



Conservation payments and perceptions of equity: Experimental evidence from Indonesia, Peru, and Tanzania

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ABSTRACT

While monetary incentives may be a promising tool for encouraging tropical forest conservation in order to reduce greenhouse gas emissions, the equity implications of such incentives are drawing scrutiny. Furthermore, little is known about how program design shapes perceptions of fairness and equity among program participants, and it remains unclear whether devolving the decision power over the distribution of payments to local leaders helps or harms local perceptions of equity. We implemented a 'lab-in-the-field' experiment with 448 participants in rural villages in Indonesia, Peru, and Tanzania, framed around two versions of a collective payments for ecosystem services (PES) program. Participants perceived the program as less equitable when the collective payment was distributed according to the discretion of a locally chosen leader, compared to when the payment was distributed perfectly equally by design. The negative effect is only seen among participants who were given a low share of the payment, which suggests that it is not the involvement of a leader per se that leads to lower perceptions of equity, but the inegalitarian distribution of the payment that sometimes occurs when a leader has the discretion to choose how the payment is distributed. The results highlight the importance of designing conservation incentive programs that give opportunities for local involvement while still encouraging equitable local decisions.

1. Introduction

In recent years, the discourse surrounding climate equity and justice has broadened to include not only debates about apparent disparities in the impacts of climate change and Western countries' degree of responsibility in correcting them, but also debates around the equity implications of policies and programs aimed at mitigating greenhouse gas emissions (Morgan and Waskow, 2014; Winkler, 2020). It is becoming increasingly clear that climate change mitigation and adaptation strategies should be judged not only by their capacity to reduce or offset greenhouse gas emissions, but also by how they alleviate, exacerbate, or create environmental inequities (Fleurbaey, 2014). How might climate change mitigation programs contribute to, or undermine, goals related to climate equity and justice? This question is especially salient in debates around payments for ecosystem services (PES). Although there is evidence that monetary payments to landowners and communities under PES programs may sometimes avert deforestation and offset greenhouse gas emissions (Alix-Garcia et al., 2012; Andersson et al.,

2018; Jayachandran et al., 2017; Min-Venditti et al., 2017), the equity implications of these programs have drawn recent scrutiny.

As implemented in the Global South, PES is based on the idea that rural people in low- and middle-income countries should be duly compensated for taking costly actions that protect the environment. On its face, this idea seems to be compatible with climate equity. There is some evidence, however, that suggests that in practice, the individuals at the local level who are most likely to participate in and benefit from PES programs tend to be the more privileged, wealthier members of local communities (Bremer et al., 2014; Grillos, 2017). In addition, the poorer members of local communities may disproportionately shoulder the costs of these programs (Grieg-Gran et al., 2005). Perhaps as a result of such circumstances, participants in PES programs do not always perceive the payments as equitable (Hayes and Murtinho, 2018). Local perceptions of equity, while important in their own right, are believed to play an important role in reinforcing local people's motivations to participate in PES programs and to provide ecosystem services (Loft et al., 2020; Loft et al., 2017; Martin et al., 2014a; Pascual et al., 2010;

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Pascual et al., 2014). Perceptions of inequity may therefore undermine the effectiveness of PES as a climate policy instrument.

Collective PES programs, wherein local populations are paid collectively to conserve forests that are under communal or public ownership, are an increasingly important tool for the conservation of tropical forests (Hayes et al., 2019; Kerr et al., 2014). While collective programs may incentivize conservation without the transaction costs associated with PES programs targeted at private landowners (Kerr et al., 2014; Wunder et al., 2018), there is a growing recognition that they are uniquely complicated from the perspective of equity (Cook et al., 2019; Hayes et al., 2019; Sommerville et al., 2010). On one hand, collective PES programs may avoid some of the equity concerns associated with individual PES. Individual PES programs create barriers to entry for participant households, and therefore favour wealthier rural households with formal land tenure (Bremer et al., 2014). Collective PES, however, addresses this problem of inequitable inclusion by making payments to communities, rather than individual households. Inclusiveness is therefore one potential equity-related rationale for collective PES over individual PES. However, because collective payments must be either distributed among community members or spent on local public goods that may benefit some households more than others, there may be wide variation in how much households in a community benefit from collective PES relative to their opportunity costs of participating in the program. In other words, while it is possible that collective PES programs offer an advantage in terms of equity, they also raise equity-related concerns of their own.

Regardless of whether they are collective or individual, existing evidence suggests that some PES programs may exacerbate inequity and perceptions of inequity (Calvet-Mir et al., 2015; Corbera et al., 2007; McDermott et al., 2013), which can undermine conservation motivations (Loft et al., 2020). While local perceptions of equity are believed to be influenced by a variety of factors, such as the design of PES programs and the local social context (Loft et al., 2017), these influences remain poorly understood. This is due in part to the fact that much of the work on equity in PES is theoretical (McDermott et al., 2013; Pascual et al., 2010). This study uses a field experiment to broaden existing understandings of equity in collective PES by focusing on the effects of specific, but common, existing design features of collective PES programs on local perceptions of fairness.

