Conservation versus Equity: Can Payments for Environmental Services Achieve Both?

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ABSTRACT. *Based on a framed field experiment, we investigate the trade-off between conservation and equity in the use of payments for environmental services (PES). We compare the effects of two PES schemes that implicitly incorporate different distributive justice principles: a flat-rate payment per biophysical unit conserved and a redistributive payment based on the Rawls maxi-min distributional principle. The main findings indicate that the introduction of a redistributive scheme can function as a multipurpose instrument. Under the assumed condition that participants with lower endowments face higher opportunity costs of conservation, it realigns the income distribution in favor of low-endowed participants without compromising conservation outcomes.* (JEL Q15, Q57)

I. 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, De Janvry, and Sadoulet 2008; Jack, Kousky, and Sims 2008; Muradian et al. 2010; Engel, Pagiola, and Wunder 2008; Pascual et al. 2010). Although PES are proposed as an efficient instrument to promote conservation compared to traditional command-and-control mechanisms (Pagiola, Arcenas, and Platais 2005), critics argue that PES are regressive, as they privilege a few large-scale landholders, who are often the least-cost suppliers of environmental services (Pascual et al. 2010; Narloch, Pascual, and Drucker 2013; Muradian et al. 2010). In addition, the environmental effectiveness and efficiency of PES schemes are contested, as the large-scale landholders might have conserved their land even in the absence of PES schemes (Wunder 2005).

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, Porras, and Wunder 2005; Corbera, Brown, and Adger 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, Arcenas, and Platais 2005; Grieg-Gran, Porras, and Wunder 2005; Corbera, Brown, and Adger 2007; Muradian et al. 2010; Corbera and Pascual 2012; Narloch, Pascual, and Drucker 2013; Muradian et al. 2013). In this paper we investigate the potential of using PES as a multipurpose instrument to promote conservation and enhance equity.

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. Ac-

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countability-based principles seek to compensate service providers according to their actual ecosystem service 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 are often not available in practice. PES schemes based on an egalitarian principle pay a flat rate per biophysical unit conserved (e.g., per hectare), which thus does not equate with the marginal benefit of ecosystem service provision. However, due to their relative ease of implementation, flat-rate PES schemes 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 per biophysical unit conserved to poorer landholders. Such redistributive PES schemes thus consider the reduction of inequalities as an explicit goal, irrespective of the marginal benefits and costs of the provision of ecosystem services. In this paper, we address the questions of whether the implementation of a redistributive PES scheme that offers differential payments improves distributional outcome in favor of the disadvantaged and whether this comes at the cost of conservation outcomes. In our analysis, conservation outcome is measured as the net impact on land units conserved[2] and is compared to the situation where a flat-rate payment rule 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 agroforest and oil palm. In Jambi province, rubber agroforest 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). In this context, 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 an investment game where households, who differ in terms of their land endowment, decide 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 private profit than oil palm, is associated with positive externalities that benefit other group members. In line with the observation that in our research area small-scale family farms tend to obtain higher oil palm yields compared to large-scale family farms, participants with lower endowments have a higher marginal incentive to invest in oil palm (equivalent to higher opportunity costs of conservation) than participants with high endowments. In our analysis, we compare participants' land allocations to rubber agroforestry and the associated income distributions under a flat-rate and a redistributive PES scheme.

A central assumption in our experimental design is that participants with low endowments have a higher marginal incentive to cultivate oil palm and thus higher opportunity costs of conservation. To what extent this applies to small-scale farmers in reality is debated in the literature. Pagiola, Arcenas, and Platais (2005) show that the desire of the poor to participate in a PES scheme is often restricted by low marginal incentives to allocate scarce resources to conservation. Some authors have explained this based on the need of the poor to use their limited endowments to generate income for survival (Baland and Platteau 1999; Narloch, Pascual, and Drucker 2013). In contrast, other scholars point out

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

[2] Environmental outcome should ideally be measured as additional environmental services provided. However, these are difficult to measure, and therefore in practice, rough proxies such as land units conserved are often used to quantify the environmental impact of a policy.

that poor households are likely to have higher marginal incentives for conservation as they tend to own marginal land of low soil fertility, resulting in lower productivity of commercial crops like oil palm. In our research area, this does not seem to be the case, as we observe a negative relationship between cultivated land size and land productivity among oil palm family farms. From a policy perspective, the scenario considered in our experiment is most interesting. If small landholders had lower marginal incentives to invest in oil palm than larger landholders, they would more readily benefit from the introduction of PES in any case (no equity-efficiency trade-off). It is this specific scenario of small landholders having high incentives to cultivate oil palm, where we are likely to observe a conflict between conservation and equity goals. Nonetheless, before implementing an actual PES scheme, key parameters should be validated in the local context.

Several authors have used framed field experiments to investigate the role of PES-like incentive schemes on conservation decisions between homogenous resource users (e.g., Vollan 2008; Travers et al. 2011; Kerr, Vardhan, and Jindal 2012). Expanding on these previous studies, we explicitly incorporate heterogeneity among participants, which allows us to focus on the distributional effects of PES schemes. We consider in our experiment not only endowment heterogeneity (see Cherry, Kroll, and Shogren 2005; Narloch, Pascual and Drucker 2012; Reuben and Riedl 2013) or only productivity heterogeneity (see Cardenas, Stranlund, and Willis 2002; Reuben and Riedl 2013), but similar to Chan et al. (1999) we assume that participants with different endowments also differ with respect to their marginal incentive to conserve. This extension allows us to capture potential trade-offs between distributional and conservation outcomes when comparing redistributive and flat-rate PES schemes.

To the best of our knowledge only the paper by Narloch, Pascual, and Drucker (2012) implemented a framed field experiment (using a public good game) with endowment heterogeneity in the context of PES. While they consider how individual versus collective reward schemes affect conservation, we focus on the distributive principles of PES. Therefore, our paper is also complementary to former studies that have attempted to capture the effect of different distributive justice principles on PES using microsimulation modeling (Alix-Garcia, De Janvry, and Sadoulet 2008; Börner et al. 2010). Unlike microsimulation studies, our experimental approach allows capturing the effect of intangible factors associated with policy design, such as the local norms of what is perceived as fair or equitable (Kosoy et al. 2007; Rodriguez-Sickert, Guzmán, and Cardenas 2008; Sommerville et al. 2010; Narloch, Pascual, and Drucker 2013).

II. BACKGROUND

Among the countries that faced significant losses in forestland between 1990 and 2005, Indonesia ranks second with regard to the absolute decline in forest area (280,000 km^2) (World Trade Organization 2010). Rapid oil palm expansion has been identified as a major driver of deforestation (Koh et al. 2011). Estimates suggest that between 1990 and 2005 at least 56% of the oil palm expansion in Indonesia occurred at the expense of tropical rainforest (Koh and Wilcove 2008). Laumonier et al. (2010) document that between 1985 and 2007, forest cover in Sumatra declined from 57% to 30%. Jambi province is among the areas on Sumatra that experienced the most drastic forest losses during this time span (Laumonier et al. 2010).

The transformation of tropical lowland rainforest was initially driven by the trans-migrant program, which was launched by the Indonesian government in the early 1980s to relocate households from the overpopulated island of Java to the less populous islands of Sumatra and Kalimantan (Feintrenie and Levang 2009; Feintrenie, Chong, and Levang 2010; Gatto, Wollni, and Qaim 2015). More recently, new oil palm plantations have increasingly been established by independent smallholder farmers (Euler et al. 2016; Ekadinata and Vincent 2011). Between 2000 and 2010, the oil palm area in Indonesia almost doubled from 4.2 million ha to around 8 million ha (Obidzinski et al. 2012). This expansion took place mostly on the islands of Sumatra and Kalimantan, which concentrate

66% and 30% of the national oil palm area, respectively (Rianto, Mochtar, and Sasmito 2012). In the near future, further expansions are planned, and local governments have earmarked 18 million ha, mainly located on the islands of Kalimantan, Sulawesi, and Papua (*Jakarta Post* 2009).

