2015

Conservation vs. Equity
–
Can Payments for Environmental Services achieve both?

Miriam Vorlaufer, Marcela Ibanez, Bambang Juanda, Meike Wollni

EFForTS discussion paper series Nr. 18

Vorlaufer, Miriam; Ibanez, Marcela; Juanda, Bambang; Wollni, Meike: Conservation vs. Equity : Can Payments for Environmental Services achieve both?
Göttingen : GOEDOC, Dokumenten- und Publikationsserver der Georg-August-Universität, 2015
(EFForTS discussion paper series 18)

Verfügbar:
PURL: http://resolver.sub.uni-goettingen.de/purl/?webdoc-3962

Bibliographische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie; detaillierte bibliographische Daten sind im Internet über <http://dnb.ddb.de> abrufbar.

Erschienen in der Reihe
EFForTS discussion paper series

ISSN: 2197-6244

Herausgeber der Reihe
SFB 990 EFForTS, Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesien) - Ökologische und sozioökonomische Funktionen tropischer Tieflandregenwald-Transformationssysteme (Sumatra, Indonesien)

Georg-August-Universität Göttingen
Johann-Friedrich-Blumenbach Institut für Zoologie und Anthropologie, Fakultät für Biologie und Psychologie

Abstract: This paper investigates the trade-off between conservation and equity considerations in the use of payments for environmental services (PES) that implicitly incorporate different distributive justice principles. Using a public good experiment with heterogeneous participants, we compare the effects on additional area conserved and distribution of earnings of two PES schemes: an equal payment and a payment based on Rawls distributional principle, which we refer to as maxi-min payment scheme. The main findings of the framed field experiment conducted in Jambi province (Indonesia) indicate that the introduction of a maxi-min PES scheme can function as a multi-purpose instrument. It realigns the income distribution in favor of low-endowed participants and does not necessarily need to be compromised by lower environmental additionality at the group level.

Keywords: Payments for Environmental Services, efficiency equity trade-off, public good experiment, endowment heterogeneity, productivity heterogeneity

Conservation vs. Equity:
Can Payments for Environmental Services achieve both?

Miriam Vorlaufer, Marcela Ibanez, Bambang Juanda, Meike Wollni

EFForTS Discussion Paper Series

No. 18 (August 2015)

Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)

Funded by the German Research Foundation (DFG) through the CRC 990 "EFForTS, Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)"

www.uni-goettingen.de

SFB 990, University of Goettingen

Berliner Straße 28, D-37073 Goettingen, Germany

ISSN: 2197-6244

Managing editors:

At the University of Goettingen, Germany

Prof. Dr. Christoph Dittrich, Institute of Geography, Dept. of Human Geography
(Email: christoph.dittrich@geo.uni-goettingen.de)

Dr. Stefan Schwarze, Dept. of Agricultural Economics and Rural Development
(Email: sschwar1@gwdg.de)

At the Universities of Bogor and Jambi, Indonesia

Prof. Dr. Zulkifli Alamsyah, Dept. of Agricultural Economics, Faculty of Agriculture, University of Jambi
(Email: zalamsyah@unja.ac.id)

Dr. Satyawan, Sunito, Dept. of Communication and Community Development Sciences, Faculty of Human Ecology, Bogor Agricultural University (IPB)
(Email: awansunito@gmail.com)

Table of contents

List of Tables

List of Figures

Conservation vs. Equity: Can Payments for Environmental Services achieve both?

Miriam Vorlaufer [1], Marcela Ibanez[2], Bambang Juanda[3], Meike Wollni[1]

Abstract

This paper investigates the trade-off between conservation and equity considerations in the use of payments for environmental services (PES) that implicitly incorporate different distributive justice principles. Using a public good experiment with heterogeneous participants, we compare the effects on additional area conserved and distribution of earnings of two PES schemes: an equal payment and a payment based on Rawls distributional principle, which we refer to as maxi-min payment scheme. The main findings of the framed field experiment conducted in Jambi province (Indonesia) indicate that the introduction of a maxi-min PES scheme can function as a multi-purpose instrument. It realigns the income distribution in favor of low-endowed participants and does not necessarily need to be compromised by lower environmental additionality at the group level.

Keywords: Payments for Environmental Services, efficiency equity trade-off, public good experiment, endowment heterogeneity, productivity heterogeneity

JEL classification: Q15; Q5

[1] Department of Agricultural Economics and Rural Development, Georg-August-University Göttingen, Germany, email: mvorlau@gwdg.de (M. Vorlaufer); mwollni1@gwdg.de (M.Wollni)

[2] Courant Research Centre, Equity, Poverty and Growth, Georg-August-University Göttingen, Germany, email: marcela.ibanez@zentr.uni-goettingen.de (M.Ibañez)

[3] Department of Economics, Bogor Agricultural University (IPB), Bogor, Indonesia, email: bbjuanda@yahoo.com

1 Introduction

Payments for environmental services (PES) aim to create, conserve and restore natural resources by creating a market in which buyers compensate providers who voluntarily accept to forgo benefits in order to provide a well-defined service (Alix-Garcia et al., 2008; Jack et al., 2008; Muradian et al., 2010; Engel et al., 2008; Pascual et al., 2010). Although PES are proposed as an efficient instrument to promote conservation compared to traditional command-and-control mechanisms (Pagiola et al., 2005), critics argue that PES are regressive as they privilege few large-scale farmers, who are often the least-cost suppliers of environmental services (Pascual et al., 2010; Narloch et al., 2013; Muradian et al., 2010). In addition, the environmental effectiveness and efficiency of PES schemes are contested, as the large-scale farmers might have conserved even in the absence of PES schemes (Wunder, 2005).

Evidence shows that in the majority of PES schemes poor landholders tend to be excluded from participation or lack adequate benefits generated through PES adoption (Landell-Mills, 2002; Zbinden and Lee, 2005; Grieg-Gran et al., 2005; Corbera et al., 2007; Sommerville et al., 2010). Hence, practitioners (e.g. NGOs, government agencies) have proposed that PES shall be used as a win-win mechanism for both environmental protection and poverty alleviation (Landell-Mills and Porras, 2002; Pagiola et al., 2005; Grieg-Gran et al., 2005; Corbera et al., 2007; Muradian et al., 2010; Corbera and Pascual, 2012; Narloch et al., 2013; Muradian et al., 2013). In this paper we investigate the potential of using PES as a multi-purpose instrument to promote conservation and enhance equity. In particular, we study if the use of PES as an income redistributive instrument compromises conservation goals measured as environmental additionality. In this context, environmental additionality is defined as the net impact on environmental services compared to the situation where no payments are offered.

PES schemes can vary in terms of the relative importance given to efficiency and equity concerns and thus the implicit concept of distributional justice. Pascual et al. (2010) identify several implicit distributive justice principles in PES, including accountability-based, egalitarian and Rawlsian principles. Accountability-based principles seek to compensate service providers according to their actual service provision or to the effort associated with that provision and thereby place major emphasis on the efficient allocation of given funds to achieve maximum conservation outcomes. However, such a payment rule rests on comprehensive data requirements, which can represent an important cost factor. PES schemes based on an egalitarian principle pay a flat rate per unit conserved irrespective of marginal conservation benefits or marginal costs of provision. An egalitarian scheme may perform less well in terms of the efficient allocation of conservation funds to the least-cost providers of ecosystem services, but overall may be more cost-effective, if program administration costs are taken into account. Due to its relative ease of implementation, egalitarian PES systems are widely used in practice[1].

Depending on the initial distribution of resources and returns to these resources among landholders, both egalitarian and accountability-based schemes may perpetuate and even exacerbate prevailing inequalities. In contrast, PES schemes based on the Rawlsian principle seek to maximize the welfare of the most disadvantaged, by offering higher payments to poorer landholders per unit conserved, irrespective of the marginal benefits and costs of the provision of ecosystem services. As the welfare of the least advantaged is used as a criterion to maximize welfare, this payment rule is also referred to as a maxi-min principle. PES schemes based on the maxi-min principle thus consider the reduction of inequalities as an explicit goal, even if this implies a trade-off with respect to efficiency objectives. In this paper, we address the question whether the implementation of a maxi-min scheme improves distributional outcome in favor of the disadvantaged and whether this comes indeed at the cost of environmental additionality. We compare the maxi-min scheme to the widely used egalitarian payment rule and to a situation where no PES scheme is in place.

To investigate the effect of two PES schemes with different implicit distributive justice principles, we conducted a framed field experiment, where participants make decisions in a controlled and incentive compatible environment. To increase the external validity of our study, we conducted the experiment with Indonesian farmers, who in their daily life face the decision to cultivate rubber agro-forest and oil palm. In Jambi province rubber agro-forest area has continuously declined due to the growing demand for oil palm area. The practice of rubber agroforestry, while generating a lower private profit than oil palm, generates positive externalities, such as increased biodiversity (Barnes et al., 2014). Therefore, PES to protect rubber agroforestry has been identified as a promising tool to internalize externalities and foster sustainable land use (Villamor et al., 2011).

Our design builds on a modified public good game that captures the social dilemma that households face when deciding how to allocate their land between oil palm and rubber agroforestry. Mimicking real life conditions in the experiment, the practice of rubber agroforestry, while generating lower

[1] An example for a PES scheme that is based on an egalitarian principle is the nation-wide forest conservation program (FONAFIFO) in Costa Rica.

private profit than oil palm, is associated with positive externalities that benefit all group members. Pagiola et al. (2005) show that the desire of the poor to participate in a PES scheme, in our experiment equivalent to the ability to participate and actual participation, is often restricted by significantly higher relative opportunity costs to allocate scarce resources to conservation, when limited endowments need to be used for income generation (Baland and Platteau, 1999; Narloch et al., 2013). This is reflected in our experimental design, where participants with lower endowments have higher opportunity costs of conservation than participants with high endowments.

Several authors have used framed field experiments to investigate the role of PES-like incentive schemes on cooperation between homogenous resource users (e.g., Vollan, 2008; Travers et al., 2011; Kerr et al., 2012). This literature generally finds positive effects of monetary incentives on cooperation (Vollan, 2008; Travers et al., 2011), albeit the effectiveness depends to some extent on pre-existing social norms (Kerr et al., 2012). Furthermore, low payment levels may be ineffective, as shown in experiments in Tanzania, where participants cooperated less under low payments than under no payments (Kerr et al., 2012). Expanding on these previous studies, we explicitly incorporate heterogeneity among participants. This allows us to capture the effect of the relative position of a participant within a group on the willingness to conserve. For example, Cardenas et al. (2002), Janssen et al. (2012), and Janssen et al. (2013) show that social preferences associated with the provision of a public good differ under conditions of endowment heterogeneity. Moreover, Schilizzi (2011) and Sommerville et al. (2010) show that the valuation of intangible factors associated with the PES scheme (i.e. equity) depends on the relative position of a participant within a group. By incorporating heterogeneity across participants we can focus on the distributional effects of PES schemes. Hence, the consideration of heterogeneity is an essential extension of the public good literature in general and the literature on PES in particular.