Specifically, it is not yet clear how allowing local leaders to determine how benefits from PES programs are distributed shapes perceptions of equity, compared to a scenario in which those benefits are awarded to local community members equally by design. This question is especially policy-relevant in light of substantial variation in the degree to which collective PES programs around the world empower local people to make distributive decisions (Hayes et al., 2019). For example, a PES program in Nepal funded by the Norwegian development aid agency (NORAD) has emphasized local involvement in these decisions. The program, which was a pilot project for the international Reducing Emissions from Deforestation and Forest Degradation (REDD+) initiative, relied upon elected local leaders—executive committee members of village-level forest management committees—to decide how to distribute program funds to individual households in the village. In accordance with the design of the program, local leaders played a key role in deciding how much compensation should be awarded to different households (Saito-Jensen et al., 2014). In contrast, *Bolsa Floresta Familiar*, a collective PES program in Brazil, paid all households an equal rate in exchange for their participation (Börner et al., 2013).

In other words, while payments to individual households under the NORAD program in Nepal varied due to the decisions of local leaders, payments under Brazil's *Bolsa Floresta Familiar* were pre-determined, and were equal by design. It is notable that some participants disagreed with distributive decisions under the NORAD program in Nepal, and appear to have perceived the mechanism as unfair (Saito-Jensen et al., 2014). These two examples represent two common methods for determining the distribution of collective payments within a village—an

egalitarian division of payments mandated by an outside organization, and a division decided by local leaders. This is because the practical options for implementing collective PES are often either for an external organization to use a one-size-fits-all decision rule, in which case they lack the local knowledge on which to base a deviation from strict egalitarianism, or for local actors to exercise some level of discretion over how payments are distributed.

1.1. Local control, collective PES, and equity perceptions: competing theories

While the devolution of decision-making powers to local leaders is a common feature of collective PES programs (Hayes et al., 2019), the existing state of the knowledge suggests two competing theories about how this devolution shapes perceptions of equity. On one hand, locally controlled decision-making and implementation, either through group consensus or the decisions of locally chosen leaders, may promote a sense of equity (Loft et al., 2017). There is some limited empirical evidence to suggest that collective PES participants base their perceptions of equity on the procedural features of PES programs, perceiving programs as more equitable when communities have the autonomy to decide how payments should be distributed among community members (Martin et al., 2014b; Nieratka et al., 2015). Furthermore, local citizens or leaders have local time-and-place specific knowledge that may allow them to use the PES to compensate members of the community who expend more effort in providing ecosystem services. To the extent that community members care whether the flow of benefits to individual households is 'merit-based,' or made according to the effort made in the provision of ecosystem services, local autonomy may promote a sense that the distribution of the PES is equitable (Loft et al., 2017; Pascual et al., 2010). Based on this body of theory and evidence, we might expect PES programs designed to allow for local control over the distribution of payments to be perceived as more equitable than programs using some externally imposed decision rule to distribute payments, such as 'egalitarian' programs that automatically divide payments equally among community members.¹

On the other hand, there are compelling reasons to expect the opposite pattern, that programs allowing for local control over the distribution of payments are perceived as less equitable than programs without such local control. Local people with discretionary powers over the distribution of the payment may award a lower share of the payment to some community members than others, and this may lead to a sense that the distribution of the PES is less equitable than an 'egalitarian' program that awards each community member the same amount, regardless of the level and cost of their participation in the program (Pascual et al., 2014). This effect could be due to the fact that community members associate an egalitarian distribution of the PES with fairness (Pascual et al., 2014), or it could be due to the fact that some participants believe that the program is unfair when they perceive that they have been personally disadvantaged by inequality in how the payment is distributed. If the former is true, we would expect local perceptions of equity to be lowest when local leaders decide to distribute the payment very unequally. If the latter is true, we would expect the lowest perceptions of equity among community members who were personally disadvantaged by the unequal distribution—individuals who received a share of the payment that was below some social reference point, or noticeably lower than the norm.

¹ Some have pointed out that while equity is a multidimensional concept with distributive, procedural, and recognitional dimensions, conservation research tends to focus largely on distributional equity rather than the other dimensions (Friedman et al., 2018). While the analysis presented in this paper focuses specifically on distributive equity and procedural concerns, we do not mean to imply that often-neglected dimensions of equity, such as recognitional equity (Martin et al., 2016), are unimportant in relation to PES.

Furthermore, devolving control over conservation or development programs to local leaders creates opportunities for elite capture (Persha and Andersson, 2014; Platteau, 2004; Platteau and Abraham, 2002), and evidence suggests that perceptions of equity are lower when programs are captured by elites—wealthy local households or members of privileged ethnic groups or castes (Beath et al., 2018). Collective PES programs are vulnerable to elite capture (Almeida-Leñero et al., 2017; McGrath et al., 2018; To et al., 2012), and community members may view the programs less positively if they perceive elite capture in the distribution of the payment (Loft et al., 2017). If concerns of elite capture are a primary driver of perceptions of program fairness, we should not only expect PES programs to potentially be perceived as less equitable when local leaders control the distribution of the payment compared to a counterfactual ‘egalitarian’ program that awards each community member the same amount, but we should also expect perceptions to be most negative where payments flow disproportionately toward local leaders or members of the privileged elite.