For many rural households the growing oil palm sector offers an attractive pathway out of poverty (in 2010, 38% of the total oil palm area was managed by smallholder farmers) (Rianto, Mochtar, and Sasmito 2012; McCarthy, Gillespie, and Zen 2012).[3] 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, Gillespie, and Zen 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 forestlike vegetation type in Jambi province. Rubber agroforestry, which has been in place since the early twentieth 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 trees, and medical plants. From a biodiversity viewpoint, rubber agroforestry mimics secondary forest, since it incorporates the components of spontaneous secondary vegetation (pioneer, postpioneer and late-phase species[4]) (Beukema et al. 2007; Feintrenie and Levang 2009; Feintrenie, Chong, and Levang 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). While the conversion of tropical forest to any managed land use system is associated with losses in carbon storage, rubber agroforestry systems still fare much better in terms of carbon sequestration potential in comparison to monoculture oil palm plantations (Kotowska et al. 2015).[5]

Despite the environmental benefits of rubber agroforestry, oil palm and rubber monocultures are often preferred by farmers due to their higher economic profitability.[6] For the case of Jambi, Feintrenie, Chong, and Levang (2010) estimate that the relative profit of agroforestry represents approximately 61% to 69% of the profit of oil palm and about 50% of the profit of rubber monoculture, depending on relative prices.[7] Furthermore, technical

[3] Private enterprises managed 58% of the total oil palm area in 2000, dropping to 54% in 2010. Meanwhile the share of smallholder plantations increased from 28% to 38% in the same period (Rianto, Mochtar, and Sasmito 2012).

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

[5] Kotowska et al. (2015) find that total biomass in the natural forest (mean: 384 Mg/ha) was more than two times higher than in rubber agroforestry (147 Mg/ha) and more than four times higher than in monoculture rubber and oil palm plantations (78 and 50 Mg/ha). Net primary productivity was highest in oil palm (33 Mg/ha/yr) compared to natural forest (24 Mg/ha/yr), rubber agroforestry (20 Mg/ha/yr), and rubber plantations (15 Mg/ha/yr). Yet, in oil palm more than 50% of the carbon was sequestered in the fruits and thus exported through harvest and released into the atmosphere.

[6] To the best of our knowledge, no previous studies have quantified the economic value of the environmental effects of rubber agroforestry.

[7] Only the study by Feintrenie, Chong, and Levang (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/ha for oil palm, €2,600/ha for rubber plantations, and €1,300/ha for rubber agroforestry. With low rubber and palm oil prices (November 2008), average returns to land decrease to €990/ha for oil

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. 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). Incentive schemes developed under the framework of Reduced Emissions from Deforestation and Degradation (REDD+) may target rubber agroforestry,[8] given its positive carbon impacts compared to oil palm plantations (Kotowska et al. 2015). Our research aims to inform the development and design of market-based incentive schemes offering monetary incentives for the provision of ecosystem services, such as agro-biodiversity conservation and carbon sequestration.

III. 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.[9] 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 $a < 1$. 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.

Furthermore, we take into account that producers are heterogeneous in terms of the size of available land and also vary with respect to their relative return from rubber agroforestry, and thus their marginal incentive to cultivate oil palm. Type 1 producers have land endowments L_L and a marginal return from rubber agroforestry a_L. In contrast, type 2 producers have land endowments L_H and a marginal return from rubber agroforestry a_H. We consider the particular case where $L_L < L_H$, and $a_L < a_H$. Hence, type 1 producers are smaller (in terms of land endowment) and relatively less productive in rubber agroforestry than type 2 producers. As the marginal return of rubber agroforestry is set to be lower for type 1 producers, they have a higher individual marginal incentive to cultivate oil palm than high-endowed participants $(1 - a_H < 1 - a_L)$.

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 their land 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 in oil palm.[10] The optimization problem for the individual producer is given by

palm, €1,300/ha for rubber, and €690/ha for rubber agroforestry.

[8] There is an ongoing 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).

[9] Although rubber monoculture is still an important land use type in the research area (see our descriptive statistics), oil palm is the land use type most rapidly expanding (and thus threatening biodiversity) in the region (Gatto, Wollni, and Qaim 2015). Therefore, in the conceptual framework and in the experimental design we focus only on the choice between oil palm and rubber agroforestry. The model could be extended to consider rubber monoculture as a third alternative. In this case, the decision to choose rubber agroforestry would depend on the net return and negative externalities of two production systems, oil palm and rubber monoculture. Given that our main interest is to consider the impacts of alternative payment schemes on conservation, this would complicate the model unnecessarily.

[10] The moral cost is related to one's own conscience addressing concerns about the effect of one's decisions on neighbors (as described by Sheeder and Lynne 2011), or

$$\max_{x_i} U = x_i + a_K(L_{K,i} - x_i) + b\sum_{j\neq i}^{N}(L_{K,j} - x_j) - c_i x_i^2$$
$$\text{for } K = \text{L,H}, \qquad [1]$$

where the subindex K denotes producer type L or H. If $1 - a_K > 0$, 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

$$x_{K,i}^* = \frac{1 - \mathrm{a}_{K,i}}{2\mathrm{c}_i}. \qquad [2]$$

Since $a_L < a_H$, we would expect that in the absence of payments for environmental services, type 1 producers—with low endowments of land and high marginal incentive to invest in oil palm—allocate a smaller fraction of land to rubber agroforestry than type 2 producers—with high endowments of land and lower marginal incentive to invest in oil palm.

The Social Planner Problem

The problem for the social planner is to maximize social welfare by selecting the optimal amount of land to be transformed to oil palm cultivation. For a society that is composed of N producers, the problem of a social planner is to maximize the sum of the weighted utility of all individuals:

$$\max_{x=(x_i,\ldots,x_N)} W = \sum_{i=1}^{N} w_i[x_i + a_K(L_{K,i} - x_i) + b\sum_{j\neq i}^{N}(L_{K,j} - x_j) - c_i x_i^2], \qquad [3]$$

where $\mathrm{w_i}$ represents the weights that the social planner gives to the different individuals such that $\sum_{i=1}^{N} w_i = 1$, and K represents a subindex for type 1 (L) and type 2 (H) producers. A social planner who has preferences for progressive redistribution could give a higher weight to the utility of low-endowed than to the utility of high-endowed participants ($w_L > w_H$).

Defining $v = w_L/w_H$ as the relative weight that the low-endowed participant has in comparison to the high-endowed participant, and assuming that there are two type 1 producers and one type 2 producer, the optimal allocation of land to oil palm from the social point of view is $x_L^* = [1 - a_L - b(1/v + 1)]/2c_i$ and $x_H^* = (1 - a_H - 2vb)/2c_i$, for producers type 1 and type 2, respectively. From the social planner point of view, the amount of land that each individual should invest in oil palm is lower than the optimal investment from an individual point of view, as the social planner would internalize the negative externality that oil palm production imposes on other individuals. In order to induce producers to internalize the positive externalities associated with conservation, the social planner could offer monetary incentives, such as payments for environmental services (PES), and thereby reduce the divergence between private and social optimum levels of land allocated to oil palm.