To the best of our knowledge only the paper by Narloch et al. (2012) implemented a public good game with heterogeneous groups in the context of PES. In these groups, game participants only differ in terms of endowment status. They investigate to which extent alternative reward systems (individual vs. collective) interact with social norms. Results indicate that the impact of alternative reward schemes on cooperation is not conditional on the endowment status. Similar to Narloch et al. (2012), the vast majority of the experimental literature on public good games considers only one type of heterogeneity, either e.g. endowment heterogeneity (see Cherry et al., 2005; Narloch et al., 2012; Reuben and Riedl, 2013) or productivity heterogeneity (see Cardenas et al., 2002; Reuben and Riedl, 2013). Only Chan et al. (1999) introduce inequality by varying both the endowment and the value of the public good. They found that under a perfect information and non-communication scenario, adding a single type of inequality (endowment or value) does not change the public contribution, while introducing both types of inequality simultaneously significantly increases contribution to the group account. We extend this research considering both heterogeneity in endowment and in the opportunity costs of conservation.

Former studies using micro simulation modelling (Alix-Garcia et al., 2008; Börner et al., 2010) have attempted to capture the effect of different distributive justice principles on PES. However, intangible factors associated with policy design may affect the intrinsic motivation of landholders to conserve (Kosoy et al., 2007; Rodriguez-Sickert et al., 2008; Sommerville et al., 2010; Narloch et al., 2013). In practice, manifold equity criteria exist, and what is perceived as fair or equitable is time and context dependent and varies within heterogeneous groups. Consequently, individuals participating in a program may differ with respect to their supported equity criteria, and as a result the implicit equity criterion adopted in a PES scheme will have implications for conservation and equity outcomes (Pascual et al., 2010). Unlike micro simulation studies, our experimental approach, where decisions are made in a controlled and incentive-compatible environment, allows measuring behavioral responses to two alternative PES schemes that are associated with different distributional justice principles.

The next section briefly outlines the field context in which the framed field experiment was carried out. Sections 3 and 4 develop the conceptual framework and describe the experimental design and procedures used in the implementation. Descriptive and econometric results are presented in Section 5. The last section concludes the paper with a discussion of the major findings and limitations of the study.

2 Background

Among the countries, which faced significant losses in forest land between 1990 and 2005, Indonesia ranks second with regard to the absolute decline in forest area (280,000 km^2) (WTO, 2010). Jambi Province on Sumatra is one of the provinces with the fastest and most complete transformation of forest into rubber and oil palm plantations worldwide (Laumonier et al., 2010). Lowland rainforest area was massively cut by concession logging, leaving only few remaining rainforest spots in national parks (National Park Bukit Duabelas, Harapan rainforest). Rapid oil palm expansion has been identified as a major driver of deforestation (Koh et al., 2011). Estimates suggest that between 1990 and 2005 around 57% of the oil palm expansion occurred at the expense of tropical rainforest (Koh and Wilcove, 2008). During the last decade oil palm cultivation increased rapidly in Indonesia. Between 2000 and 2010, the oil palm area almost doubled from 4.2 million hectares to around 8 million hectares, accounting for 46% of the world's crude palm oil production (Obidzinski et al., 2012). This expansion mostly took place on the islands of Sumatra and Kalimantan, which account for 66% and 30% of the national oil palm area, respectively (PWC, 2012). In the near future, further expansions are planned and 18 million hectares have been earmarked by local governments mainly located on the islands of Kalimantan, Sulawesi and Papua (The Jakarta Post, 2009).

The transformation of tropical lowland rainforest into rubber and oil palm plantations was mainly driven by the transmigrant program, which was launched by the Indonesian government in the early 1980's. It aimed at moving households from the over-populated island of Java to the less populous islands of Sumatra and Kalimantan (Feintrenie and Levang 2009; Feintrenie et al., 2010). Transmigrant households received two hectares of oil palm plantation within Nucleus Estate and Smallholder schemes (NES) (Fearnside, 1997; Elmhirst, 1999). In the last one or two decades, however, new oil palm plots have been mainly established by independent smallholders, who are located in autochthonous, rather than in transmigrant villages (Ekadinata and Vincent, 2011).

For many rural households the growing oil palm sector offers an attractive pathway out of poverty (PWC, 2012; McCarthy et al., 2012)[2]. At the same time, oil palm expansion in Indonesia has been associated with significant social conflicts and negative environmental impacts (Colchester et al., 2006; Belcher and Schreckenberg, 2007; McCarthy et al., 2012). The transformation of complex land use systems into oil palm plantations has been identified as a major factor in the significant loss in biodiversity (Danielsen et al., 2009; Wilcove and Koh, 2010) and ecosystem functioning (Barnes et al., 2014).

Since primary lowland rainforest has been almost completely converted into more intensive land uses, currently rubber agroforestry systems are the most extensive, forest-like vegetation type in Jambi province. Rubber agroforestry, which has been cultivated since the early 20th century in Jambi province, is a smallholder cultivation system that combines the cultivation of a perennial crop (i.e. rubber) with other plants, such as timber and fruit trees, building/handicraft and medical plants.

[2] In 2000, private enterprises manage 58% of the total oil palm area and dropped to 54% in 2010. Meanwhile the share of smallholder plantation increased by 10 percentage points, from 28% to 38% in the same period (PWC, 2012).

From a biodiversity viewpoint, rubber agroforests mimic secondary forest, since they incorporate the components of spontaneous secondary vegetation (pioneer, post-pioneer and late-phase species[3]) (Beukema et al., 2007; Feintrenie and Levang, 2009; Feintrenie et al., 2010). In rubber agroforestry systems fertilizer and pesticide applications are rarely reported. Weeding is limited to paths, which allow the tapping of the rubber trees. Beukema et al. (2007) show that rubber agroforestry systems incorporate high levels of bird and plant species richness and are more similar to neighboring forest than to oil palm monocultures. Ecological functions of the forest such as water flow regulation and soil protection can be preserved in rubber agroforestry systems (Feintrenie and Levang, 2009).

Despite the environmental benefits of rubber agroforestry, oil palm and rubber monocultures are often preferred by farmers due to their higher economic profitability. For the case of Jambi, Feintrenie et al. (2010) estimate that the relative profit of agroforestry represents approximately 61% to 69% of the profit of oil palm, depending on relative prices[4]. Furthermore, technical characteristics, in particular lower labor requirements, and the encouragement and support by the government and private oil palm companies may explain farmers' preferences for oil palm compared to rubber agroforestry. As a result, the remaining rubber agroforestry area in Jambi province is threatened by conversion into monocultures, in particular, oil palm plantations.

Payments for environmental services have been proposed as an option to counteract the threat of rapidly decreasing agro-biodiversity in Jambi province (Villamor et al., 2011). In 2002, the World Agroforestry Centre (ICRAF) launched the Rewarding Upland Poor for Environmental Services (RUPES) program in upland Jambi Province (Bungo district) (ICRAF, 2014). Due to the climatic conditions, the upland of Jambi is not affected by oil palm expansion, but rubber agro-forest gives way to more intensively managed rubber monoculture plantations. The RUPES program implemented conservation agreements with local communities, providing them with extension services and in-kind rewards (such as the installation of micro-hydro power plants) in exchange for the preservation of rubber agroforestry. Based on these experiences, the aim is to strengthen the communities' negotiating power and support the development of market-based incentive schemes,

[3] In the pioneer stage, the first stage after slash and burn, heliophilous crops (such as rice and vegetables) function as pioneers, inhibiting weed. This stage creates a favorable microclimate for tree species (such as rubber, fruit and timber trees). Post- pioneers are fast growing species, such as coffee or pepper maintaining a favorable biophysical environment for the main perennial crops (such as rubber). After 15-20 years rubber agroforestry systems simulate complex secondary forests, reaching maximum canopy height of 20-40 meters (Feintrenie and Levang, 2009).

[4] To the best to our knowledge, only the study of Feintrenie et al. (2010) compares the profitability of oil palm monoculture, rubber monoculture and rubber agroforestry in Jambi Province. Considering relatively high rubber and palm oil prices (July 2008), they estimate an average return to land based on a full plantation cycle of 2,100 Euro/ha for oil palm, 2,600 Euro/ha for rubber plantation and 1,300 Euro/ha for rubber agroforestry. With low rubber and palm oil prices (November 2008), average returns to land decrease to 990 Euro/ha for oil palm, 1,300 Euro/ha for rubber and 690 Euro/ha for rubber agroforestry.

such as rubber latex eco-certifications[5] and Reduced Emissions from Deforestation and Degradation (REDD)[6] schemes, offering monetary incentives to conserve agro-biodiversity.

3 Conceptual framework

The producer problem

We consider a partial equilibrium model in which farmers individually decide how to allocate their land, L, between rubber agroforestry and oil palm cultivation. The private profit of rubber agroforestry is lower than the profit generated from oil palm cultivation. Hence each land unit allocated to oil palm, x, yields a return of 1, while each land unit allocated to rubber agroforestry gives a return a, where a < 1[7]. Assuming that all land units need to be distributed, the number of land units allocated to rubber agroforestry equals (L-x). Rubber agroforestry generates positive environmental effects, such as improved water quality, increased soil fertility and higher biodiversity. Let b be the positive externalities for N community members, generated by each unit of land allocated to rubber agroforestry. We consider that the marginal incentive to cultivate oil palm is positive, so a+b<1. Furthermore, we take into account that producers are heterogeneous in terms of the size of available land and the opportunity cost that they face to conserve rubber agroforestry. Type 1 producers have low land endowments L_L and high opportunity cost of conservation, whereas Type 2 producers have high land endowments L_H and low opportunity cost of conservation. In order to represent this difference in the opportunity cost of conservation, we allow the relative profit of rubber agroforestry to differ between Type 1 and Type 2 producers. Thus, the relative profit of rubber agroforestry of low-endowed producers *(a_L)* is lower than that generated by high-endowed participants *(a_H)* ($a_L < a_H$).