Taken together, this theoretical discussion leads to two competing hypotheses regarding the effects of local autonomy on perceptions of equity in the context of PES. Depending on which specific contextual factors contribute to perceptions of equity, one could expect that either (H_{a1}) local leaders' control over the distribution of payments leads to higher perceptions of equity among the populations targeted by collective PES programs, or that (H_{a2}) such local control leads to lower perceptions of equity. This study tests these competing hypotheses regarding the effects of local autonomy in the distribution of collective PES on perceptions of equity, and seeks to understand the behavioral mechanisms underlying those effects, through a lab-in-the-field experiment deployed with rural participants in Indonesia, Peru, and Tanzania (see Material and Methods). There is substantial variation in how payments are distributed under collective PES programs, and there are theoretical reasons to think that these design differences would produce differences in perceived equity. There is also a growing interest in the equity implications of collective PES as a conservation tool. The problem is that there is not enough evidence regarding the impacts of PES program design on local perceptions of equity—perceptions that may differ from funders' understandings of PES programs (Massarella et al., 2020). Our study generates new evidence on these impacts.

Indonesia, Peru, and Tanzania are ideal settings in which to explore perceptions of different PES program designs. All three are lower-middle-income or upper-middle-income countries and have substantial forest cover, with Peru and Indonesia counted recently among the top ten countries in the world with the largest percentage of forested area (FAO, 2020). Furthermore, forest cover declined in all three countries between 2010 and 2020, with Indonesia and Tanzania counted among the top ten countries in terms of net forest loss (FAO, 2020). The three countries therefore represent the types of settings where PES may be an attractive policy tool. While all three countries have experience with PES programs, these experiences differ in scope. Various policy initiatives in Indonesia have sought to implement PES over the past two decades, but a study in 2017 was only able to identify a small number of operational projects covering relatively small areas, and found that most of PES projects for forest carbon sequestration were collective (Suich et al., 2017). A large number of PES programs have been implemented in Peru, and the country has experience with both individual and collective PES schemes (Montoya-Zumaeta et al., 2021). In Tanzania, a number of REDD+ pilot projects have emerged, supported by various bilateral and multilateral initiatives (Handberg and Angelsen, 2019).

2. Material and methods

2.1. Study design

We implemented a lab-in-the-field experiment framed around collective conservation incentive payments, based on the classic common-pool resource appropriation game (Ostrom et al., 1994)(Andersson

et al., 2018). Framed experiments such as ours are a well-established approach for studying PES programs because they allow experimental control and random assignment of different PES designs, and because they enable the researcher to measure behavior and perceptions in relation to simulated PES programs (Andersson et al., 2018; Cook et al., 2019; Kaczan et al., 2017; Kolinjivadi et al., 2019; Loft et al., 2019; Loft et al., 2020). Beyond these studies of PES, there is a broader literature demonstrating the usefulness of economic games and lab-in-the-field experiments for simulating the economic decisions and social dilemmas that research subjects encounter in daily life, and suggesting that behavior in these experimental settings correlates with subjects' real-world decision-making (Afridi et al., 2020; Czura, 2015; Meinzen-Dick et al., 2016; Meinzen-Dick et al., 2018; Nourani et al., 2021; Rus-tagi et al., 2010; Stopnitzky, 2016; Turiansky, 2021).

We executed our experiment with 448 adults from 31 rural villages in three countries: Indonesia, Peru, and Tanzania, as part of a larger research effort reported elsewhere (Andersson et al., 2018). In order to ensure that the communities in our sample resembled typical target communities for collective PES programs, we selected them purposively from a sample of sites from the CIFOR Global Comparative Study on REDD+ in the three countries (Sunderlin et al., 2014). The selected study sites were all located near forests that villagers managed, at least partially, as common property. Inhabitants at the selected sites had existing relationships with one or more non-governmental organizations (NGOs) that worked to promote forest conservation in the rural landscapes of the study sites. As a result of the work of these NGOs, most of the villagers participating in our study had knowledge of PES programs, such as REDD+. Although these NGOs planned to initiate PES programs in many of the targeted villages, payments had not yet been made at the time of our fieldwork in 2013. In that sense, participants generally did not have direct experience with PES, at least not in the context of forest conservation. Our recruitment strategy, described in Appendix A, was designed so that participants were the users of local forests.

The game was designed to simulate a scenario in which participants made decisions about the use of a shared forest resource. Participants were offered a conditional, collective payment under a PES scheme. To mimic the incentives that rural forest users face in real life, participants earned payoffs (‘tokens’) that were converted to local currency and paid in cash at the end of the session.

Participants played the game over 24 rounds in groups of eight participants each. At each round, individual participants decided how many trees (from zero to ten) to extract from a shared forest of 80 trees, knowing that each participant would earn five tokens for each tree they chose to extract, and all participants would earn one token each for each tree that the group left standing in the forest. Participants communicated their private extraction decisions to the moderator of the experiment by marking them on paper decision cards that were kept private from other group members. The moderator did not convey individuals' extraction decisions to other group members. The game was designed so that the socially optimal strategy in any given round was for an individual player to extract no trees, while the Nash equilibrium in a given round was for all players in a group to extract the maximum number (ten trees each).