Payments for Environmental Services

Modeling PES as an increase in the relative profit of rubber agroforestry, $a_K + PES$, it is straightforward 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 a flat-rate PES scheme on the proportion of land endowment contributed to conservation would be different for type 1 and type 2 producers. This leads to our first hypothesis:

Hypothesis 1. The implementation of a flat-rate PES scheme will result in a larger increase in the proportion of land conserved for type 1 producers with low endowments and high marginal incentive to invest in oil palm than for type 2 producers with high endowments and low marginal incentive to invest in oil palm. (Proof 1 in Appendix A.)

Since the introduction of a flat-rate PES scheme induces a larger marginal change in

more abstract concerns such as the moral cost of seeing all forest cleared for oil palm.

the proportion of land allocated to rubber agroforestry for type 1 producers than for type 2 producers, and the PES scheme does not fully compensate for the forgone benefits, the implementation of the flat-rate PES scheme results in an increase in income inequality between type 1 and type 2 producers.

Hypothesis 2. Assuming that the individual moral costs of cultivating oil palm c_i, c_j are equal in absolute values, that is, $c_i = c_j = c$, a flat-rate PES scheme might increase inequality by generating a larger reduction in the income of type 1 producers relative to type 2 producers. (Proof 2 in Appendix A.)

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 choose a redistributive PES scheme, offering higher payments to type 1 producers with low endowments and lower payments to type 2 producers with high endowments.

Hypothesis 3. A redistributive PES scheme that reallocates payments toward the low-endowed participants and hence results in a higher payment for low-endowed participants in exchange for a lower payment for high-endowed participants, decreases income inequality compared to a flat-rate PES scheme. (Proof 3 in Appendix A.)

Last but not least, we address the question of whether using PES as a redistributive mechanism necessarily compromises conservation outcomes. While the proportion of land conserved by high-endowed and low-endowed participants is affected by the different payment mechanisms considered here, we hypothesize that at the aggregate level, conservation outcomes will not diverge significantly between the different PES schemes.

Hypothesis 4. The redistributive PES scheme does not lead to a reduction in the increase in the conservation area at the aggregate level compared to a flat-rate PES scheme. (Proof 4 in Appendix A.)

IV. EXPERIMENTAL DESIGN AND PROCEDURES

To empirically test our model we set up an investment game. Participants were randomly matched into groups of three. Two participants in the group were endowed with 5 experimental units of land ($L_L = 5$); one participant received 10 experimental units of land ($L_H = 10$). Considering the rubber agroforestry and oil palm profitability estimates for Jambi province by Feintrenie, Chong, and Levang (2010) as a benchmark, the relative profit of rubber agroforestry of low-endowed participants was set to $a_L = 0.5$, and that of high-endowed participants to $a_H = 0.6$. Thus, as described before, our experimental setup includes endowment heterogeneity, and we implicitly consider the case where low-endowed participants have a higher marginal incentive to cultivate oil palm.

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 agroforestry. To illustrate these investment options, pictures of the two systems were presented to the participants. Each participant decided individually, how much of her endowment to allocate to oil palm and rubber agroforestry, respectively. We explained to participants that rubber agroforestry has positive effects on the environment, which in the experiment translate into higher pay-offs for other group members. Accordingly, each land unit allocated to rubber agroforestry increased the income of other group members by $b = 0.2$.[11]

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

[11] Since there are no estimations on the economic value of the environmental externalities of rubber agroforestry, we assumed this value. Future research should quantify these effects.

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 we can compare the effect of PES on conservation and equity. Table 1 shows the pay-off structure in the baseline scenario, when we assume no moral cost of cultivating oil palm ($c_i = 0$). Under this scenario and assumption, it can be seen that low-endowed participants are better off if all land is allocated to rubber agroforestry, whereas high-endowed participants are better off if all land is allocated to oil palm.[12] Irrespective of their type, individual participants benefit most if they invest their endowment in oil palm (given that $1 - a_K > 0$, i.e., the marginal incentive to invest in oil palm is positive).

In Scenarios 2 and 3, payments for environmental services, δ, associated with the practice of rubber agroforestry were introduced. The marginal incentive per unit of land endowment allocated to rubber agroforestry was $1 - a - \delta$. Each participant played one scenario with a low and one with a high payment level. 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. Moreover, to control for order effects, the decision sets were presented in different orders to participants. Hence, half of the participants received a low payment in the second decision and a high payment in the third decision, whereas the other half received a high payment first, and a low payment subsequently.

[12] The total gain that low-endowed participants receive when all endowment is allocated to rubber agroforestry is smaller than the loss experienced by high-endowed participants. However, this could be justified, if the weight attached to the welfare function of low-endowed participants is sufficiently high ($w_1 > 2w_2$).

Finally, the between-subject design allows us to compare the conservation and distributional outcomes of the two alternative PES schemes: a flat-rate payment rule and a redistributive (Rawlsian maxi-min) payment rule. Each participant took part in only one of the two PES schemes. In the flat-rate PES scheme, high- and low-endowed participants were offered a unitary payment for each unit of land conserved ($\delta_L = \delta_H$). In the redistributive PES scheme, low-endowed participants received a higher payment than high-endowed participants per unit of land conserved ($\delta_L > \delta_H$). This payment rule implies that higher payments are given to the more costly providers of conservation units and may thus result in a trade-off between redistributive and conservation goals. To compare the two alternative PES schemes, and to avoid generating income effects, the average payment per unit conserved (average PES) was kept constant across the two alternative PES schemes. Table 2 depicts the marginal private incentive to invest in rubber agroforestry ($a + \delta$) by endowment status (L, H), payment set (1, 2), payment level (none, low, high), and PES scheme (flat-rate, redistributive).

Procedures

The experiment was conducted in four villages in the Batanghari district (Jambi province); two autochthonous[13] villages (Pulau Betung, Karmeo), which were not targeted by the governmental trans-migration program, and two trans-migrant 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.

[13] In this context, "autochthonous" refers to villages that were formed by indigenous people from the local area, as opposed to villages formed by migrants or their descendants.

TABLE 1
Pay-off Structure in the Baseline Scenario

	All Land Allocated to Oil Palm	All Land Allocated to Rubber Agroforestry	Participant Allocates All Land to Oil Palm, Other Group Members Allocate All Land to Rubber Agroforestry
Low endowed ($L_L = 5$)	$L_L \times 1 = 5$	$L_L \times 0.5 + (L_L + L_H) \times 0.2 = 5.5$	$L_L \times 1 + (L_L + L_H) \times 0.2 = 8$
High endowed ($L_H = 10$)	$L_H \times 1 = 10$	$L_H \times 0.6 + (L_L + L_L) \times 0.2 = 8$	$L_H \times 1 + (L_L + L_L) \times 0.2 = 12$

Note: The estimations assume that the moral cost of cultivating oil palm is zero.

TABLE 2
Relative Profit of Rubber Agroforestry ($a + \delta$) by PES Scheme, Payment Set, Payment Level, and Endowment Status

		PES Scheme			
		Flat-Rate Scheme		Redistributive Scheme	
		L ($e = 5$)	H ($e = 10$)	L ($e = 5$)	H ($e = 10$)
Payment set 1					
No payment		$a_L = 0.50$	$a_H = 0.60$	$a_L = 0.50$	$a_H = 0.60$
Low payment	$av.PES = 0.05$	$a_L + 0.05$	$a_H + 0.05$	$a_L + 0.10$	$a_H + 0.00$
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		$a_L = 0.50$	$a_H = 0.60$	$a_L = 0.50$	$a_H = 0.60$
Low payment	$av.PES = 0.10$	$a_L + 0.10$	$a_H + 0.10$	$a_L + 0.15$	$a_H + 0.05$
High payment	$av.PES = 0.30$	$a_L + 0.30$	$a_H + 0.30$	$a_L + 0.35$	$a_H + 0.25$

Note: PES, payments for environmental services.