This model can be extended by considering that producers have an intrinsic motivation to conserve. We thus assume that producers experience a moral cost of transforming the area into oil palm, M, which is a function of an individual parameter c_i, capturing the importance that the individual gives to conservation, and the individual area cultivated with oil palm, x_i. Similar to Ibanez and Martinsson (2013), we assume that the moral cost of transformation is given by $M = c_i x_i^2$, implying that the cost increases at an increasing rate with an increase in the area cultivated with oil palm. The optimization problem for the individual producer is given by:

---

5 Though there is no market yet for certified rubber (see Gouyon, 2003).

6 There is an on-going discussion whether to allow rubber agroforestry through Hutan desa (village forest) to be included as a land use in the REDD+ scheme (see Pramova et al., 2013; Villamor et al., 2011).

7 The relative profit of rubber agroforestry is based on the findings of Feintrenie et al. (2010).

$$\max_{x_i} \text{U} = \left(x_i \; + a_{K_i} \left(L_{k_i} \; - \; x_i \; \right) + b \sum_{i=1}^{N} (L_i - \; x_i) - c_i x_i^2 \right) \quad For\ K = L, H \qquad (1)$$

where the sub index K denotes producer type L or H. Given that $a_K + b < 1$, the first order condition implies that individual producers who derive no intrinsic utility from conservation (c_i =0) would specialize and allocate all land units to oil palm cultivation. For producers who give a certain importance to conservation (c_i>0), the optimal area cultivated with oil palm, x_i* is given by:

$$x_{Ki}\;^{*} = \frac{1 - a_{K_i} \; - b}{2c_i} \qquad (2)$$

Since a_L<a_H, producer Type 1 has a higher incentive to cultivate oil palm than producer Type 2. Hence, our first hypothesis is:

Hypothesis 1 – H1

In the absence of payments for environmental services, Type 1 producers with low endowments of land and high opportunity cost of conservation allocate a smaller fraction of land to rubber agroforestry than Type 2 producers with high endowments of land and low opportunity cost of conservation.

<u>*Proof 1:*</u> The proportion of land endowment allocated to rubber agroforestry, R, is:

$\text{R} = \frac{L-x}{L} = 1 - \frac{1-a-b}{2c_i L}$; with $\frac{d\text{R}}{da} = \frac{1}{2c_i L} > 0$; $\frac{d\text{R}}{dL} = \frac{\frac{1-a-b}{2c_i}}{L^2} > 0$; hence $R_L < R_H$.

The social planer problem

The problem for the social planner is to maximize social welfare selecting the optimal amount of land to be transformed into oil palm. For a society that is composed of *N* producers, the problem of a social planner is to maximizing the sum of the individual pay-off functions:

$$\max_{x=(x_i,\dots,x_N)} \text{W} = \left(\sum_{i=1}^{N} \left(x_i \; + a_{K_i} (L_{K_i} - \; x_i \,) + b \sum_{j=1}^{N} (L_{K_j} - \; x_j) - c_i x_i^2 \right) \right) \qquad (3)$$

The optimal social allocation of land to oil palm is given by $x_s{}^{*} = \frac{1-a_{K_i}-Nb}{2c_i}$. If the social benefit of rubber agroforestry conservation (Nb) is larger than the private net benefit 1-a_{K_i} (1- a_{K_i} < Nb), the optimal amount of land allocated to oil palm is zero. Otherwise, the optimal amount of land allocated to oil palm is positive, but from the social point of view it is always smaller than the optimal amount of land that is allocated to oil palm privately. In order to induce producers to internalize the positive externalities associated with conservation, the social planer could offer monetary incentives, such as payments for environmental services (PES), such that $x_s{}^* = \sum_{i=1}^{N} x^*$.

Payments for Environmental Services (PES)

Modeling PES as an increase in the relative profit of rubber agroforestry, a_{K_i}+ PES, it is straight-forward to show that keeping everything else constant, the proportion of land allocated to rubber agroforestry increases with the introduction of PES. Yet, the effect of the introduction of an egalitarian PES scheme on the proportion of land endowment contributed to conservation would be different for producers Type 1 and Type 2. This leads to our second hypothesis:

Hypothesis 2 – H2

The implementation of an egalitarian PES scheme will result in a larger increase in the proportion of land conserved for producers Type 1 with lower endowments and high opportunity costs of conservation than for producers Type 2 who are high-endowed and have low opportunity costs of conservation.

<u>Proof 2:</u> As shown in Proof 1, the proportion of land that is conserved increases linearly with an increase in the relative profit of rubber agroforestry, a. The change in the proportion of land that is conserved is a negative function of the land size $\frac{d^2R}{dadL} = -\left(\frac{1}{2c_iL^2}\right) < 0$. Hence, the increase in the proportion of land conserved by Type 2 producers with higher relative profit of rubber agroforestry, a_H, and higher land endowments, L_H, is lower than the increase in the proportion of land conserved by Type 1 producers.

Since the introduction of an egalitarian PES scheme induces a larger marginal change in the proportion of land allocated to rubber agroforestry for Type 1 producers than Type 2 producers and the PES does not fully compensate for the forgone benefits, the implementation of the PES scheme might result in an increase in income inequality among Type1 and Type 2 producers.

Hypothesis 3 – H3

Assuming that the individual preferences for rubber agroforestry c_i, c_j are equal in absolute values, i.e. $c_i = c_j = c$, an egalitarian PES scheme might increase income inequality by generating a larger reduction in the income of Type 1 producers relative to Type 2 producers.

Proof: Based on equation (2) it is possible to show that the optimal amount of land allocated to oil palm cultivation of producer Type 1 is $x_L = x_H + \frac{a_H - a_L}{2c}$. The difference in the income between Type 1 and Type 2 producers is hence given by:

$$I\,(a_H, a_L) = \pi_H - \pi_L = \frac{a_L - a_H}{2c}\left(1 - \frac{a_L - a_H}{2}\right) + a_H L_H - a_L L_L \qquad (4)$$

The larger the differences in the amount of available land endowments and in the relative profit of rubber agroforestry, the larger the inequality, I, among Type 1 and Type 2 producers. Next, we want to know how income inequality, I, changes if we add a fixed amount of δ to both returns a_H, a_L. Defining a new function

$G(\delta, a_H, a_L) := \mathrm{I}(a_H + \delta, a_L + \delta)$

$$G(\delta;\, a_H, a_L) = I(a_H, a_L) + \delta(L_H - L_L - \frac{a_L - a_H}{2c}) \qquad (5)$$

In particular, differentiating G with respect to δ yields:

$\frac{dG(\delta;\, a_H, a_L)}{d\delta} = L_H - L_L + \frac{a_H - a_L}{2c} > 0$ (6)

A social planner that takes into account the distributional outcome might consider using PES not only to increase conservation, but also to reduce inequality. Hence, this social planner might offer a higher PES to producer Type 1 with low endowments and a lower PES to producer Type 2 with high endowments.

Hypothesis 4 – H4

A maxi-min PES scheme that reallocates payments toward the low-endowed participants, and hence results in a higher (lower) payment for low-endowed (high-endowed) participants, decreases income inequality (compared to the egalitarian PES scheme).

Proof: Defining a new function $D(\delta, \gamma, a_H, a_L) := \mathrm{I}(a_H + \delta - \gamma, a_L + \delta + \gamma)$, where γ is the fraction of payment that is taken from the high-endowed participant and redistributed to the low-endowed participant. It can be shown that:

$$D(\delta, \gamma, a_H, a_L) := I(a_H, a_L) + \delta\left(L_H - L_L - \frac{a_L - a_H}{2c}\right) + \frac{\gamma}{c}\left(1 - \frac{a_L + a_H}{2} - \delta - cL_H - cL_L\right) \qquad (7)$$

The effect of an increase in the relative profit of rubber agroforestry on income inequality is given by:

$$\frac{dD}{d\delta} = L_H - L_L + \frac{a_H - a_L}{2c} - \frac{\gamma}{c} < \frac{dG(\delta; a_H, a_L)}{d\delta} \qquad (8)$$

Therefore, the use of a maxi-min PES scheme reduces the income inequality increasing effect of an increase in the relative profit of rubber agroforestry compared to an egalitarian PES scheme. Moreover, the effect of an increase in the amount of payment that is redistributed in favor of low-endowed participants, γ, on income inequality is:

$$\frac{dD}{d\gamma} = \frac{1}{c}\left(1 - \frac{a_L + a_H}{2} - \delta - cL_H - cL_L\right) \qquad (9)$$

with $\frac{1}{c}\left(1 - \frac{a_L + a_H}{2} - \delta\right) < L_H + L_L; \frac{dD}{d\gamma} < 0.$

Hence, income inequality decreases, the larger the amount of payment redistribution.

Hypothesis 5 – H5

The maxi-min PES scheme does not lead to a reduction in the increase in the conservation area at community level compared to an egalitarian PES scheme.

<u>*Proof:*</u> Since the change in the proportion of land that is conserved is a negative function of the land size $\frac{d^2R}{dadL} = -\left(\frac{1}{2c_iL^2}\right) < 0$, we can assume that the relative increase (compared to the egalitarian PES scheme) in land endowments that is allocated to conservation by Type 1 producers is higher than the respective decrease of conservation by Type 2 producers.

4 Experimental Design and Procedures

To capture perceptions and preferences associated with the two cultivation systems, the endowment allocation decision was framed as a cultivation decision between oil palm and rubber agro-forest. We explained to participants that rubber agroforestry has positive environmental effects that translate into higher payments for all group members. To illustrate this we presented posters with photos of each cultivation system. Each land unit allocated to rubber agro-forest by a group member increased the income of each group member by *b=0.2*. This is consistent with equal marginal benefits of conservation for all types of participants. Each participant took three decisions under scenarios that combine different monetary incentives of conservation. In order to avoid potential income and learning effects, participants did not receive feedback on their own earnings or group contributions between decisions. Moreover, to control for order effects the decision sets were presented in different orders to participants as explained below.