During rounds 1–8 and 17–24, communication was prohibited between group members. During rounds 9–16, group members were allowed to communicate freely with one another, and the experiment moderator introduced a scenario consisting of a conditional, collective conservation incentive at the beginning of each of these eight rounds. Before each round during this period (rounds 9–16), participants were told that the conservation payment was conditional on the group's compliance with forest conservation; an external organization had offered to pay a bonus of 160 tokens to the group if the group did not extract any trees in that round. Monitoring by the external organization, which was explained to participants, was designed to be imperfect. Each tree extracted by group members in a given round caused a 2.5% increase in the probability that the external organization would find out

and withdraw the bonus in that round. When a group extracted 40 or more trees in a given round, monitoring became perfect and the bonus was automatically withdrawn in that round.

In our analysis, we compare two different versions of the game representing two distinct PES program designs that were assigned at random to each group of eight participants. In the 'external egalitarian' design, which we assigned to 29 groups, the PES was automatically divided equally among participants, so that if the group was awarded the payment in a given round, each of the eight participants would automatically be awarded 20 tokens from that payment. We assigned 27 of the groups to the 'internal leader discretion' design. In this design, participants selected a leader at the beginning of each round during rounds 9–16, and the leader had full discretion over how the PES was distributed among the eight participants in the group in that round. In this design, the leader was able to distribute each bonus equally among the eight players in the group, award the entire bonus to a single player, keep the entire bonus, or anything in between. While the amount awarded to each participant by the leader was not announced to the group during the experiment, participants were free to discuss their payoffs during the open communication periods in rounds 9–16. Participants therefore had imperfect information regarding other players' payoffs, as we expect would be the case in many real-world collective PES scenarios. Groups assigned to this design were allowed to re-elect the same leader or choose a new leader at any of the eight PES rounds. Because each group of eight participants played the game together in a room where the participants were visible to one another before and during game play but individual participants' extraction decisions were not announced by the experiment facilitator, groups would have been able to select leaders with information on those leaders' real-world names and faces but with incomplete information on extraction decisions.

Our field protocol, presented in full in Appendix B, included several elements to maximize participants' comprehension of the game design. First, there was a training period at the beginning of the activity in which the experiment facilitator explained the workings of the game and presented multiple worked examples to the participants showing how different game decisions would lead to different payoffs, and there was a similar (but shorter) period once the PES was introduced. Visual aids accompanied these worked examples to make the examples more tangible for the participants. Second, participants followed along with the examples, filling in their answers on paper decision cards, and observers checked to see whether participants were filling in the correct numbers so that participants could be corrected during this practice stage if they were confused. Third, our facilitators were trained to continue with the examples and illustrations of the game until they were confident that all participants had understood its basic logic. Finally, several question-and-answer opportunities were built into these training periods so that participants could get clarification throughout the activity if needed.

Given our experimental setup, it was not possible for the internal leader discretion design to outperform the external egalitarian design on the grounds of pure equality, since the latter was designed to distribute payments perfectly equally. Nonetheless, it was still possible for the internal leader discretion design to outperform the external egalitarian design on the grounds of *equity* if equity perceptions are shaped primarily by a preference for local decision-making autonomy, or because participants believe that leaders are using benefit-sharing decisions to reward those who contribute to conservation efforts and punish those who do not.

In addition to these two versions of the game, we randomly assigned three other versions of the game that are described in previous work (Andersson et al., 2018; Cook et al., 2019; Lopez and Andersson, 2016). In a given village, separate sessions with different groups of eight participants each were arranged on sequential days, and the order of the five versions of the game across those sequential sessions was assigned at random. See Appendix A for additional details on sampling,

randomization, and statistical power, and for descriptive statistics on participants included in the analysis and tests of balance on pre-treatment covariates.

2.2. Analytic methods

After the game, individual participants answered survey questions in local languages. Participants assigned to both designs were asked the following question: "In this game, an external organization offered a payment to the village for taking care of your forest. Do you feel that the way this payment was shared among participants was fair? [Answer choices: (i) Yes, (ii) More or less, (iii) No]". Because this survey question was asked once at the conclusion of the game rather than at each individual round, our dependent variable relates to perceptions of fairness throughout the entire game rather than in specific game rounds. To test the difference in perceived equity between the two designs, we aggregated these scores by calculating, for each group, the percentage of participants who had answered either "Yes" or "More or less" to the question. Because only two respondents in our entire sample selected the middle category, we simplified our analysis by collapsing the number of categories from three to two. While the choice to combine the "More or less" category with the "Yes" category (rather than the "No" category) is arbitrary, we show in Appendix C that our key findings do not change when we collapse the middle category in the other direction. Averages of these percentages for the two designs, along with a non-parametric difference of means test to estimate the average treatment effect of the internal leader discretion treatment, are given in Results. In Appendix D, we also present the results of individual-level parametric regression models that perform the treatment effect estimation, with and without individual-level covariates, group-level covariates, and country dummies. These results represent our best estimates of the equity differences between the two randomly assigned PES program designs.