Each experimental session consisted of four different stages. First, the instructions of the game were read aloud to the participants, followed by several examples. To illustrate the different choices, we presented posters with photos of each cultivation system. Participants received full information about the rules of the game and the pay-off structures and payments offered to both low-endowed and high-endowed players. In the second stage, two hypothetical decisions without feedback were played to improve and confirm the understanding of the game. In the third stage, participants were presented with three sequential scenarios and made their decisions. In order to avoid potential income and learning effects, participants did not receive feedback on their own earnings or group members' allocations between 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 Indonesian rupiah (IDR 1). All participants were paid privately using checks made payable to them at their local shops. Typical earnings (mean IDR 86,347) were worth between one and two days of wage labor. In the fourth stage, a brief postexperimental questionnaire was completed, incorporating questions related to the experiment, participants' demographics, and farming activities.

V. RESULTS

Socioeconomic Characteristics of the Sample

Based on the postexperimental questionnaire, Table 3 provides a description of socioeconomic characteristics of the participants, such as information on age, gender, educational level, household size, and farming ac-

TABLE 3
Socioeconomic Characteristics of Participants

Variable	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
Trans-migrant[a]	= 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 agroforest	= 1 if HH cultivates rubber agroforest	0.127	0.334
Rubber agroforest_ha	Total individually cultivated rubber agroforest 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 agroforest	= 1 if HH cultivates rubber agroforest and oil palm	0.042	0.202
Size of owned land (ha)	Area of owned land (ha)	4.160	4.919

Note: Total number of observations = 260. HH, household.
[a] 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.

tivities. In daily life, 61% of the participants cultivate oil palm, 48% practice rubber monoculture, and 12.7% practice rubber agroforestry. While 17.3% of the participants combine the cultivation of oil palm and rubber monoculture, only 4.2% of the participants cultivate both oil palm and rubber agroforest. Overall, these numbers reflect the declining role of rubber agroforestry in the research area and hence the importance of studying mechanisms that promote more sustainable land use options such as rubber agroforestry. 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 socioeconomic characteristics and session characteristics as dependent variables[14] (see Appendix Table B1). The results support the randomization strategy, and we find no significant differences across participants in the different treatments or status groups.

Descriptive Results

In the descriptive analysis of our experimental results, we pool the data from payment sets 1 and 2 (cf. Table 2), resulting in two payment levels (low and high). Panel A in Table 4 presents 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% of their endowment, depending on the treatment. This is consistent with our conceptual framework, which considers that economic decisions are not driven solely by economic incentives but are also shaped by normative factors (see equation [2]). The average share of endowment contributed to conservation tends to increase when PES are introduced. The effect is more pronounced in the case of the redistributive PES scheme.

Regarding the distributional outcome of the alternative PES schemes, panel B in Table 4 provides the descriptive results. In the baseline, low-endowed participants earn around 28% and high-endowed participants around 44% of the total group earnings. The introduction of a flat-rate PES scheme with high payment levels tends to exacerbate inequalities in the prevailing income distribution. Table 4 shows that under this scenario, low-endowed participants earn a smaller share and high-endowed participants a larger share of total group earnings, compared to the baseline scenario. The introduction of a redistributive

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

TABLE 4
Descriptive Results

PES Scheme	Endowment Status	Payment Level: Baseline: No Payment	Low Payment	High Payment
Panel A: Share of Endowment Contributed to Rubber Agroforestry				
Flat rate	Low endowed	41.319 (30.667)	43.077 (30.973)	49.451*** (33.776)
	High endowed	47.234 (26.841)	51.489 (28.512)	50.000 (28.817)
Redistributive	Low endowed	45.532 (35.609)	52.553*** (37.097)	54.681*** (37.466)
	High endowed	39.362 (33.062)	39.787 (31.032)	44.468* (32.020)
Panel B: Share of Total Group Earnings Held by Individual				
Flat rate	Low endowed	28.505 (3.724)	28.625 (3.407)	28.052* (2.383)
	High endowed	42.991 (4.863)	42.749 (4.572)	43.896** (3.252)
Redistributive	Low endowed	27.399 (4.838)	27.719 (4.124)	27.997 (2.676)
	High endowed	45.203 (6.242)	44.562* (5.629)	44.006** (3.900)
Panel C: Compensation Costs at the Group Level (in Indonesian Rupiahs)				
Flat rate			73,977 (41,285)	274,886 (102,890)
Redistributive			73,830 (37,238)	278,298 (116,747)

Note: Standard deviations are in parentheses. PES, payments for environmental services.
*, **, *** Based on a Wilcoxon sign-rank test, the difference from the respective baseline value is statistically significant at $p < 0.1$, $p < 0.05$, $p < 0.01$, respectively.

PES scheme tends to realign the income in favor of the low-endowed participants, as expected. In particular, the share of total group earnings held by high-endowed participants tends to decrease, leading to more equal sharing of group earnings between high- and low-endowed participants.

As described earlier, in the experimental design we kept the average payment per unit conserved constant across the two PES schemes in order to provide comparability. Yet, since the two schemes may induce different levels of conservation, total compensation costs may ultimately vary. Panel C in Table 4 compares the two PES schemes with respect to compensation costs at the group level and shows that compensation costs per group are very similar across the schemes. Yet, as expected, there is a pronounced difference in compensation costs between different payment levels. This is particularly noteworthy, as this increase in program budget is not reflected in an equally substantial increase in area conserved (see panel A in Table 4).

Econometric Results

To test for the effects of the redistributive PES scheme, we estimate a number of random effects GLS and Tobit models according to the following specification:

$$Y_{it} = \theta_0 + \theta_1 Redistrib_{it} + \theta_2 PesLevel_{it} + \theta_3 Redistrib_{it} * PesLevel_{it} + \eta_i + \varepsilon_{it}. \quad [4]$$

We estimate separate models for three outcome variables Y: (1) share of total group earnings held by individual i in scenario t, (2) Gini index capturing distributional outcome at the group level, and (3) share of total endowment allocated to rubber agroforestry. The variable *Redistrib* is a dummy variable that takes the value 1 for the redistributive PES scheme. *PESLevel* is a continuous variable on the payment level offered for conservation, taking positive values ($\delta = [0.05, 0.10, 0.20, 0.25, 0.30, 0.35, 0.40]$). The parameter η_i captures individual time-invariant unobserved heterogeneity that is assumed to be uncorrelated with the other covariates. The parameter ε_{it} is the individual time-variant unobserved heterogeneity.

The θ values are parameters to be estimated: θ_0 captures the average value of the outcome variable under the flat-rate PES scheme treatment in the baseline ($PESLevel = 0$), θ_1 captures differences in the outcome variable between the baseline decisions of the two alternative PES schemes[15], θ_2 measures the change in outcome associated with a change in payment level under the flat-rate PES scheme, and θ_3 tests for potential differences in the payment level effects between the two alternative PES schemes.

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.

Impact of Alternative PES Schemes on Distributional Outcome

We first address the impact of the two alternative PES schemes on distributional outcomes. In particular, we test whether the introduction of a flat-rate PES scheme increases inequality among group members, as proposed in Hypothesis 2, and whether the redistributive PES scheme can function as a redistributive instrument decreasing inequality among group members, as proposed in Hypothesis 3. For this purpose, we estimate equation [4] separately for low- and high-endowed participants. Table 5 presents the estimation results obtained by random effects GLS.[16] Columns 1 and 2 provide the results on the earnings share held by low-endowed and high-endowed participants, respectively. Column 3 provides the results on the group-level Gini index.