4.1 Experimental treatments

Our experiment uses a within-between subject design. The within-subject design was used to capture individual preferences for conservation and test how changes in conservation incentives interact with these preferences. Hence, each participant played three scenarios that were presented as sequential decisions. In each scenario, we varied the monetary incentives for conservation. In the first scenario or decision, participants decided how to allocate their endowment without any PES. This first decision allows us to capture individual heterogeneity in preferences for conservation. Moreover, this decision allows us to build a baseline against which to compare the effect of PES on the additional units of experimental land conserved. In scenarios 2 and 3, monetary incentives for the practice of rubber agroforestry were introduced. Each unit of endowment allocated to rubber agro-forest hence generated a relative profit of $(a+\delta)$. Each participant was confronted with a low and a high payment level. To account for order effects we randomly switched the order in which payments were offered. Hence, half of the participants received a high payment in the second decision and a low payment in the third decision, whereas the other half received a low payment in the second decision and a high payment subsequently. Since we were interested in testing the effect of different payment levels without creating a high cognitive load for participants, we used two payment sets that were randomly allocated to participants. The first payment set offered relatively lower payments compared to the second payment set. Decisions 2 and 3 allow us to generate the supply response to PES.

The between-subject design allows us to compare the conservation and distributional outcomes of two alternative PES schemes: an egalitarian payment rule and a Rawlsian or maxi-min payment rule. Each participant took part in only one of the payment rules. In the egalitarian PES scheme high and low-endowed participants received a unitary payment for each unit of land conserved ($\delta_L = \delta_H$). Thus, under this scheme the difference in the relative profit of agroforestry between high and low-endowed participants remains, $a_L+\delta_L < a_H+\delta_H$, implying higher opportunity costs of conservation for low-endowed participants. In addition, we tested a maxi-min PES scheme in which low-endowed participants received a higher payment than high-endowed participants ($\delta_L > \delta_H$). In our experimental design, this scheme allowed to completely compensate the differences in the opportunity costs of conservation between high and low-endowed participants, $a_L+ \delta_L = a_H+ \delta_H$. This payment rule implies that higher payments are given to the more costly providers of environmental services, and may thus result in a trade-off between redistributive and conservation goals.

Table 1 depicts the relative profit of rubber agro-forest (a+δ) by payment level (no, low, high), PES scheme (egalitarian, maxi-min), payment set (1, 2) and endowment status (L, H). In the baseline decision (decision 1) no PES are offered. Under the egalitarian PES scheme, payment set 1 offered a payment of 0.05 (low level) and 0.25 (high level) experimental units for each unit of land invested in rubber agro-forest, whereas payment set 2 offered a payment of 0.1 (low level) and 0.3 (high level) for each unit of land conserved. The maxi-min PES scheme provided different payments to low and high-endowed participants. Compared to the egalitarian PES scheme, the payments for low-endowed participants increased by 0.05, whereas the payments for high-endowed participants decreased by 0.05 experimental units. Hence under the low payment scheme low-endowed participants received either 0.1 or 0.15 in payment set 1 and 2, respectively. On the other hand, high-endowed participant received either zero or 0.05 in each of the payment sets. To compare the two alternative PES schemes, the average payment per unit conserved (av. PES) was kept constant across the two alternative PES schemes.

Table 1: Relative profit of rubber agroforestry (a+δ) by PES scheme, payment set, payment level, and endowment status

		PES schemes			
		Egalitarian scheme		**Maxi-min scheme**	
Payment Set 1		L (e=5)	H (e=10)	L (e=5)	H (e=10)
No Payment		$a_L = 0.30$	$a_H = 0.40$	$a_L = 0.30$	$a_H = 0.40$
Low Payment	av.PES = 0.05	$a_L + 0.05$	$a_H + 0.05$	$a_L + 0.10$	a_H
High Payment	av.PES = 0.25	$a_L + 0.25$	$a_H + 0.25$	$a_L + 0.30$	$a_H + 0.20$
Payment Set 2					
No Payment		$a_L = 0.30$	$a_H = 0.40$	$a_L = 0.30$	$a_H = 0.40$
Low Payment	av.PES = 0.10	$a_L + 0.10$	$a_H + 0.10$	$a_L + 0.15$	$a_H + 0.05$
High Payment	av.PES = 0.30	$a_L + 0.30$	$a_H + 0.30$	$a_L + 0.35$	$a_H + 0.25$

4.2 Procedures

The experiment was conducted in four villages in Batanghari district (Jambi province); two autochthonous villages (Pulau Betung, Karmeo), which were not targeted by the governmental transmigration program, and two transmigrant villages (Bukit Harapan, Bukit Sari). In total, 32 experimental sessions were carried out between November 2012 and March 2013. Participants were randomly selected among household heads of oil palm and/or rubber cultivating families using village census information. A total number of 260 farmers took part in the experiment. All decisions were made anonymously and information on group membership or identity was not revealed to participants. Thus, the composition of their group was unknown to the participants. Each experimental session consisted of four different stages. First the instructions of the game were read aloud to the participants, followed by several examples. In a second step, two hypothetical decisions without feedback were played to improve and confirm the understanding of the game. In the third stage, participants were presented the different scenarios and made their decisions. Assistants were available for those participants who had difficulties with reading or arithmetic. Once participants had completed the three decisions, one was randomly drawn and paid out to them. Earnings in the game were transferred to local currency units at a rate of 10 experimental units of payment to 1 IDR. All participants were paid privately using checks made payable for them in their local shops. Typical earnings (mean IDR 86347) were worth between one and two days of wage labor. At the end of the game a brief post-experimental questionnaire was completed, incorporating questions related to the experiment, participants' demographics and farming activities.

5 Results

5.1 Socioeconomic characteristics of the sample

Based on the post-experimental questionnaire, Table 2 provides a description of socioeconomic characteristics of the participants, such as information on age, gender, educational level, household size and farming activities. 61% of the participants cultivate oil palm, 48% practice rubber monoculture and 13% practice rubber agroforestry. While 17% of the participants combine the cultivation of oil palm and rubber monoculture, only 4% of the participants cultivate both oil palm and rubber agro-forest. Overall, these numbers reflect the declining role of rubber agro-forest in the research area.

To test for differences in socioeconomic characteristics of participants across treatments and endowment status in our experiment, we estimate a set of seemingly unrelated regressions with the socio-economic characteristics and session characteristics as dependent variables (see Table A1)[8]. The results support the randomization strategy and we find no significant differences across participants in the different treatments or status groups.

[8] Session characteristics include the following variables: share of participants known by name in session and share of family members in session.

Table 2: Socio-economic characteristics of participants.

Variables	Definition	Mean	Std. Dev.
Age	Age of participant in years	43.37	10.501
Female	=1 if female participant	0.085	0.279
Secondary	=1 if completion of secondary education	0.415	0.494
HH_size	Number of hh members	4.204	1.494
Transmigrant*	=1 if hh has migrated to Jambi within trans-migrant program	0.300	0.459
Oil palm	=1 if hh cultivates oil palm	0.608	0.489
Oil palm_ha	Total individually cultivated oil palm area (ha)	3.419	2.793
Rubber monoculture	=1 if hh cultivates rubber monoculture	0.478	0.500
Rubber monoculture_ha	Total individually cultivated rubber monoculture area (ha)	1.550	1.185
Rubber agro-forest	=1 if hh cultivates rubber agro-forest	0.127	0.334
Rubber agro-forest_ha	Total individually cultivated rubber agro-forest area (ha)	2.766	4.104
Oil palm_rubber monoculture	=1 if hh cultivates rubber monoculture and oil palm	0.173	0.379
Oil palm_rubber agro-forest	=1 if hh cultivates rubber agro-forest and oil palm	0.042	0.202
Size of owned land (ha)	Area of owned land (ha)	4.160	4.919

Total number of observations: 260
* The remaining 70% of the participants include second-generation trans-migrants (following family members who migrated within the trans-migrant program), other migrants, and autochthonous population.

5.2 Experimental results

5.2.1 Descriptive results

In the descriptive analysis of our experimental results, we pool the data from payment sets 1 and 2, resulting in two payment levels (low and high). Figure 1 depicts the average share of land units allocated to conservation by PES scheme, payment level, and endowment status.

We find that in the baseline decision participants conserve on average between 39 and 47 percent of their endowment, which is in line with the vast majority of experimental literature showing that participants of heterogeneous groups in public good experiments do not play purely self-interested strategies (e.g., Cardenas et al., 2002; Ostrom, 2000). This is consistent with our conceptual framework, which considers that economic decisions are not solely driven by economic incentives, but are also shaped by normative factors (see Equation 2). In the baseline decision of the egalitarian (maxi-min) PES treatment low-endowed participants allocate on average 40.68 percent (45.53

percent) of their land endowment to conservation, whereas high-endowed participants conserve on average 48.41 percent (39.36 percent). For both types of producers, the difference in the baseline contribution to conservation across the two alternative PES treatments is not statistically significant.

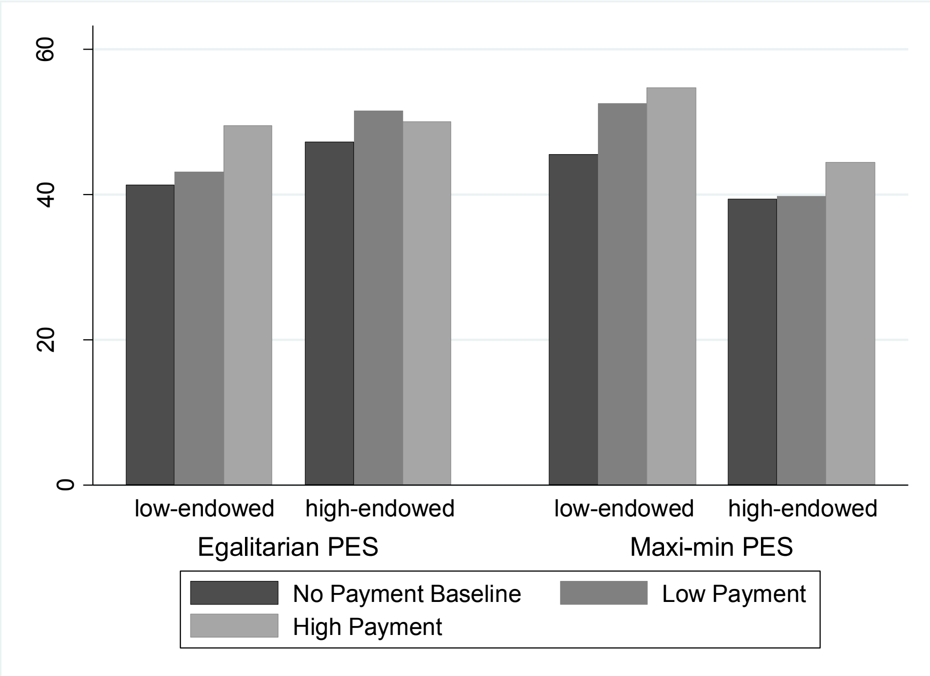

Figure 1: Average share of endowment contributed to rubber agroforestry by PES scheme, endowment status and payment level.