We also test various explanations for the difference in perceived equity between the two designs, empirically investigating whether different perceptions of equity under the internal leader discretion design compared to the other design are best explained by individuals being personally disadvantaged by inequality in the payment distribution, meritocratic or non-meritocratic allocations of the payment, overall levels of inequality in the group, or the disproportionate capture of the payment by leaders or elite group members. To explore these questions, we present (in Results) a series of individual-level logistic regression models that predict whether participants assigned to the internal leader discretion design answered "Yes" or "More or less" to the question about the payment being fair as a function of several theoretically informed variables related to how the leader distributed the payment. By design, these endogenous variables vary under the internal leader discretion design, but not under the external egalitarian design, and represent different types of deviations from perfect equality in payment distribution. They therefore enable us to use leaders' endogenous decisions under the internal leader discretion design to test different expectations regarding *why* equity perceptions differed under this design compared to a perfectly egalitarian one.

To test the theory that perceptions of equity under the internal leader discretion design are explained by individuals being personally disadvantaged by inequality in the payment distribution ("disadvantageous inequity aversion" in the fairness psychology literature (Blake et al., 2015)), we model the survey response for individuals assigned to the internal leader discretion design as a function of whether or not the individual was given a share of the PES payment that was below 20 tokens in at least one round, which is the 'egalitarian' payoff that all participants are given when the payment is divided perfectly equally (Model 1). Model 2 tests the theory that sensitivity to meritocratic or non-meritocratic allocations of the payment explains variation in perceptions of equity under the internal leader discretion design by predicting the survey response as a function of two variables representing (a) whether or not the participant was awarded a less-than-egalitarian

share of the PES in at least one round in which they did not extract any trees, and (b) whether or not the participant was awarded a less-than-egalitarian share in at least one round in which they extracted one or more trees. If participants only perceived inequity in the internal leader discretion design when they were deprived of a share of the PES despite foregoing tree extraction in compliance with the PES agreement, *a* should predict lower perceptions of equity while *b* should not.

For each group of eight participants assigned to the internal leader discretion design, we also calculated a Gini coefficient of the distribution of the PES payments among members of each group throughout the course of the experiment, with a value of zero representing perfect equality and a value of one indicating perfect inequality. To test the hypothesis that variations in perceptions of equity under the internal leader discretion design are explained by inequality aversion, we predict the survey response of individual *i* in group *g* as a function of the Gini coefficient of group *g* (Model 3).

Additionally, we present results from two models to test the theory that variations in perceptions of equity are the result of leaders or local elites capturing a disproportionate share of the PES. For a given individual *i* in group *g*, we calculated a variable representing whether or not a leader in group *g* kept a greater-than-egalitarian share of the PES in at least one round (excluding those rounds in which individual *i* was the leader), and we use this variable as a predictor of the survey response in order to test whether participants were sensitive to the decisions of leaders to keep a disproportionate share of the payment (Model 4). Recognizing that participants may not necessarily regard those chosen as leaders in the experiment as 'elites', and may instead associate a player's relatively high socioeconomic status outside the game with elite status, we also calculated a variable capturing the relationship between players' socioeconomic status in real life and the distribution of the PES in the game for each group. For each group, we calculated a dichotomous variable representing whether or not the average share of the payment received by members of a given group who had less than the median number of years of formal education in that group was lower than the average share of the payment for group members who had at least the median level of education in their group. Model 5 predicts individuals' survey responses as a function of this variable, which represents whether or not there was an educational difference in the PES split in their group.

All regression models reported in Results control for the age of the participant, their number of years of completed formal education, and whether or not they were a woman. We also control for group-level averages of these variables. Observations with missing data on these demographic characteristics were excluded from model estimation. Additionally, the variable representing the educational difference in the split is undefined for two groups in which no group members had below the median number of years of education in that group. Those two groups are therefore excluded from the estimation of Model 5. Standard errors reported in Results are adjusted to account for clustering at the group level.

3. Results

3.1. PES recipients perceived the program as less equitable when a leader distributed the payment

Participants under the internal leader discretion design were less likely to report that the sharing of the payment was fair. Only about 80% of participants in the internal leader discretion groups reported that sharing was fair, compared to 91% in the external egalitarian groups, yielding a treatment effect estimate of -11.8% for the leader treatment ($p < 0.05$; Table 1). A generalized linear modelling approach at the individual level produces similar results with covariates, and without (see Appendix D).

Fig. 1 shows how these proportions are distributed. Under the external egalitarian design (panel b), the vast majority of groups had all

Table 1

Average percentages of participants in the groups who reported that the distribution of the payment was fair, by treatment assignment. Statistic represents the average percentage of participants in the group of eight players who answered either "Yes" or "More or less" to the following question: "In this game, an external organization offered a payment to the village for taking care of your forest. Do you feel that the way this payment was shared among participants was fair?". Bias-corrected and accelerated (BCa) 95% confidence intervals for each statistic are given in brackets. See Material and Methods for details on the experimental design.