The constant term (θ_0) indicates that in the baseline, on the average, low-endowed participants receive 29% of the group earnings (column 1), high-endowed participants receive 43% of the group earnings (column 2), and the Gini index is 0.11[17] (column 3). The estimated parameters on *PESLevel* (θ_2) indicate that the introduction of payments under a flat-rate PES scheme significantly increases the earnings share held by high-endowed participants. Yet, these effects are not reflected in significant changes in the Gini index, implying that the evidence for an inequality-increasing effect of the flat-rate PES scheme, as presented in Hypothesis 2, is rather weak.

In contrast, we find significant evidence in favor of Hypothesis 3, stating that the introduction of a redistributive PES scheme reduces inequality. The estimated coefficient on the interaction term (θ_3) indicates that under the redistributive 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 flat-rate PES scheme. These changes in distributional outcome are also reflected in the group-level analysis: column 3 shows that a one percentage point increase in payment levels under the redistributive PES scheme decreases the Gini coefficient by 0.1 index points. The results, hence, imply that the introduction of a redistributive PES scheme, under the assumptions made, can have an inequality-decreasing effect, influencing the income distribution in favor of producers with lower endowments.

Result 1. While we do not find strong evidence for an inequality-enhancing effect of the flat-rate PES scheme, it is associated with the perpetuation of existing inequality structures. In contrast, the introduction of a redistributive PES based on a Rawlsian maxi-min payment rule has a significant inequality-reducing effect.

[15] Given that under the redistributive PES scheme and payment set 1, high-endowed participants do not receive any payment when the low payment level is introduced (see Table 2), this decision is also reflected in the redistributive PES dummy.

[16] Even though the dependent variable ranges between 0 and 1, it is distributed normally, and thus GLS estimation is preferred over Tobit. Tobit model results are very similar and can be provided upon request.

[17] 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.

TABLE 5
Regression Results

	Share of Total Group Earnings[a]		Gini Index[a]	Share of Endowment Conserved[b]					
				$e=5$		$e=10$		All	
	$e=5$ (1)	$e=10$ (2)	All (3)	Extensive (4)	Intensive (5)	Extensive (6)	Intensive (7)	Extensive (8)	Intensive (9)
Redistributive	−0.012**	0.022**	0.030***	0.015	0.075	−0.044	−0.102*	−0.006	−0.020
	(0.005)	(0.009)	(0.010)	(0.012)	(0.049)	(0.028)	(0.055)	(−0.540)	(−0.550)
PESLevel	−0.018	0.037*	0.018	0.044	0.226***	0.030	0.070	0.055	0.171*
	(0.011)	(0.022)	(0.022)	(0.027)	(0.084)	(0.048)	(0.110)	(−1.870)	(−2.170)
Redistributive × PESLevel	0.037**	−0.081**	−0.096***	0.0012	0.0063	0.055	0.128	0.015	0.046
	(0.015)	(0.032)	(0.030)	(0.022)	(0.113)	(0.074)	(0.166)	(−0.420)	(−0.430)
Constant	0.286***	0.428***	0.109***						
	(0.004)	(0.007)	(0.007)						
Number of observations	546	273	273	546		273		273	
Number of groups	182	91	91	182		91		91	
Wald chi^2	8.51	9.04	19.05	19.52		6.11		13.67	
Prob > chi^2	0.037	0.029	0.000	0.000		0.106		0.003	

Note: Standard errors are in parentheses. *PESLevel* is a continuous variable defined over the interval 0.05 and 0.40 on 0.05 interval units. At the group level, *PESLevel* is calculated as the average payment offered to low- and high-endowed individuals within group g in decision t.
[a] Random effects GLS estimation.
[b] Random effects Tobit model.
* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

Impact of Alternative PES Schemes on Additional Land Units Conserved

Next, we investigate whether the introduction of a redistributive PES scheme that offers higher payments to low-endowed participants comes at the cost of lower aggregate conservation outcomes at the group level, compared to a flat-rate PES scheme. Taking into account that individuals made repeated decisions and that the share of endowment allocated to conservation is censored at zero and one, we estimate three random effects Tobit models. We present the effect separately for low- and high-endowed participants and at the group level. 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 additional units of experimental land conserved conditional on a nonzero share of endowment being allocated to conservation. The estimation results are presented in columns 4 to 9 in Table 5.

The group-level results in columns 8 and 9 indicate that the extensive margin derived from the coefficient on *PESLevel* is positive and significant. This indicates that conditional on conservation, a one percentage point increase in payment levels offered under the flat-rate PES scheme increases the share of land conserved at the group level by 0.17 percentage points. Furthermore, we find no significant difference in the increase in the proportion of land conserved between the flat-rate and the redistributive PES scheme (cf. θ_3). These findings support Hypothesis 4 that the introduction of a redistributive PES scheme (compared to a flat-rate PES scheme) does not need to be compromised by lower conservation outcomes at the aggregate level.

Furthermore, the results in columns 4 to 7 indicate that the observed effect at the group level is driven mainly by the land allocation decisions of low-endowed participants. Column 5 shows that low-endowed participants significantly increase the proportion of land conserved in response to higher payment levels, and this effect does not differ significantly between the two alternative PES schemes. For high-endowed participants, however, the results in columns 6 and 7 suggest that their propensity to conserve remains unaffected by the introduction of payments under both alternative PES schemes.

Result 2. Conditional on a positive conservation decision, the introduction of PES leads to an increase in the proportion of land dedicated to conservation. The magnitude of the effect is similar for the flat-rate and the redistributive PES schemes. The effect observed at the group level is driven mainly by the conservation decisions of low-endowed participants.

In a nutshell, the experimental results reported in this section provide evidence that the design of PES schemes matters for distributional outcomes: While a flat-rate PES contributes to the perpetuation of existing inequalities, a redistributive PES scheme can have inequality-reducing effects. We do not find a trade-off between conservation and equity: our results indicate that—under certain conditions—a redistributive PES scheme can be designed that enhances equity, while overall achieving the same level of additional land units conserved as a flat-rate PES scheme.

VI. DISCUSSION

While PES 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 under the experimental assumed conditions, the introduction of a redistributive PES scheme realigns income in favor of low-endowed participants, while inducing conservation outcomes (in terms of additional land units conserved) similar to those of a flat-rate PES scheme. This implies that payment schemes can be designed in such a way that they function as multipurpose 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 in our case study, the increase in conservation area at the group level in response to the introduction of PES stems mainly 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 conservation targets.

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, Engel, and Kosfeld 2010; Gurven and Winking 2008; Travers et al. 2011). As pointed out before, a central assumption in our experimental design is that low-endowed participants have higher marginal incentives to cultivate oil palm and thus higher opportunity costs of conservation. If, alternatively, small-scale farmers indeed face higher marginal incentives to conserve (i.e., adopt rubber agroforestry), their initial conservation levels in the absence of incentive payments are likely to be higher, and potentially, their response to the introduction of payments could 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 resulted mostly from the conservation decision of low-endowed participants. Regarding the distributional implications of the PES scheme, we would still expect the redistributive scheme to have an (even stronger) inequality-decreasing effect. But even the flat-rate PES scheme may contribute to decreasing inequality in such a scenario. Equation [A2] shows that the inequality-increasing effect of the flat-rate PES scheme is conditional on the difference in the marginal return of rubber agroforestry between large and small landholders. If the marginal return of rubber agroforestry of low-endowed participants is substantially higher than that of high-endowed participants, the introduction of a flat-rate PES scheme may indeed decrease inequality. These considerations point to the importance of estimating key parameters and pretesting the policy before scaling up the intervention.

From a policy perspective, it is important to note that the focus of our analysis is on additional units of land conserved, and hence, our analysis disregards potential agglomeration effects that would derive from contagious protected areas (Parkhurst et al. 2002). In case such effects exist, the increase in environmental services associated with the protection of land by relatively large landholders is likely to be higher than that of dispersed landholders. Under such circumstances, the redistributive PES introduced here would not necessarily function as a win-win strategy to promote conservation and poverty reduction.