Pooling the data from both treatments, we find that when no incentives for conservation are offered, low-endowed participants conserve a slightly smaller share of their endowment than high-endowed participants, although this difference is not statistically significant (Wilcoxon rank-sum test 0.6461). These results are in line with other experimental studies showing that in relative terms low-endowed participants conserve as much as their better endowed counterparts (Cardenas et al. 2002; Narloch et al. 2012)[9].

Figure 1 further shows that with the introduction of PES the average share of endowment contributed to conservation tends to increase. In the case of low-endowed participants, the introduction of an egalitarian PES scheme leads to significant increases in conservation only if high payment levels are offered (Low Payment: Wilcoxon sign-rank test 0.2973; High Payment:

[9] Cardenas et al. (2002) e.g. introduce heterogeneity by varying the private returns in an experiment and find that low-wage participants contribute less in absolute terms, but are willing to bear a higher burden in relative terms showing significantly more restraint to their pure Nash equilibrium compared to high-wage participants.

Wilcoxon sign-rank test 0.0033), whereas the introduction of a maxi-min PES scheme leads to significant increases in the share of land allocated to conservation irrespective of the payment level (Low Payment: Wilcoxon sign-rank test 0.0005; High Payment: Wilcoxon sign-rank test 0.0010). Figure 1 also suggests that for low-endowed participants we can observe a standard price effect, indicating that with increasing relative payment levels the average conservation behavior increases (see Frey and Jegen, 2001). In contrast, for high-endowed participants, the introduction of an egalitarian PES scheme does not induce significant increases in conservation behavior (Low Payment: Wilcoxon sign-rank test 0.1383; High Payment: Wilcoxon sign-rank test 0.4032). We only observe a significant increase in the share of land allocated to conservation by high-endowed participants when high payment levels are offered under the maxi-min PES scheme (Low payment: Wilcoxon sign-rank test 0.6327; High payment: Wilcoxon sign-rank test 0.0723).

Regarding the distributional outcome of the alternative PES schemes, Figure 2 depicts the average share of total earnings held by individual by PES scheme, payment level, and endowment status.

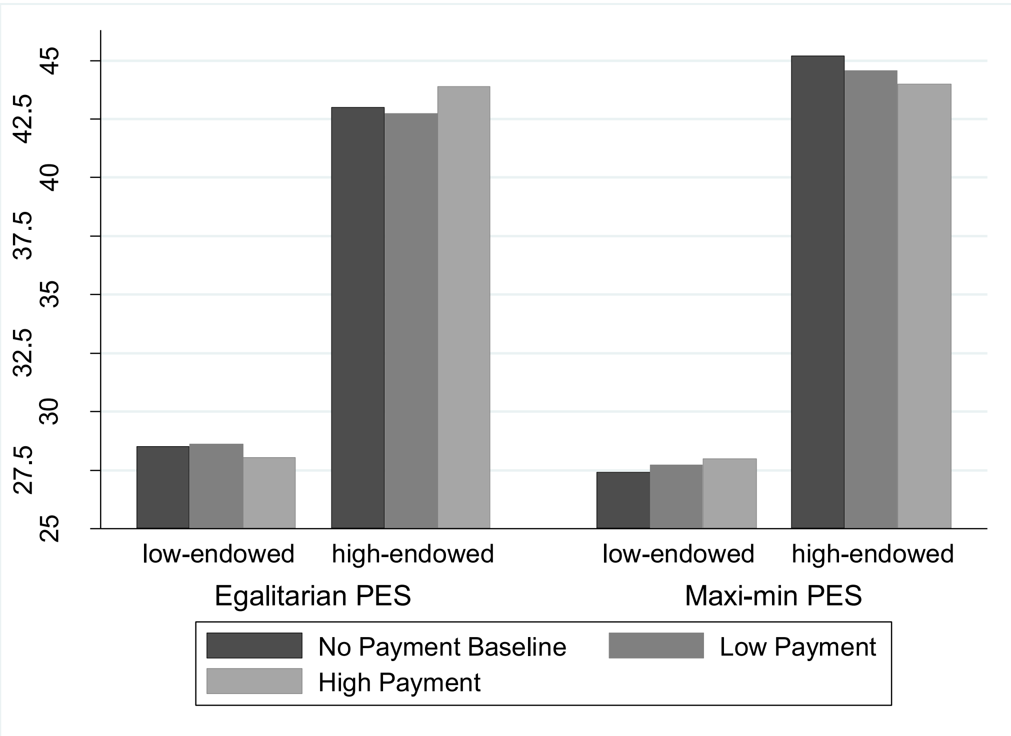

Figure 2: Average share of total group earnings held by individual by PES scheme, payment level, and endowment status.

In the baseline, low-endowed participants earn around 28 percent and high-endowed participants around 44 percent of the total group earnings. Under the egalitarian PES scheme, low payment levels do not significantly shift the income distribution (Low-endowed: Wilcoxon sign-rank test

0.5190; High-endowed: Wilcoxon sign-rank test 0.9907). Yet, when high payment levels are offered, low-endowed participants earn significantly smaller shares and high-endowed participants significantly larger shares of the total group earnings, compared to the baseline distribution (Low-endowed: Wilcoxon sign-rank test 0.0896; High-endowed: Wilcoxon sign-rank test 0.0400). Thus, the introduction of an egalitarian PES tends to exacerbate inequalities in the prevailing income distribution.

The introduction of a maxi-min PES scheme tends to redistribute the income in favor of the low-endowed participants, as expected. In particular, we can observe that the share of total group earnings held by high-endowed participants significantly decreases irrespective of the offered payment level (Low Payment: Wilcoxon sign-rank test 0.0966; High payment: Wilcoxon sign-rank test 0.0277). Yet, the observed increase in the share of total group earnings held by low-endowed participants is not statistically significant (Low Payment: Wilcoxon sign-rank test 0.3024; High Payment: Wilcoxon sign-rank test 0.1439).

5.2.2 Econometric results

To test the hypotheses derived in the conceptual framework, we estimate a series of econometric models. Econometric estimation allows us to obtain the effect of a variable of interest (e.g. the payment scheme) while holding other variables constant (e.g. the payment level). Based on the within-subject design of the experiment, we are able to analyze individual behavioral dynamics over time.

Impact of endowment status on conservation behavior

In the following, we address the first two hypotheses, which posit that both the conservation behavior in the baseline and the change in conservation behavior induced by the introduction of PES are conditional on the endowment status. In Model 1 and Model 2, we analyze the share of individual land endowment allocated to conservation, R, by individual i in decision t, under the egalitarian and maxi-min PES scheme, respectively. Taking into account that individuals took repeated decisions and that the share of endowment allocated to conservation is censored at zero and one, we estimate the following random effects Tobit model:

$$R_{it} = \beta_0 + \beta_1 Ha10_{it} + \beta_2 PesLevel_{it} + \beta_3 Ha10_{it} * PesLevel_{it} + \vartheta_i + \mu_{it} \quad (10)$$

where *Ha10* is a dummy variable taking the value of one for participants allocated to the high endowment status (e=10), and *PesLevel* is a continuous variable on the payment level offered for conservation taking positive values (δ=[0.05, 0.10, 0.20, 0.25, 0.30, 0.35, 0.40]). The parameter ϑ_i captures individual time-invariant unobserved heterogeneity that is assumed to be uncorrelated with the other covariates. The parameter μ_{it} is the individual time-variant unobserved heterogeneity.

Based on the estimated beta coefficients we obtain extensive and intensive marginal effects. The extensive margins represent the effects on the probability of allocating a positive share of experimental land units to conservation. The intensive margins indicate the effects on an additional unit of experimental land conserved conditional on a non-zero share of endowment being invested in conservation. Accordingly, the intensive margin derived from the estimated parameter β_0 indicates the area conserved by low-endowed participants conditional on investing in conservation when no payments are offered. The intensive margin based on $\beta_1$reflects the difference in the area conserved conditional on investing in conservation by high-endowed participants compared to low-endowed participants, when payments equal zero (no payment = baseline)[10]. The intensive margin derived from β_2 provides the effect of payments on the share of endowment conserved by low-endowed participants; whereas β_3 tests for differences in this effect between low and high-endowed participants. Estimation results are presented in Table 3[11].

H1 posits that the share of endowment allocated to conservation is larger for high-endowed participants; thus we expect β_1 to be positive and significant. Results of Model 1 indicate that compared to low-endowed participants, high-endowed participants are more likely to conserve, and conditional on conservation, their share of endowment contributed to conservation in the baseline is significantly higher. This is consistent with H1 suggesting that Type 1 producers with low endowment and high opportunity costs of conservation tend to conserve less in the absence of PES. Under the maxi-min PES scheme, however, the share of endowment allocated to conservation by high and low-endowed participants does not differ significantly. We thus do not find strong and unambiguous support for H1.

[10] Given that under the maxi-min PES scheme and payment set one, high-endowed participants do not receive any payment when the low payment level is introduced (see Table 1), this decision is also reflected in the ha10 dummy.

[11] Since potential income and learning effects as well as order effects were minimized in the implementation phase of the experiment (no feedback on earnings was provided during decisions, order of payment levels was randomly varied), we do not include decision (scenario) fixed effects in the models.

Table 3: Random effects Tobit model on the share of endowment conserved under egalitarian and maxi-min PES schemes

	Model (1) Egalitarian PES scheme						Model (2) Maxi-min PES scheme					
	Coefficient		Extensive dy/dx		Intensive dy/dx		Coefficient		Extensive dy/dx		Intensive dy/dx	
Dummy_ Ha_10	0.1424	*	0.0386	*	0.0918	*	-0.1506		-0.0123		-0.0852	
	(0.0760)		(0.0235)		(0.049)		(0.1098)		(0.0122)		(0.0623)	
PES level	0.3679	***	0.0997	**	0.2370	***	0.4079	***	0.0334		0.2310	***
	(0.1289)		(0.0471)		(0.0836)		(0.1322)		(0.0263)		(0.0755)	
Dummy_ Ha_10 * PES level	-0.2575		-0.0698		-0.166		-0.0870		-0.00713		-0.0493	
	(0.2202)		(0.0635)		(0.1420)		(0.2630)		(0.0221)		(0.1490)	
Constant	0.3648	***					0.4791	***				
	(0.0441)						(0.0650)					
No. of observations	396						423					
No. of groups	132						141					
Wald chi2	10.98						14.41					
Prob>chi2	0.0118						0.0024					

PES Level is a continuous variable defined over the interval 0.05 and 0.40 on 0.05 interval units.
*p<0.10, **p< 0.05, ***p<0.01.