Internal leader discretion ($N = 27$)	79.6% [67.7%, 87.5%]
External egalitarian ($N = 29$)	91.4% [83.5%, 96.0%]
Difference in means	-11.8% [-24.5% , -1.5%]

participants state that the payment distribution was fair. Almost no groups assigned to the external egalitarian design had fewer than half of the eight participants state that the payment distribution was fair, and none had all eight participants state unanimously that the payment was *unfair*. While most groups under the internal leader discretion design (panel a) had all participants state that the payment distribution was fair, there is much greater heterogeneity in these responses compared to the groups assigned to the external egalitarian design. Responses across groups assigned to the internal leader discretion design ranged from unanimously fair to nearly unanimously unfair.

3.2. The difference in perceived equity is only evident among individual participants who were excluded from a payment by the leader

Why did PES recipients perceive the program as less equitable when leaders were responsible for distributing the payment? To explore this question, we first use data from the experiment that identifies whether or not individual participants assigned to the internal leader discretion design received a less-than-egalitarian split of the payment in at least one round (<20 tokens; see Material and Methods). A total of 68 participants, about one third of those assigned to the internal leader discretion design, received a less-than-egalitarian split in at least one round. Participants assigned to the internal leader discretion design were significantly less likely to perceive the PES as fair if they were given a less-than-egalitarian split of the PES in at least one round of the game, according to Model 1 in Table 2. Of the participants who were assigned to the internal leader discretion design and received a less-than-egalitarian split in at least one round of the game, only about 56% reported that the PES was fair. Those who were assigned to the internal leader discretion design and received an 'egalitarian' split of the payment or greater every time reported that the PES was fair about 91% of the time, a number which is comparable to that seen under the external egalitarian design (Table 3).

These results suggest that it is not the involvement of a leader per se that leads to lower perceptions of equity, because the difference was only seen when leaders chose to distribute the payment unequally. However, readers should note that whereas we had experimental control over the rules governing whether or not leaders could make distributional decisions in the game, we did not have experimental control over the decisions themselves. This means that while the difference-in-means estimates in Table 1 represent the average treatment effect of a randomly assigned treatment, the estimates in Table 2 should be treated as correlational.

Additionally, we find no strong evidence that the apparent negative effect of the internal leader discretion treatment on perceived equity is explained by either (a) the degree of correspondence between individual contributions to conservation efforts and the share of the payment awarded to the individual, (b) the overall level of inequality in how the payment was distributed among group members, or (c) elite capture of

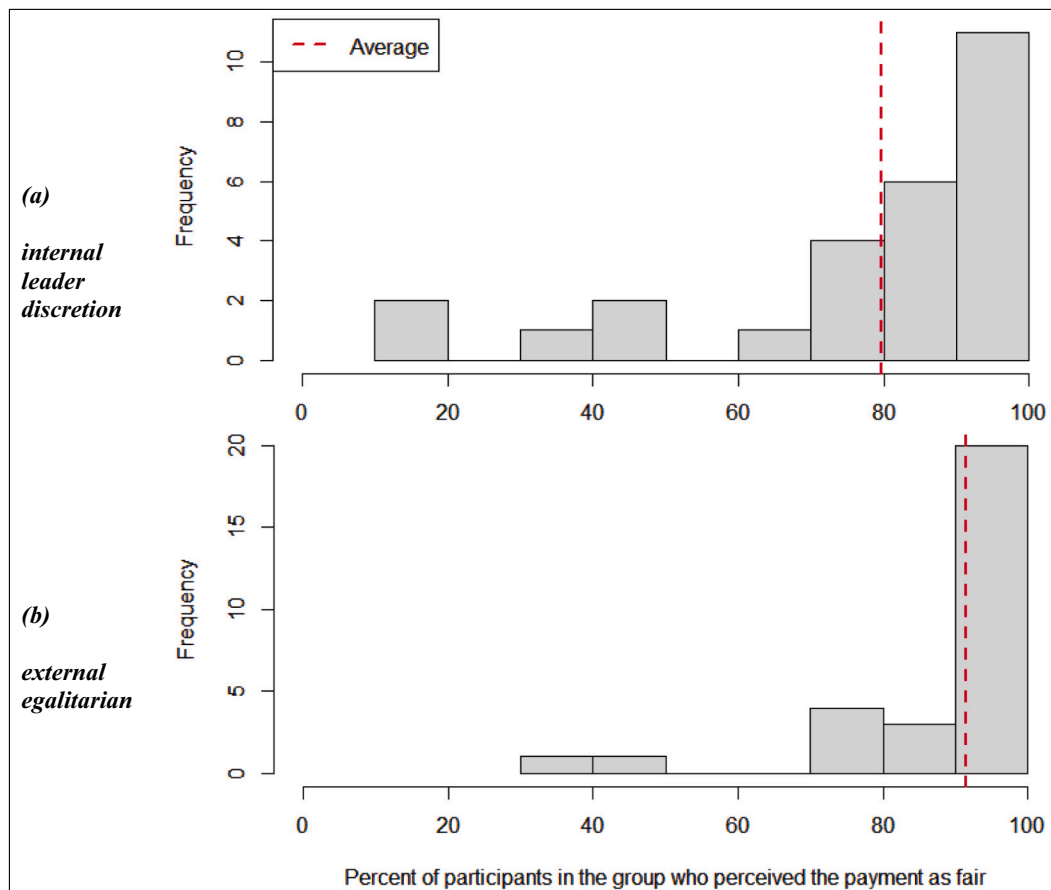


Fig. 1. Percentages of group members who perceived the distribution of the payment as fair, by treatment assignment. Each observation represents, for one group of eight participants, the percentage of group members who answered “Yes” or “More or less” to the following question: “In this game, an external organization offered a payment to the village for taking care of your forest. Do you feel that the way this payment was shared among participants was fair?”. See Material and Methods for details on the experimental design.

the PES, operationalized as the leader keeping a greater-than-egalitarian split of the payment or awarding a greater-than-egalitarian share to higher-status group members.