Furthermore, our outcome measure focuses on increases in biophysical units conserved. Admittedly, this does not necessarily correspond to the marginal benefit of ecosystem service provision. Environmental performance depends on many factors, including the location of the land unit (e.g., on peat soils, in riparian buffer zones, in close proximity to forest areas) as well as the management. This is further complicated due to the fact that for many ecosystem services, changes in land use and management intensity induce a nonlinear shift in environmental benefits due to, for example, threshold effects in ecosystems (Jack, Kousky, and Sims 2008). Our experimental findings are relevant for PES schemes aiming to increase, for example, forest area in general, such as the forest conservation program FONAFIFO in Costa Rica. In contrast, when the program's aim is to increase a specific ecosystem service, the above-cited management factors need to be taken into account. In particular, if management practices differ between large and small landholders (e.g., due to differences in available technology or human capital), the redistributive scheme may induce the same level of conservation area as the flat-rate scheme but differ with respect to environmental performance.

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 yield a return only 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 lack of information on private tenure (Engel and Palmer 2008; Muradian et al. 2010; Börner et al. 2010; Grimm and Klasen 2015). 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, Gillespie, and Zen 2012; Hauser-Schäublin and Steinebach 2014). In the case of customary land tenure, 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 tenure security.

Furthermore, the ability of farmers to participate in a given PES scheme may be restricted by transaction costs, such as program enrollment costs, that are not taken into account in our experimental setup. For example, in the Costa Rican forest conservation program FONAFIFO, applicants are required to submit a management plan approved by an audited forest engineer (Pagiola, Arcenas, and Platais 2005). Such costs are usually fixed costs, implying that smaller landholders face significantly higher costs per hectare, and thus such costs introduce a bias against smallholder enrollment in PES schemes. Thus, taking enrollment costs into account would likely lead to lower levels of conservation in general and in particular among low-endowed producers.

Finally, alternative schemes may also differ in terms of their implementation costs. In our experiment, we were able to show that the compensation budget was similar across the two alternative PES schemes. However, the actual compensation expenses are a function of the number of hectares conserved and, in the case of the redistributive scheme, also of the proportions of small and large landholders enrolling in the scheme. In particular, if the farming structure is relatively homogenous and dominated by small landholders, the higher expected compensation costs of the redistributive scheme compared to the flat-rate scheme may outweigh its equity-enhancing benefits.

Besides the direct costs of compensation, implementation costs also comprise the transaction costs associated with searching for information, delivering payments, and enforcing agreements. If land size is a good indicator of wealth, as assumed in the experiment, a redistributive payment in principle could be based on land title registrations. However, in a setting like our study region, where customary land tenure arrangements are widespread, such a procedure would risk excluding the most disadvantaged landholders lacking formal titles to their land. Furthermore, depending on the setting, land size may represent a rather imperfect proxy for wealth. Hence, a redistributive PES scheme would require substantial information on the potential beneficiaries and thus imply higher implementation costs for program administrators than a flate-rate PES scheme (Pascual et al. 2010).

Given high program administration costs, a redistributive PES scheme may result in lower cost-effectiveness compared to a flat-rate PES scheme—an important policy criterion that is beyond the scope of our study. Yet, it should also be kept in mind that the equity principle underlying the redistributive PES scheme may increase acceptance of the scheme in the community, which could induce community cooperation and thereby facilitate program implementation. Which equity principle local communities indeed favor will vary from case to case, and therefore, our results should be validated in the local context. Before the implementation of a PES scheme, it is necessary to establish the social acceptability of different schemes and investigate whether local norms favor equity of outcomes (as in the flat-rate PES scheme, where everybody receives the same payment) or equity of opportunities (as reflected by the redistributive PES scheme).

VII. CONCLUSION

In conclusion, our study provides behavioral evidence on the implications of different payment scheme designs (based on different principles of distributive justice) for environmental and social outcomes. As Guerry et al. (2015) emphasize, such insights from behavioral economics are crucial to better understand how people make conservation decisions and for designing more effective policy interventions. As discussed in the previous section, some limitations apply to our data and, accordingly, to the results that can be derived from our analysis. In order to inform policy makers, further research is needed testing alternative PES designs beyond the two schemes evaluated here, as well as different scenarios of heterogeneity. It may be interesting, for example, to use a full factorial design in order to disentangle the effects of heterogeneity in endowment on the one hand, and in marginal incentives to conserve on the other hand. Given that the results presented here apply under the experimental assumed conditions of heterogeneity, it is critical that further research be dedicated to discovering the actual values of these key parameters in the local context before implementing PES.

Future research could also extend our research by choosing a more comprehensive measure to assess conservation outcomes. Our measure of additional number of land units conserved clearly has the advantage of being easy to measure and implement in an experimental setting. Yet, monitoring and evaluating environmental performance more directly would be of great interest, in particular for the design of accountability-based PES schemes.

Furthermore, future experimental studies could seek to capture additional institutional drivers and constraints of land use decisions, such as land tenure security and program enrollment costs, as well as initial investment costs and capital constraints. Similarly, the role of social norms and preferences in conservation decision-making could be further explored. Sheeder and Lynne (2011), for example, show that some of the farmers in their study in the United States take the welfare of their neighbors into account when making conservation decisions. Such social preferences could be explicitly integrated in an experimental design to gain further knowledge on the social interactions and preferences that shape human-nature interactions.

APPENDIX A: PROOFS FOR THE CONCEPTUAL FRAMEWORK

Proof 1. The proportion of land endowment allocated to rubber agroforestry, R, is

$$R = \frac{L - x}{L} = 1 - \frac{1 - a}{2c_i L},$$

where x is defined according to equation [2].

$$\frac{dR}{da} = \frac{1}{2c_i L} > 0; \frac{dR}{dL} = \frac{\frac{1-a}{2c_i}}{L^2} > 0; \frac{d^2R}{dadL} = -\left(\frac{1}{2c_i L^2}\right) < 0.$$

Hence, the proportion of land that is conserved increases linearly with an increase in the relative profit of rubber agroforestry, a. Yet, the effect of changes in the relative return of rubber agroforestry decreases with land size.

Proof 2. Based on equation [2] it is possible to show that from an individual point of view, 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, $I(a_H, a_L) = \pi_H - \pi_L$, is hence given by

$$I(a_H, a_L) = \left(\frac{a_L - a_H}{2c}\right)(2 - a_L - a_H + b) + a_H L_H - a_L L_L - b(L_H - L_L). \quad [A1]$$

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

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

$$G(\delta; a_H, a_L) = I(a_H, a_L) + \delta\left(L_H - L_L + \frac{a_H - a_L}{c}\right). \quad [A2]$$

In particular, differentiating G with respect to δ yields

$$\frac{dG(\delta; a_H, a_L)}{d\delta} = L_H - L_L + \frac{a_H - a_L}{c} > 0. \quad [A3]$$

Proof 3. Defining a new function $D(\delta, \gamma, a_H, a_L) := I(a_H + \delta - \gamma, a_L + \delta + \gamma)$, 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

$$D(\delta, \gamma, a_H, a_L) := I(a_H, a_L) + \delta\left(L_H - L_L + \frac{a_H - a_L - 2\gamma}{c}\right) + \frac{\gamma}{c}(2 - a_L - a_H + b - cL_L - cL_H). \quad [A4]$$

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

$$\frac{dD}{d\delta} = L_H - L_L + \frac{a_H - a_L - 2\gamma}{c} < \frac{dG(\delta; a_H, a_L)}{d\delta}. \quad [A5]$$

Therefore, the use of a redistributive PES scheme reduces the income inequality compared to a flat-rate 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

$$\frac{dD}{d\delta d\gamma} = -\frac{2}{c} < 0. \quad [A6]$$

Hence, the larger the amount of payment redistribution, the larger the decrease in income inequality.