Model 1 reveals that when payment levels increase by one percentage point, low-endowed participants are significantly more likely to conserve and, conditional on conservation, increase the share of land allocated to conservation by 0.24 percentage points. The second hypothesis predicts a larger increase in the proportion of land conserved among low-endowed participants when payments are introduced under an egalitarian PES scheme. Hence, we expect β_3 to be negative. The coefficient of the interaction term, while having a negative sign as expected, is not statistically significant. Thus, we do not find evidence for significant differences in the price effect between low and high-endowed participants, neither in terms of the increase in the probability of conservation nor in the proportion of land conserved, and accordingly reject H2.

Under the maxi-min PES scheme the payment effects look similar. Conditional on conservation, low-endowed participants increase the share of their land conserved by 0.23 percentage points in response to a one-percentage point increase in payment levels. As under the egalitarian PES scheme, the supply response of high-endowed participants does not significantly deviate from that of low-endowed participants.

Despite this finding, it should be noted that on the average high-endowed participants hardly react at all to changes in the offered payment for conservation. Table 4 presents separate estimation results for high and low-endowed participants, respectively. In Model 3 and Model 4, we introduce the dummy variable *Maximin* that takes the value of one for the maxi-min PES scheme. Consistent with previously reported results, low-endowed participants significantly increase the proportion of land conserved in response to higher payment levels and this price effect does not differ significantly between the two alternative PES schemes. For high-endowed participants, however, our experimental evidence suggests that their propensity to conserve remains unaffected by the introduction of the economic incentives under both alternative PES schemes.

Table 4: Random effects Tobit model on the share of endowment conserved by endowment status

	Model (3) low endowment					**Model (4) high endowment**				
	Coefficient		**Extensive dy/dx**	**Intensive dy/dx**		**Coefficient**		**Extensive dy/dx**	**Intensive dy/dx**	
Dummy_MaxiMin	0.1287		0.0145	0.0745		-0.1570	*	-0.0435	-0.102	*
	(0.0850)		(0.0116)	(0.0493)		(0.0846)		(0.0277)	(0.0551)	
PESLevel	0.3901	***	0.0439	0.2260	***	0.1080		0.0299	0.0702	
	(0.1449)		(0.0274)	(0.0843)		(0.1688)		(0.0482)	(0.1100)	
Dummy_MaxiMin* PES level	0.0108		0.00122	0.00627		0.1967		0.0545	0.128	
	(0.1956)		(0.0220)	(0.1130)		(0.2550)		(0.0736)	(0.1660)	
Constant	0.3492	***				0.5070	***			
	(0.0602)					(0.0610)				
No. of observations	546					273				
No. of groups	182					91				
Wald chi2	19.52					6.11				
Prob>chi2	0.0002					0.1063				

PESLevel is a continuous variable defined over the interval 0.05 and 0.40 on 0.05 interval units.
*p<0.10, **p< 0.05, ***p<0.01.

Impact of alternative PES schemes on distributional outcome

In this section we address the impact of the two alternative PES schemes on distributional outcomes. In particular, we test whether the introduction of an egalitarian PES scheme increases inequality among group members, as proposed in H3, and whether the maxi-min PES scheme can function as a redistributive instrument decreasing inequality among group members, as proposed in

H4. For this purpose, we estimate two random effects GLS models[12] for low and high-endowed participants, respectively:

$$I_{it} = \theta_0 + \theta_1 MaxiMin_{it} + \theta_2 PesLevel_{it} + \theta_3 MaxiMin_{it} * PesLevel_{it} + \vartheta_i + \mu_{it} \quad (11)$$

where the dependent variable I captures the distributional outcome and is measured as the share of total group earnings held by individual i in decision t. The variable *MaxiMin* is a dummy variable that takes the value of one for the maxi-min PES scheme. The θ's are parameters to be estimated: θ_0 captures the degree of inequality under the egalitarian PES scheme treatment in the baseline (*PesLevel* = 0); θ_1 captures differences in distributional outcome between the baseline decisions of the two alternative PES schemes[13]; θ_2 measures the change in distributional outcome associated with a change in payment level under the egalitarian PES scheme; and θ_3 tests for potential differences in the payment level effects between the two alternative PES schemes.

We also estimate a random effects GLS model at the group level (indexed by subscript *g*):

$$GI_{gt} = \theta_0 + \theta_1 MaxiMin_{gt} + \theta_2 PesLevel_{gt} + \theta_3 MaxiMin_{gt} * PesLevel_{gt} + \eta_g + \varepsilon_{gt} \quad (11)$$

where the dependent variable GI is measured as the Gini index capturing distributional outcome at the group level. The Gini coefficient is calculated based on the income distribution within groups and varies between 0, reflecting complete equality, and 1, reflecting complete inequality. At the group level, $PesLevel_{gt}$ is calculated as the average payment offered to low and high-endowed participants of group g in decision *t*. The parameters η_g and ε_{gt} capture time-invariant and time-variant group-level heterogeneity and the time-invariant heterogeneity is assumed to be uncorrelated with the other covariates. Table 5 presents the estimation results. Model 5 and Model 6 provide the results on the earnings share held by low-endowed and high-endowed participants, respectively. Model 7 provides the results on the group-level Gini index.

[12] Even though the dependent variable ranges between zero and one, it is distributed normally, and thus GLS estimation is preferred over Tobit. Tobit model results lead to the same conclusions and can be provided upon request.

[13] Given that under the Maxi-min PES scheme and payment set one, high-endowed participants do not receive any payment when the low payment level is introduced (see Table 1), this decision is also reflected in the maxi-min PES dummy.

Table 5: Random effects GLS model on the share of total group earnings by endowment status and on the Gini index at group level

	Model (5)		Model (6)		Model (7)	
	Earnings share low endowment		**Earnings share high endowment**		**Gini index**	
Dummy_ MaxiMin	-0.0118	**	0.0218	**	0.0296	***
	(0.0051)		(0.0094)		(0.0103)	
PESLevel	-0.0184		0.0369	*	0.0183	
	(0.0113)		(0.0219)		(0.0216)	
Dummy_MaxiMin * PESLevel	0.0367	**	-0.0812	**	-0.0957	***
	(0.0148)		(0.0315)		(0.0295)	
Constant	0.2861	***	0.4278	***	0.1090	***
	(0.0036)		(0.0068)		(0.0074)	
No. of observations	546		273		273	
No. of groups	182		91		91	
Wald chi2	8.51		9.04		19.05	
Prob>chi2	0.0366		0.0288		0.0003	

At group level, PES Level is calculated as the average payment offered to low and high-endowed individuals within group *g* in decision *t*.
*p<0.10, **p< 0.05, ***p<0.01.

The constant term indicates that when no payments in the egalitarian treatment group are offered, on the average low-endowed participants receive 29 percent of the group earnings, high-endowed participants receive 43 percent of the group earnings, and the Gini Index is 0.11[14]. Results presented in Table 5 allow us to address H3 hypothesizing that the introduction of an egalitarian PES scheme increases inequality. The signs of the coefficients on *PesLevel* indeed indicate that the increase of payments under an egalitarian PES scheme decreases the earnings share held by low-endowed participants and increases the earnings share held by high-endowed participants. In line with these distributional changes, the Gini index increases in response to the introduction of payments under the egalitarian scheme. Yet, these effects are only significant in the case of high-endowed participants implying that the evidence for an inequality-increasing effect of the egalitarian PES scheme is rather weak.

In contrast, we find significant evidence in favor of H4 stating that the introduction of a maxi-min PES scheme reduces inequality. The estimated coefficient on the interaction term indicates that

[14] While this suggests relatively low levels of inequality, we do not intend to interpret the absolute level of the Gini index, which is partly an artifact of the small number of individuals within groups for which the Gini index is calculated, but rather focus on changes in the Gini index.

under the maxi-min PES scheme the effect of a one-percentage point increase in payment levels leads to an increase of 0.04 percentage points in the share of group earnings of low-endowed participants and to a decrease of 0.08 percentage points in the share of group earnings of high-endowed participants compared to the egalitarian PES scheme. These changes in distributional outcome are also reflected in the group level analysis. Model 7 shows that a one-percentage point increase in payment levels under the maxi-min PES scheme decreases the Gini coefficient by 0.1 index points. The results hence imply that the introduction of a maxi-min PES scheme, under the assumptions made, can have an inequality-decreasing effect influencing the income distribution in favor of producers with lower endowments.

Impact of alternative PES schemes on environmental additionality at group level

Finally, we investigate whether the introduction of a maxi-min PES scheme that offers higher payments to low-endowed participants comes at the cost of lower environmental additionality at group level. To test for this effect, and considering the panel structure of our experimental data, we estimate the following random effects Tobit model at group level:

$$R_{gt} = \theta_0 + \theta_1 MaxiMin_{gt} + \theta_2 PesLevel_{gt} + \theta_3 MaxiMin * PesLevel_{gt} + \eta_g + \varepsilon_{gt} \quad (11)$$

where R measures the share of total endowment contributed to rubber agroforestry by group g in decision t. Table 6 presents the results.

Table 6: Random effects Tobit model on the share of endowment conserved at group level

	Model (8) All				
	Coefficient		Extensive dy/dx	Intensive dy/dx	
Dummy_ MaxiMin	-0.0211		-0.0065	-0.0200	
	(0.0388)		(-0.5400)	(-0.5500)	
PESLevel	0.1812	**	0.0553	0.171	*
	(0.0835)		(-1.8700)	(-2.1700)	
Dummy_ MaxiMin* PES level	0.0485		0.0148	0.0457	
	(0.1137)		(-0.4200)	(-0.4300)	
Constant	0.4526	***			
	(0.0278)				
No. of observations	273				
No. of groups	91				
Wald chi2	13.67				
Prob>chi2	0.0034				

At group level, PES Level is calculated as the average payment offered to low and high-endowed individuals within group g in decision t. *p<0.10, **p< 0.05, ***p<0.01.

