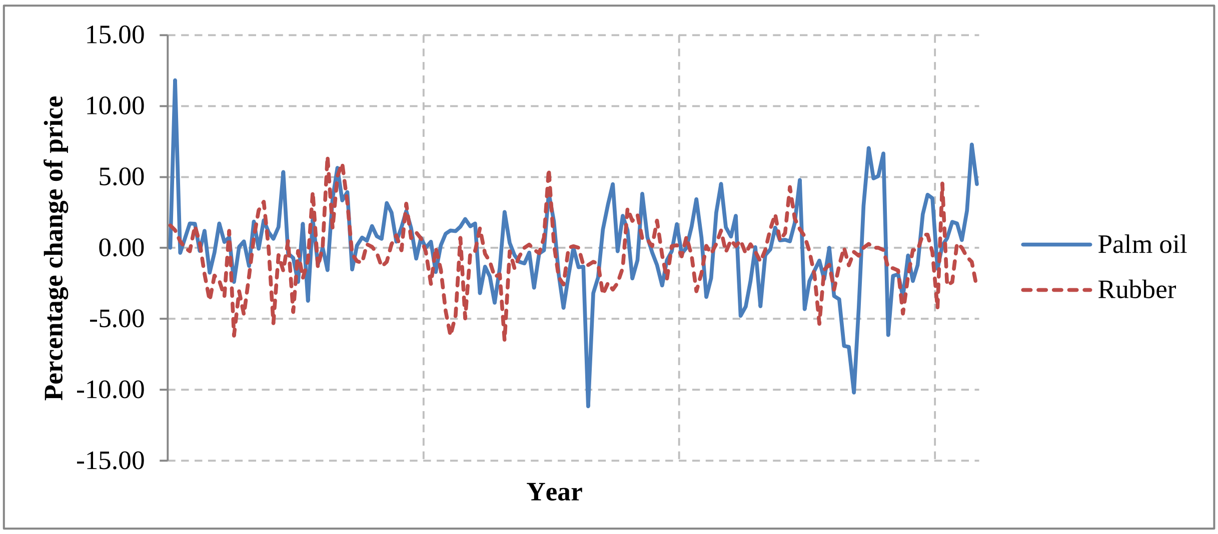
FIGURES

Figure 1. Percentage price change of palm oil and rubber for the year 2013 - 2015



Sources:
Palm oil price from weekly meeting of the Ministry of Agriculture at province level;
Rubber price from GAPKINDO

TABLES

Table 1. Multiple price list of the HL-task[a]			
Series	Option A	Your choice	Option B
1	10% of 4,000, 90% of 3,200	…	10% of 7,600, 90% of 200
2	20% of 4,000, 80% of 3,200	…	20% of 7,600, 80% of 200
3	30% of 4,000, 70% of 3,200	…	30% of 7,600, 70% of 200
4	40% of 4,000, 60% of 3,200	…	40% of 7,600, 60% of 200
5	50% of 4,000, 50% of 3,200	…	50% of 7,600, 50% of 200
6	60% of 4,000, 40% of 3,200	…	60% of 7,600, 40% of 200
7	70% of 4,000, 30% of 3,200	…	70% of 7,600, 30% of 200
8	80% of 4,000, 20% of 3,200	…	80% of 7,600, 20% of 200
9	90% of 4,000, 10% of 3,200	…	90% of 7,600, 10% of 200
10	100% of 4,000, 0% of 3,200	…	100% of 7,600, 0% of 200
Notes: [a]The amount of payoff is in IDR			

Table 2. Matrix payoff of CW- task[a]			
Row	Option *I* (1 week)	Your choice	Option *II* (3 months)
1	50,000	…	51,300
2	50,000	…	52,500
3	50,000	…	53,800
4	50,000	…	55,200
5	50,000	…	56,500
6	50,000	…	57,900
7	50,000	…	59,300
8	50,000	…	60,700
9	50,000	…	62,000
10	50,000	…	63,600
Notes: [a]The amount of payoff is in IDR			

Table 3. Descriptive Statistics[a]				
Variables (measurement unit) (1)	Variables' explanations (2)	Mean (standard deviations) / share in %		Mann-Whitney test[b] (5)
		Rubber smallholders (3)	Double-crop smallholders (4)	
Socio-demographic				
Age (years)	Age of smallholder	45.85 (10.21)	47.94 (10.31)	0.01**
Dependency	Ratio of dependents and total household members	1.50 (1.26)	1.36 (1.13)	0.34
Education (years)	Formal education	8.17 (3.44)	8.51 (3.84)	0.35
Full-time farmer (1/0)	= 1, ≥50% income from farming	88.78%	87.93%	0.77
Gender	= 1, if male	95.88%	98.49%	0.09*
Land title (1/0)	= 1, if systematic land title	26.32%	37.19%	0.01**
Plantation age (years)	The age of the plantation	18.07 (9.42)	Rubber 20.04 (9.31) Oil-palm 7.56(5.83)	0.01**
Plantation (hectares)	Size of plantation area	2.98 (3.23)	Rubber 3.89 (4.94) Oil-palm 2.83(3.15)	0.01**
Productive plantation (hectare)	Size of productive plantation area	2.39 (2.49)	Rubber 3.19 (3.92) Oil-palm 1.93 (3.19)	0.01**
Assets				
Car (1/0)	= 1, if own cars	6.17%	17.09%	0.00***
Motorbike	Number of motorbikes	1.86 (0.82)	2.19 (1.03)	0.00***
Truck (1/0)	= 1, if own trucks	0.46%	3.52%	0.00***
Access to microfinance				
Loan	= 1, loan within a year	44.62%	56.78%	0.00***
Saving	= 1, saving within a year	23.34%	43.72%	0.00***
Notes: [a]N = 636 (437 rubber smallholders and 199 double-crops smallholders); [b]Significance level: *** at 1% level, ** at 5% level, * at 10% level				

Table 4. Joint-estimations of risk attitude and discount rate for two types of smallholders without household characteristics				
Parameter	Coefficient	Robust standard error	95% confidence interval	
			Lower	Upper
(1)	(2)	(3)	(4)	(5)
Panel A. Rubber smallholders[b]				
θ	0.03	0.04	-0.05	0.11
δ	2.97	0.48	2.04	3.90
Panel B. Double-crops[c]				
θ	0.21	0.05	0.11	0.31
δ	2.06	0.43	1.22	2.92

Notes: [a]To categorize the risk attitude, we refer to the classification of risk aversion coefficient by Holt and Laury (2002; page 10); [b]Number of observations = 8,740 (number of clusters = 437); [c]Number of observations = 3,980 (number of clusters = 199)