Proof 4. The proportion of land that is conserved in rubber agroforestry due to PES,

$$R = \frac{(L - x_i)}{L_i},$$

is a negative function of land size,

$$\frac{d^2R}{dadL} = -\left(\frac{1}{2c_i L^2}\right) < 0.$$

Hence, the redistributional payment scheme would result in an increase in the fraction of land allocated to conservation of rubber agroforestry by type 1 producers that is not smaller than the respective decrease in conservation by type 2 producers.

APPENDIX B: RANDOMIZATION TESTS

TABLE B1

Results of the Seemingly Unrelated Regressions with Socioeconomic and Session Characteristics as the Dependent Variables

	Flat-Rate PES		Redistributive PES	
	$e = 5$ (Constant)	$e = 10$	$e = 5$	$e = 10$
Age (number of 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)

Note: Standard errors are in parentheses. PES, payments for environmental services.

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References

Alix-Garcia, Jennifer, Alain De Janvry, and Elisabeth Sadoulet. 2008. “The Role of Deforestation Risk and Calibrated Compensation in Designing Payments for Environmental Services.” *Environment and Development Economics* 13 (3): 375–94.

Baland, Jean-Marie, and Jean-Philippe Platteau. 1999. “The Ambiguous Impact of Inequality on Local Resource Management.” *World Development* 27 (5): 773–78.

Barnes, Andrew D., Malte Jochum, Steffen Mumme, Noor Farikhah Haneda, Achmad Farajallah, Tri H. Widarto, and Ulrich Brose. 2014. “Consequences of Tropical Land Use for Multitrophic Biodiversity and Ecosystem Functioning.” *Nature Communication* 5: 1–7.

Belcher, Brian, and Kathrin Schreckenberg. 2007. “Commercialization of Non-timber Forest Products: A Reality Check.” *Development Policy Review* 25 (3): 355–77.

Beukema, Hendrien, Finn Danielsen, Grégoire Vincent, Suryo Hardiwinoto, and Jelte van Andel. 2007. “Plant and Bird Diversity in Rubber Agroforestry in the Lowlands of Sumatra, Indonesia.” *Agroforestry Systems* 70 (3): 217–42.

Börner, Jan, Sven Wunder, Sheila Wertz-Kanounnikoff, Marcos Rügnitz Tito, Ligia Pereira, and Nathalia Nascimento. 2010. “Direct Conservation Payments in the Brazilian Amazon: Scope and Equity Implications.” *Ecological Economics* 69 (6): 1272–82.

Cardenas, Juan C., John Stranlund, and Cleve Willis. 2002. “Economic Inequality and Burden-sharing in the Provision of Local Environmental Quality.” *Ecological Economics* 40 (3): 379–95.

Castillo, Daniel, François Bousquet, Marco A. Janssen, Kobchai Worrapimphong, and Juan C. Cardenas. 2011. “Context Matters to Explain Field Experiments: Results from Colombian and Thai Fishing Villages.” *Ecological Economics* 70 (9): 1609–20.

Chan, Kenneth S., Stuart Mestelman, Robert Moir, and R. Andrew Muller. 1999. “Heterogeneity and the Voluntary Provision of Public Goods.” *Experimental Economics* 2 (1): 5–30.

Cherry, Todd L., Stephan Kroll, and Jason F. Shogren. 2005. “The Impact of Endowment Heterogeneity and Origin on Public Good Contributions: Evidence from the Lab.” *Journal of Economic Behavior and Organization* 57 (3): 357–65.

Colchester, Marcus, Norman Jiwan, Andiko, Martua Sirait, Asep Y. Firdaus, A. Surambo, and Herbert Pane. 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, Esteve, Katrina Brown, and W. Neil Adger. 2007. "The Equity and Legitimacy of Markets for Ecosystem Services." *Development and Change* 38 (4): 587–613.

Corbera, Esteve, and Unai Pascual. 2012. "Ecosystem Services: Head Social Goals." *Science* 335 (6069): 655–56.

Danielsen, Finn, Hendrien Beukema, Neil D. Burgess, Faizal Parish, Carsten A. Brühl, Paul F. Donald, Daniel Murdiyarso, Ben Phalan, Lucas Reijnders, Matthew Struebig, and Emily B. Fitzherbert. 2009. "Biofuel Plantations on Forested Lands: Double Jeopardy for Biodiversity and Climate." *Conservation Biology* 23 (2): 348–58.

Ekadinata, Andree, and Grégoire Vincent. 2011. "Rubber Agroforests in a Changing Landscape: Analysis of Land Use/Cover Trajectories in Bungo District, Indonesia." *Forests, Trees and Livelihoods* 20 (1): 3–14.

Engel, Stefanie, Stefano Pagiola, and Sven Wunder. 2008. "Designing Payments for Environmental Services in Theory and Practice: An Overview of the Issues." *Ecological Economic* 65 (4): 663–74.

Engel, Stefanie, and Charles Palmer. 2008. "Payments for Environmental Services as an Alternative to Logging under Weak Property Rights: The Case of Indonesia." *Ecological Economics* 65 (4): 799–809.

Euler, Michael, Stefan Schwarze, Hermanto Siregar, and Matin Qaim. 2016. "Oil Palm Expansion among Smallholder Farmers in Sumatra, Indonesia." *Journal of Agricultural Economics* 67 (3): 658–76.

Feintrenie, Laurène, Wan K. Chong, and Patrice Levang. 2010. "Why Do Farmers Prefer Oil Palm? Lessons Learnt from Bungo District, Indonesia." *Small-Scale Forestry* 9 (3): 379–96.

Feintrenie, Laurène, and Patrice Levang. 2009. "Sumatra's Rubber Agroforests: Advent, Rise and Fall of a Sustainable Cropping System." *Small-scale Forestry* 8 (3): 323–35.

Gatto, Marcel, Meike Wollni, and Matin Qaim. 2015. "Oil Palm Boom and Land-Use Dynamics in Indonesia: The Role of Policies and Socioeconomic Factors." *Land Use Policy* 46: 292–303.

Grieg-Gran, Maryanne, Ina Porras, and Sven Wunder. 2005. "How Can Market Mechanisms for Forest Environmental Services Help the Poor? Preliminary Lessons from Latin America." *World Development* 33 (9): 1511–27.

Grimm, Michael, and Stephan Klasen. 2015. "Migration Pressure, Tenure Security, and Agricultural Intensification: Evidence from Indonesia." *Land Economics* 91 (3): 411–34.

Guerry, Anne D., Stephen Polasky, Jane Lubchenco, Rebecca Chaplin-Kramer, Gretchen C. Daily, Robert Griffin, Mary Ruckelshaus, Ian J. Bateman, Anantha Duraiappah, Thomas Elmqvist, et al. 2015. "Natural Capital and Ecosystem Services Informing Decisions: From Promise to Practice." *Proceedings of the National Academy of Sciences USA* 112 (24): 7348–55.

Gurven, Michael, and Jeffery Winking. 2008. "Collective Action in Action: Prosocial Behavior in and out of the Laboratory." *American Anthropologist* 110 (2): 179–90.

Hauser-Schäublin, Brigitta, and Stefanie Steinebach. 2014. "Harapan: A 'No Man's Land' Turned into a Contested Agro-industrial Zone." EFForTS Discussion Paper 4. Göttingen, Germany: University of Göttingen.

Ibanez, Marcella, and Peter Martinsson. 2013. "Curbing Coca Cultivation in Colombia: A Framed Field Experiment." *Journal of Public Economics* 105: 1–10.