According to the results reported in Table 6, the coefficient on *PESLevel* is positive and significant. Conditional on conservation, a one-percentage point increase in payment levels offered under the egalitarian PES scheme increases the share of land conserved at group level by 0.17 percentage points. Furthermore, we find no significant difference in the increase in the proportion of land conserved between the egalitarian and the maxi-min PES scheme. These findings support hypothesis H5 that the introduction of a maxi-min PES scheme (compared to an egalitarian PES scheme) does not necessarily need to be compromised by lower conservation outcomes at the aggregate level.

6 Conclusion

While payments for environmental services are increasingly proposed as an efficient instrument to promote conservation, concerns have been raised that they privilege large landowners and perpetuate or even aggravate existing inequalities in income distribution. Against this background, it has been claimed that besides environmental goals PES should also address equity considerations to secure the social and political legitimacy of program interventions. In this paper, we contribute to this discussion by providing experimental results on the effects of two alternative PES schemes on conservation decisions and distributional equity. Our results show that the introduction of a maxi-min PES scheme realigns income in favor of low-endowed participants, while providing environmental additionality similar to an egalitarian PES scheme. This implies that payment schemes can be designed in such a way that they function as multi-purpose instruments suitable for policy-makers wishing to reconcile equity and conservation goals.

Our findings further suggest that while low-endowed participants conserve significantly more with increasing payment levels, the conservation behavior of high-endowed participants remains largely unaffected by the introduction of incentive payments. We can thus conclude that the increase in conservation area at the group level in response to the introduction of PES mainly stems from low-endowed participants. This supports the common criticism that large-scale farmers may cash-in on PES for conservation activities that they would have carried out anyway. It also suggests that under the conditions explored here, targeting large landowners does not necessarily make conservation policy interventions more effective in achieving environmental additionality.

When assessing policy implications, it is crucial to consider the external validity of the experiment. Evidence has shown that the necessary simplifications in experimental settings can affect the external validity of experimental results (Castillo et al., 2011; Rustagi et al., 2010; Gurven and

Winking, 2008; Travers et al., 2011). A central assumption in our experimental design is that low-endowed participants have higher opportunity costs of conservation. To what extent this applies to small-scale farmers is debated in the literature. Some scholars point out that poor households tend to own marginal land of low soil fertility, which results in lower opportunity costs of conservation. Here, we assume that poor households face survival constraints when making conservation efforts that endure present sacrifices (Baland and Plateau, 1999) and thus have high opportunity costs of conservation. In a situation, where small-scale farmers indeed face lower opportunity costs of conservation, their initial conservation levels in the absence of incentive payments is likely to be higher, and consequently, their response to the introduction of payments will be lower. Thus, the aggregate conservation outcome at the group level is unclear, in particular, because under the current setting the increase in group-level conservation mostly resulted from the conservation decision of low-endowed participants. Regarding the distributional implications of the PES scheme, we would still expect the maxi-min scheme to have an (even stronger) inequality-decreasing effect. But even the egalitarian PES scheme may contribute to decreasing inequality in such a scenario: equation (5) shows that the inequality-increasing effect of the egalitarian PES scheme is conditional on the opportunity costs of conservation. If the opportunity costs of low-endowed participants are substantially lower than those of high-endowed participants, the introduction of an egalitarian PES scheme may indeed decrease inequality.

From a policy perspective, it is important to note that the focus of our analysis is on environmental additionality and hence disregards the cost-effectiveness of the alternative PES schemes. To evaluate cost-effectiveness, the implementation costs of alternative schemes need to be taken into account, which besides the direct costs of compensation, also comprise the transaction costs associated with the delivery of payments. Since these costs depend to a large extent on the amount of information required, it can be argued that a maxi-min PES scheme would imply higher transaction costs than an egalitarian PES scheme relying on a flat-rate payment (Pascual et al., 2010). On the other hand, if the equity principle underlying the maxi-min PES scheme increases acceptance of the scheme in the community, this is likely to facilitate program implementation, induce community cooperation, and effectively reduce transaction costs.

In our study, we investigated the behavioral responses of Indonesian farmers to the introduction of alternative payment schemes reflecting different implicit equity principles. It should be kept in mind that several other institutional factors potentially affecting the conservation decision of farmers could not be considered in the experimental design. In practice, the establishment of oil palm plantations is associated with high upfront investments that only yield a return once the palms start producing. Effectively, for credit-constrained farmers this is likely to be a barrier to oil palm adoption. Thus, in comparison to the experimental land use decisions, in reality we may observe less land allocated to oil palm cultivation, due to existing capital constraints.

On the other hand, land use decisions are likely to be influenced by insecure land tenure, overlapping claims and lacking information on private tenure (Engel and Palmer, 2008; Muradian et al., 2010; Börner et al., 2010). This is of special relevance in our study region. While oil palm farmers who obtained their land through nucleus estate smallholder schemes — in our sample, the trans-migrant villages—and who participate in the rural microfinance program often hold formal land titles, other rural households receive private land through "informal" land markets based on customary land tenure arrangements (McCarthy et al., 2012; Hauser-Schäublin and Steinebach, 2014). In the case of customary land, overlapping claims from the community and state are common, posing a threat to land tenure security. Given that rubber agroforestry is traditionally practiced on customary land, farmers may be reluctant to convert oil palm into rubber agroforestry, as this may jeopardize land security.

In summary, our study provides behavioral evidence on the implications of different payment scheme designs for environmental and social outcomes. In order to inform policy-makers, further research is needed testing alternative PES designs and capturing additional institutional drivers and constraints of land use transformation.

Acknowledgements
We thank all the farmers who participated in the workshop. Logistical support was provided by the EFForTS staff and coordination. This study was financed by the Deutsche Forschungsgemeinschaft (DFG) in the framework of the collaborative German-Indonesian research project CRC990.

7 References

Alix-Garcia, J., De Janvry, A., & Sadoulet, E. (2008). The role of deforestation risk and calibrated compensation in designing payments for environmental services. *Environment and Development Economics,* 13, 375–394.

Baland, J.M., & Platteau, J.P. (1999). The ambiguous impact of inequality on local resource management. *World Development, 27*, 773–778.

Barnes, A.D., Jochum, M., Mumme, S., Farikhah Haneda, N., Farajallah, A., Widarto, T.H. & Brose, U. (2014). Consequences of tropical land use for multitrophic biodiversity and ecosystem functioning, *Nature Communication*, 5, 1-7

Belcher, B., & Schreckenberg, K. (2007). Commercialization of Non-timer Forest Products: A Reality Check. *Development Policy Review*, 25, 355-377.

Beukema, H., Danielsen, F., Vincent, G., Hardiwinoto, S., & van Andel, J. (2007). Plant and bird diversity in rubber agroforestry in the lowlands of Sumatra, Indonesia. *Agroforestry Systems*, 70, 217-242.

Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Rügnitz Tito, M., Pereira, L., & Nascimento, N. (2010). Direct conservation payments in the Brazilian Amazon: Scope and equity implications. *Ecological Economics,* 69, 1272-1282.

Cardenas, J.C., Stranlund, J., & Willis, C. (2002). Economic inequality and burden-sharing in the provision of local environmental quality. *Ecological Economics,* 40, 379-395

Castillo, D., Bousquet, F., Janssen, M., Worrapimphong, K., & Cardenas, J.C. (2011). Context matters to explain field experiments: results from Colombian and Thai fishing villages. *Ecological Economics*, 70, 1609–1620.

Chan, K. S., & Mesterlman, S. (1999). Heterogeneity and the Voluntary provision of Public Goods, *Experimental Economics*, 2, 5-30

Cherry, T.L., Kroll, S., & Shrogren, J.F. (2005). The impact of endowment heterogeneity and origin on public good contributions: evidence from the lab. *Journal of Economic Behavior &Organization*, 57, 357-365

Colchester, M., Jiwan, N., Andiko, Sirait, M., Firdaus, A.Y., Surambo, A., & Pane, H. (2006). Promised land: Palm oil and land acquisition in Indonesia: Implications for local communities and indigenous peoples. Bogor, Indonesia: Forest Peoples Programme, Sawit Watch, ICRAF.

Corbera, E., & Pascual, U. (2012). Ecosystem services: head social goals. *Science,* 335, 655-656

Corbera, E., Brown, K., & Adger, W.N. (2007). The equity and legitimacy of markets for ecosystem services. *Development and Change*, 17, 365-380

Danielsen, F., Beukema, H., Burgess, N.D., Parish, F., Brühl, C.A. Donald, P.F. Murdiyarso, D., Phalan, B., Reijnders, L., Struebig, M., & Fitzherbert, E.B. (2009). Biofuel plantations on forested lands: Double jeopardy for biodiversity and climate. *Conservation Biology*, 23, 348-358

Ekadinata, A., & Vincent, G. (2011). Rubber Agroforests in a Changing Landscape: Analysis of Land Use/Cover Trajectories in Bungo District, Indonesia. *Forests, Trees and Livelihoods*, 20, 3–14

Elmhirst, R. (1999). Space, identity politics and resource control in Indonesia's transmigration programme. *Political Geography*, 18, 813–835

Engel, S., & Palmer, C. (2008). Payments for environmental services as an alternative to logging under weak property rights: The case of Indonesia. *Ecological Economics,* 65, 799-809

Engel, S., Pagiola, S., & Wunder, S. (2008). Designing payments for environmental services in theory and practice: An overview of the issues. *Ecological Economic,* 65, 663-674

Fearnside, P.M. (1997). Transmigration in Indonesia: Lessons from Its Environmental and Social Impacts. *Environmental Management,* 21, 553–570

Feintrenie, L., & Levang, P. (2009). Sumatra's Rubber Agroforestrys: Advent, Rise and Fall of s Sustainable Cropping System, *Small-scale Forestry, 8*, 323–335.

Feintrenie, L., Chong, W.K. & Levang, P. (2010). Why do Farmers Prefer Oil Palm? Lessons Learnt from Bungo District, Indonesia, *Small-scale Forestry*, 9, 379-396

Frey, B.S., & Jegen, R. (2001). Motivation crowding theory. *Journal of Economic Surveys, 15*, 589-611

Gouyon, A. (2003). *Eco-certification as an incentive to conserve biodiversity in rubber smallholder agroforestry systems: A preliminary study*, ICRAF Southeast Asia Working Paper No 2003_1 Bogor, Indonesia. ICRAF (World Agroforestry Centre).

Grieg-Gran, M., Porras, I., & Wunder, S. (2005). How Can Market Mechanisms for Forest Environmental Services Help the Poor? Preliminary Lessons from Latin America. *World Development*, 33, 1511-1527

Gurven, M., & Winking, J. (2008). Collective action in action: prosocial behavior in and out of the laboratory. *American Anthropologist*, 110, 179–190.