Whether or not an individual received a less-than-egalitarian split of the PES appears to explain their perceptions of fairness, but we find no evidence that this association differs based on whether or not the individual contributed to the conservation of the shared forest, as prescribed by the PES program. Regardless of whether a participant complied with the PES arrangement by refraining from extracting any trees in a given round, being given a less-than-egalitarian split in that round predicts a lower probability of reporting a fair distribution of the payments. In our experiment, 28 participants were given a less-than-egalitarian split in at least one round in which they extracted a non-zero number of trees, and 45 participants were given a less-than-egalitarian split in at least one round in which they did not extract any trees (13% and 21% of participants, respectively). The coefficient estimates for both of these variables are negative and statistically significant, and they are not statistically different from one another ($p = 0.167$; Model 2, Table 2). In other words, we find no evidence in support of the expectation that participants were sensitive to the degree of correspondence between their personal contribution to the group’s effort to conserve the forest and how much they benefited from the PES.

Controlling for whether or not an individual received a less-than-egalitarian split of the payment in at least one round, the overall level of inequality in the distribution of the PES in the group also does not appear to predict negative perceptions of equity in our data. We calculated a Gini coefficient representing the degree of inequality in the distribution of payments throughout rounds 9–16 among the eight

group members. Of the 27 groups assigned to the internal leader discretion design, 12 had a Gini coefficient greater than zero, indicating that these groups deviated, to varying degrees, from perfect equality. The results of Model 3 (Table 2) show that, controlling for whether a participant was personally disadvantaged by inequality (operationalized as whether or not they received a less-than-egalitarian split in at least one round), the group-level Gini coefficient calculated for their group does not significantly predict their perception of fairness. The results of Model 3 do not provide any evidence that a preference for an egalitarian division of the payment at the group level explained perceptions of inequity under the internal leader discretion design (and, by extension, differences in equity perceptions between the two designs).

Finally, we find no strong evidence in support of the theory that the extent to which leaders or local elites benefited disproportionately explains the negative effect of the internal leader discretion treatment on perceived equity among the experiment participants. Seven of the groups assigned to the internal leader discretion design (roughly one fourth of the groups assigned to this version of the game) had a leader keep a greater-than-egalitarian split of the payment in at least one round. While the correlation between this variable and participants’ perceptions of fairness is statistically significant while controlling for whether or not a given participant received a less-than-egalitarian split of the PES (Model 4, Table 2), the correlation is in the opposite direction as what would be expected if capture by leaders were driving the comparatively low perceptions of fairness under the internal leader discretion design. Of the 27 groups assigned to the internal leader discretion design, 12 of them exhibited a disparity in the distribution of the payment based on educational attainment, a key correlate of

Table 2

Predictors of perceived fairness under the internal leader discretion design. Estimates are from binary logistic regression models. Unit of analysis in each model is the individual participant. Dependent variable represents whether or not an individual participant answered either “Yes” or “More or less” to the following question: “In this game, an external organization offered a payment to the village for taking care of your forest. Do you feel that the way this payment was shared among participants was fair?”. Models control for a participant's age, years of schooling, and whether the respondent was a woman, as well as averages of these covariates at the group level. Standard errors in parentheses adjusted to account for group-level clustering. Difference between *a* and *b* tested using a Wald test. See Material and Methods for details on the experimental design and modelling approach.

	Model 1	Model 2	Model 3	Model 4	Model 5
Less-than-egalitarian split	-2.312 (0.653) <i>p</i> < 0.001		-3.289 (0.619) <i>p</i> < 0.001	-3.634 (0.727) <i>p</i> < 0.001	-3.863 (0.770) <i>p</i> < 0.001
Less-than-egalitarian split with zero extraction (<i>a</i>)		-1.561 (0.543) <i>p</i> = 0.004			
Less-than-egalitarian split with non-zero extraction (<i>b</i>)		-2.162 (0.629) <i>p</i> = 0.001			
Gini coefficient of total group payments			6.561 (4.093) <i>p</i> = 0.109		
Leader with greater-than-egalitarian split				1.960 (0.861) <i>p</i> = 0.023	
Educational difference in split					1.779 (0.843) <i>p</i> = 0.035
Constant	8.051 (1.733) <i>p</i> < 0.001	7.521 (2.004) <i>p</i> < 0.001	6.180 (2.307) <i>p</i> = 0.007	7.891 (1.490) <i>p</i> < 0.001	7.797 (1.698) <i>p</i> < 0.001
<i>a</i> — <i>b</i>		0.601 <i>p</i> = 0.167			
Individual-level covariates	x	x	x	x	x
Group-level covariates	x	x	x	x	x
Country dummies	x	x	x	x	x
<i>N</i>	176	176	176	176	160

socioeconomic status. We treat this is a second proxy for elite capture in the experiment (see Material and Methods). Once again, the correlation between this variable and the outcome is statistically significant, but in the opposite direction as expected (Model 5, Table 2). In other words, while it appears that leaders frequently awarded a disproportionate share of the payment to themselves or to participants of a higher-than-average socioeconomic standing, this does not help to explain why the internal leader discretion treatment caused lower equity perceptions because participants evaluated leaders *more positively* when they did so.