Jack, B. Kelsey, Carolyn Kousky, and Katharine R. E. Sims. 2008. "Designing Payments for Ecosystem Services: Lessons from Previous Experience with Incentive-Based Mechanisms." *PNAS* 105 (28): 9465–70.

Jakarta Post. 2009. "Indonesia Allocates 18 Million Hectares of Land for Palm Oil." *Jakarta Post,* Nusa Dua, Bali, December 2. Available at http://naturealert.blogspot.de/2009/12/indonesia-allocates-18-million-hectares.html (accessed January 5, 2017).

Kerr, John, Mamta Vardhan, and Rohit Jindal. 2012. "Prosocial Behavior and Incentives: Evidence from Field Experiments in Rural Mexico and Tanzania." *Ecological Economics* 73 (C): 220–27.

Koh, Lian P., Jukka Miettinen, Soo C. Liew, and Jaboury Ghazoul. 2011. "Remotely Sensed Evidence of Tropical Peatland Conversion to Oil Palm." *Proceedings of the National Academy of Sciences USA* 108 (12): 5127–32.

Koh, Lian P., and David Wilcove. 2008. "Is Oil Palm Agriculture Really Destroying Tropical Biodiversity?" *Conservation Letters* 1 (2): 60–64.

Kosoy, Nicolas, Miguel Martinez-Tuna, Roldan Muradian, and Joan Martinez-Alier. 2007. "Payments for Environmental Services in Watersheds: Insights from a Comparative Study of Three Cases in Central America." *Ecological Economics* 61 (2): 446–55.

Kotowska, Martyna M., Christoph Leuschner, Triadiati Triadiati, Selis Meriem, and Dietrich Hertel. 2015. “Quantifying Above- and Belowground Biomass Carbon Loss with Forest Conversion in Tropical Lowlands of Sumatra (Indonesia).” *Global Change Biology* 21 (10): 3620–34.

Landell-Mills, Natasha. 2002. “Developing Markets for Forest Environmental Services: An Opportunity for Promoting Equity While Securing Efficiency.” *Philosophical Transactions of the Royal Society* 360 (1797): 1817–25.

Landell-Mills, Natasha, and Ina T. Porras. 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. London: International Institute for Environment and Development.

Laumonier, Yves, Yumiko Uryu, Michael Stüwe, Arif Budiman, Budi Setiabudi, and Oki Hadian. 2010. “Eco-floristic Sectors and Deforestation Threats in Sumatra: Identifying New Conservation Area Network Priorities for Ecosystem-Based Land Use Planning.” *Biodiversity and Conservation* 19 (4): 1153–74.

McCarthy, John F., Piers Gillespie, and Zahari Zen. 2012. “Swimming Upstream: Local Indonesian Production Networks in ‘Globalized’ Palm Oil Production.” *World Development* 40 (3): 555–69.

Muradian, Roldan, M. Arsel, L. Pellefrini, F. Adaman, B. Aguilar, B. Agarwal, E. Corbera, D. Ezzine de Blas, J. Farley, G. Froger, et al. 2013. “Payments for Ecosystem Services and the Fatal Attraction of Win-win Solutions.” *Conservation Letters* 6 (4): 1–6.

Muradian, Roldan, Esteve Corbera, Unai Pascual, Nicolás Kosoy, and Peter H. May. 2010. “Reconciling Theory and Practice: An Alternative Conceptual Framework for Understanding Payments for Environmental Services.” *Ecological Economics* 69 (6): 1202–08.

Narloch, Ulf, Unai Pascual, and Adam G. Drucker. 2012. “Collective Action Dynamics under External Rewards: Experimental Insights from Andean Farming Communities.” *World Development* 40 (10): 2096–107.

———. 2013. “How to Achieve Fairness in Payments for Ecosystem Services? Insights from Agrobiodiversity Conservation Auctions.” *Land Use Policy* 35: 107–18.

Obidzinski, Kystof, Rubeta Andriani, Heru Komarudin, and Agnus Andrianto. 2012. “Environmental and Social Impacts of Oil Palm Plantations and Their Implications for Biofuel Production In Indonesia.” *Ecology and Society* 17 (1): article 25.

Pagiola, Stefano, Agustin Arcenas, and Gunars Platais. 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 (2): 237–53.

Parkhurst, Gregory M., Jason F. Shogren, Chris Bastian, Paul Kivi, Jennifer Donner, and Rodney B. W. Smith. 2002. “Agglomeration Bonus: An Incentive Mechanism to Reunite Fragmented Habitat for Biodiversity Conservation.” *Ecological Economics* 41 (2): 305–28.

Pascual, Unai, Roldan Muradian, Luis C. Rodriguez, and Anantha Duraiappah. 2010. “Exploring the Links between Equity and Efficiency in Payments for Environmental Services: A Conceptual Approach.” *Ecological Economics* 69 (6): 1237–44.

Pramova, Emilia, Bruno Locatelli, Andreas Mench, Edy Marbyanto, Karlina Kartika, and Hangga Prihatmaja. 2013. “Integrating Adaptation into REDD+: Potential Impacts and Social Return on Investment in Setulang, Malinau District, Indonesia.” CIFOR Working Paper 2013-112. Bogor, Indonesia: Center for International Forestry Research.

Reuben, Ernesto, and Arno Riedl. 2013. “Enforcement of Contribution Norms in Public Good Games with Heterogenous Populations.” *Games and Economic Behavior* 77 (1): 122–137.

Rianto, Buntoro, Hafidsyah Mochtar, and Aditya Sasmito. 2012. “Overview of Palm Oil Industry Landscape in Indonesia.” In *Palm Oil Plantation: Industry Landscape, Regulatory and Financial Overview.* Jakarta: PwC Indonesia. Available at www.pwc.com/id/en/publications/assets/palm-oil-plantation-2012.pdf (accessed January 5, 2017).

Rodriguez-Sickert, Carlos, Ricardo A. Guzmán, and Juan C. Cardenas. 2008. “Institutions Influence Preferences: Evidence from a Common Pool Resource Experiment.” *Journal of Economic Behavior and Organization* 67 (1): 215–27.

Rustagi, Devesh, Stefanie Engel, and Michael Kosfeld. 2010. “Conditional Cooperation and Costly Monitoring Explain Success in Forest Commons Management.” *Science* 330 (6006): 961–65.

Sheeder, Robert J., and Gary D. Lynne. 2011. “Empathy-Conditioned Conservation: ‘Walking in the Shoes of Others’ as a Conservation Farmer.” *Land Economics* 87 (3): 433–52.

Sommerville, Matthew, Julia P. G. Jones, Michael Rahajaharison, and E. J. Mildner-Gulland. 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 (6): 1262–71.

Travers, Henry, Tom Clements, Aidan Keane, and E. J. Mildner-Gulland. 2011. “Incentives for Cooperation: The Effects of Institutional Controls on Common Pool Resource Extraction in Cambodia." *Ecological Economics* 71: 151–61.

Villamor, Grace B., Quang B. Le, Paul L. G. Vlek, and Meine Van Noordwijk. 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, Björn. 2008. "Socio-ecological Explanations for Crowding-out Effects from Economic Field Experiments in Southern Africa." *Ecological Economics* 67 (4): 560–73.

Wilcove, David S., and Lian P. Koh. 2010. "Addressing the Threats to Biodiversity from Oil-Palm Agriculture." *Biodiversity and Conservation* 19 (4): 999–1007.

World Trade Organization. 2010. *World Trade Report 2010: Trade in Natural Resources*. Geneva, Switzerland: World Trade Organization.

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

Zbinden, Simon, and David R. Lee. 2005." Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program." *World Development* 33 (2): 255–72.