Hauser-Schäublin, B., Steinebach, S. (2014). Harapan: A "No Man's Land" Turned into a Contested Agro-Industrial Zone. EFForTS Discussion Paper Series No. 4. Göttingen, Germany.

Ibanez, M. & Martinsson, P. (2013). Curbing coca cultivation in Colombia- A framed field experiment. *Journal of Public Economics,* 105, 1-10

ICRAF (2014). Rewarding upland poor for environmental services, Kenya, Nairobi, ICRAF (World Agroforestry Centre). http://worldagroforestrycentre.net/regions/southeast_asia/Indonesia/projects/profile/RUPES%20I

Jack, B.K., Kousky, C., & Sims, K.R.E., (2008). Designing payment for ecosystem services: lessons from previous experience with incentive-based mechanisms. *PNAS*, 105, 9465-9470

Janssen, M.A., Bousquet, F., Cardena J.C., Castillo, D. & Worrapimphong, K. (2012). Field experiments of irrigation dilemmas. *Agricultural Systems*, 109, 65-75

Janssen, M.A., Bousquet, F., Cardenas, J.C., Castillo, D. & Worrapimphong, K. (2013). Breaking the elected rules in a field experiment on forestry resources. *Ecological Economics,* 90, 132-139

Kerr, J., Vardhan, M., & Jindal, R. (2012). Prosocial behavior and incentives: Evidence from field experiments in rural Mexico and Tanzania. *Ecological Economics*, 73, 220-227

Koh, L.P., Miettinen, J., Liew, S.C., & Ghazoul, J. (2011). Remotely sensed evidence of tropical peatland conversion to oil palm. *PNAS, 108*, 5127–5132

Koh, L.P., & Wilcove, D.S. (2008). Is oil palm agriculture really destroying tropical biodiversity? *Conservation Letters,* 1, 60–64

Kosoy, N., Martinez-Tuna, M., Muradian, R., & Martinez-Alier, J. (2007). Payments for environmental services in watershed: Insights from a comparative study of three cases in Central America. *Ecological Economic,* 61, 446-455

Landell-Mills, N. & Porras, I. (2002). Silver bullet or foods gold? A global review of markets for forest environmental services and their impacts on the poor. Instruments for Sustainable Private Sector Forestry Series. International Institute for Environment and Development, London

Landell-Mills, N. (2002). Developing markets for forest environmental services: an opportunity for promoting equity for while securing efficiency. *Philosophical Transactions of the Royal Society*, 360, 1817-1825

Laumonier, Y., Uryu, Y., Stüwe, M., Budiman, A., Setiabudi, B., & Hadian, O. (2010). Eco-floristic and deforestation threats in Sumatra: Identifying new conservation area network priorities for ecosystem-base land use planning. *Biodiversity and Conservation*, 19, 1153-1174

McCarthy, J.F., Gillespie, P., & Zen, Z. (2012). Swimming Upstream: Local Indonesian Production Networks in "Globalized" Palm Oil Production. *World Development,* 40, 555–569

Muradian, R., Arsel, M., Pellefrini, L., Adaman, F., Aguilar, B., Agarwal, B., Corbera, E., Ezzine de Blas, D., Farley, J., Froger, G., Garcia-Frapolli, E., Gomez-Baggethun, E., Gowdy, J., Kosoy, N., Le Coq, J.F., Leroy, P., May, P., Meral, P., Mibielli, P., Norgaard, R., Ozkaynak, B., Pascual, U., Pengue, W., Perez, M., Pesche, D., Pirard, R., Ramos-Martin, J., Rival, L., Saenz, F., Van Hecken, G., Vatn, A., Vira, B. & Urama, K. (2013). Payments for ecosystem services and the fatal attraction of win-win solutions. *Conservation letters*, 6, 1-6

Muradian, R., Corbera, E., Pascual, U., Kosoy, N., & May, P.H. (2010). Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. *Ecological Economics*, *69*, 1202–1208

Narloch, U., Pascual, U. & Drucker, A.G. (2012). Collective Action Dynamics under external Rewards: Experimental Insights from Andean Farming Communities. *World Development,* 40, 2096-2107

Narloch, U., Pascual, U., & Drucker, A.G. (2013). How to achieve fairness in payments for ecosystem services? Insights from agrobiodiversity conservation auctions. *Land use Policy*, 35, 107-118

Obidzinski, K., Andriani, R., Komarudin, H., & Andrianto, A. (2012). Environmental and Social Impacts of Oil Palm Plantations and their Implications for Biofuel Production In Indonesia. *Ecology and Society,* 17, 25

Ostrom, E. (2000). Collective action and evolution of social norms. *Journal of Economic Perspectives*, 14, 137–158

Pagiola, S., Arcenas, A., & Platais, G. (2005). Can Payments for environmental Services Help reduce Poverty? An Exploration of the Issue and the Evidence to Date from Latin America. *World Development*, 33, 237-253

Pascual, U., Muradian, R., Rodriguez, L.C., & Duraiappah, A. (2010). Exploring the links between equity and efficiency in payments for environmental services: A conceptual approach. *Ecological Economics*, *69*, 1237–1244

Pramova, E., Locatelli, B., Mench, A., Marbyanto, E., Kartika, K. & Prihatmaja, H. (2013). *Integrating adaptation into REDD+: Potential impacts and social return on investment in Setulang, Malinau District, Indonesia* (CIFOR Working Paper No. 112). Bogor, Indonesia: Center for International Forestry Research.

PWC (2012). Palm Oil Plantation. Industry landscape, regulatory and financial overview. http://www.pwc.com/id/en/publications/assets/palm-oil-plantation-2012.pdf

Reuben, E., & Riedl, A. (2013). Enforcement of contribution norms in public good games with heterogenous populations. *Games and Economic Behavior*, 77, 122-137

Rodriguez-Sickert, C., Guzmán, R.A. & Cardenas, J.C. (2008). Institutions influence preferences: Evidence from a common pool resource experiment. *Journal of Economic Behavior & Organization*, 67, 215-227

Rustagi, D., Engel, S., & Kosfeld, M. (2010). Conditional cooperation and costly monitoring explain success in forest commons management. *Science,* 330, 961–965

Schilizzi, S. (2011). Equity judgements and context dependence: Knowledge, efficiency and incentives. Working Paper 1106. School of Agricultural and Resource Economics, The University of Western Australia.

Sommerville, M., Jones, J.P. G., Rahajaharison, M., & Mildner-Gulland, E.J. (2010). The role of fairness and benefit distribution in community-based Payment for Environmental Services interventions: A case study from Menabe, Madagascar. *Ecological Economics*, 69, 1262-1271

The Jakarta Post, (2009). Indonesia allocates 18 million hectares of land for palm oil. Jakarta Post. http://www.thejakartapost.com/news/2009/12/02/indonesia-allocates-18-million-hectares-land-palm-oil.html

Travers, H., Clements, T., Keane, A., & Mildner-Gulland, E.J. (2011). Incentives for cooperation: The effects of institutional controls on common pool resource extraction in Cambodia. *Ecological Economics*, *71*, 151–161

Villamor, G.B., Le, Q.B., Vlek, P.L.G., & Van Noordwijk, M. (2011). *Payments for agro-biodiversity: An analysis of participation in Jambi's conservation agreements for rubber agroforests, (Sumatra) Indonesia*. Paper presented at the 13th Annual BIOECON Conference on Resource Economics, Biodiversity Conservation and Development, Geneva, Switzerland.

Vollan, B. (2008). Socio-ecological explanations for crowding-out effects from economic field experiments in southern Africa. *Ecological Economics*, 67, 560-573

Wilcove, D.S., & Koh, L.P. (2010). Addressing the threats to biodiversity from oil-palm agriculture. *Biodiversity and Conservation*, 19, 999-1007

Wunder, S. (2005). Payments for Environmental Services:Some Nuts and Bolts, CIFOR Occasional Paper No.42, Center for International Forestry Research (CIFOR).

WTO. (2010). *World trade report 2010: Trade in natural resources*. Switzerland, Geneva

Zbinden, S., & Lee, D.R. (2005). Paying for Environmental Services: An Analysis Of Participation in Costa Rica's PSA Program. *World Development*, 33, 255-272

8 Appendices

Table A1: Results of the seemingly unrelated regressions with socioeconomic and session characteristics as the dependent variables

	Egalitarian PES		Maxi-min PES	
	e=5 (Constant)	**e=10**	**e=5**	**e=10**
Age (# years)	44.01 (1.14)	-0.79 (1.97)	-2.02 (1.58)	3.99 (2.77)
Female (0/1)	0.059 (0.029)	0.045 (0.072)	0.050 (0.041)	-0.036 (0.051)
Secondary (0/1)	0.476 (0.053)	0.036 (0.130)	-0.036 (0.074)	-0.143 (0.092)
HH_size	4.29 (0.163)	0.225 (0.396)	-0.154 (0.226)	-0.119 (0.282)
Transmigrant (0/1)	0.333 (0.049)	0.013 (0.122)	-0.037 (0.069)	-0.047 (0.087)
Oil palm (0/1)	0.642 (0.053)	-0.059 (0.129)	-0.060 (0.073)	0.024 (0.092)
Oil palm_ha (ha)	1.92 (0.299)	-0.530 (0.727)	0.342 (0.414)	0.608 (0.517)
Rubber monoculture (0/1)	0.476 (0.054)	-0.009 (0.133)	-0.015 (0.076)	0.024 (0.094)
Rubber monoculture _ha (ha)	0.708 (0.122)	-0.151 (0.298)	-0.044 (0.169)	0.238 (0.212)
Rubber agroforestry (0/1)	0.095 (0.036)	0.039 (0.088)	0.081 (0.050)	-0.048 (0.062)
Rubber agroforestry_ha (ha)	0.440 (0.186)	0.484 (0.453)	-0.091 (0.258)	-0.369 (0.323)
Oil palm_rubber monoculture (0/1)	0.178 (0.041)	-0.036 (0.100)	-0.036 (0.057)	0.059 (0.071)
Oil palm_rubber agroforestry (0/1)	0.024 (0.022)	0.029 (0.053)	0.042 (0.030)	-0.024 (0.038)
Session characteristics				
Share_known_names	0.840 (0.019)	-0.077 (0.047)	-0.038 (0.027)	0.029 (0.033)
Share_family_members	0.132 (0.022)	0.017 (0.052)	-0.013 (0.030)	-0.019 (0.037)

Standard error in parentheses