While we fail to find any strong evidence that group-level inequality, elite capture, or the extent to which an individual's share of the payment corresponded to their conservation decisions explain the negative effect of the internal leader discretion treatment on perceptions of fairness, these null findings should not be interpreted as definitive evidence that these features are *not* important. Given our relatively small sample and the large confidence intervals on some of the estimates in Table 2, it would not be correct to infer null relationships from the data.

4. Discussion and conclusion

This experiment compared two common designs for conservation

Table 3

Percentage of participants rating the PES as fair. Statistic represents the percentage of participants who answered either “Yes” or “More or less” to the following question: “In this game, an external organization offered a payment to the village for taking care of your forest. Do you feel that the way this payment was shared among participants was fair?”. Participants assigned to the internal leader discretion design are coded as receiving a less-than-egalitarian split in at least one round if they were awarded <20 tokens from at least one PES payment awarded to their group. Bias-corrected and accelerated (BCa) 95% confidence intervals for each statistic (given in brackets) were calculated using bootstrapping at the group level. See Material and Methods for details on the experimental design.

	external egalitarian design (<i>N</i> = 232)	internal leader discretion design (<i>N</i> = 216)	
		Less-than-egalitarian split in at least one round (<i>N</i> = 68)	Egalitarian split or higher in every round (<i>N</i> = 148)
Percent of participants rating the PES as fair	91.4% [84.1%, 96.1%]	55.8% [36.2%, 75.0%]	90.5% [83.8% 95.3%]

payment programs in order to understand how they impact local perceptions of equity. Participants perceived the collective PES program as substantially less fair when leaders decided how the payment should be distributed among program participants, compared to an ‘egalitarian’ scenario in which the payment was distributed equally by design. Our results also suggest that this difference arose because participants were sensitive to whether or not they were awarded a lower individual share of the payment. This result is consistent with previous research showing that “disadvantageous inequity aversion”—or an aversion to being given less than a peer—is an important driver of inequity perceptions (Blake et al., 2015). This result is important in light of mounting evidence that equity is related to local people's motivations to provide ecosystem services through these programs (Loft et al., 2020; Loft et al., 2017; Martin et al., 2014a; Pascual et al., 2010; Pascual et al., 2014).²

Although a large majority of participants in our experiment reported perceiving that the PES arrangements were fair, this should not be taken as evidence that an equivalent number of participants would perceive real-world PES programs as fair. Fairness in benefit-sharing is often a key problem in real-world collective PES programs (Hayes et al., 2019), and experiments such as the one described in this paper do not capture enough of the local socioeconomic context of real life to be treated as perfect analogues to actual PES programs. In other words, we believe that this experiment (and future experiments like it) can be helpful in investigating some of the features of programs that might make fairness perceptions more positive or more negative on average, but that such experiments would not do a good job at approximating how many participants would perceive real-world programs as fair.

One possible limitation of the field experiment is that it only facilitates the comparison of two scenarios—one with an egalitarian division of payments mandated by an outside organization, and the other with a division decided by local leaders. The experiment therefore does not allow us to compare these two designs to one in which an external organization chooses an inequalitarian division of the payment, nor does it allow us to make claims about fairness perceptions related to PES designs where the nature of local participation differs substantially from

² Although participants in our experiment who perceived the payment as unfair extracted roughly the same number of trees throughout the course of the game as those who perceived the payment as fair (standardized mean difference = 0.009), other research suggests that PES program designs that participants rate as unfair also elicit less conservation effort (Loft et al., 2020).

the designs which we simulate in our experiment.

However, as we discussed earlier in the paper, the two designs in our experiment represent two theoretically practical, and therefore common, options for designers of PES programs, since outside organizations often lack the local knowledge needed to choose a division of the payment unless it is strictly egalitarian. Furthermore, the data from our experiment allow us to show that when a local leader distributed the payment in an egalitarian manner, participants perceived the program to be just as fair as when an external organization imposed an egalitarian decision rule. This suggests that it was the inequalitarian division of the payment made possible by local leaders' discretion, not simply the involvement of a leader on its own, that caused perceptions of equity to differ between the two designs. Even where real-world PES programs have been designed to provide broader opportunities for community participation in distributive decision-making than those simulated in our experiment, communities have still delegated some authority to locally elected leaders (Nieratka et al., 2015), which means that the findings from our study and others like it are relevant for understanding fairness perceptions related to collective PES programs.

Future research should nonetheless build upon this study by examining fairness perceptions in relation to a wider range of PES program designs. Previous research also indicates that preferences and perceptions related to distributional equity in PES may vary across local and national contexts (Liso et al., 2020a; Liso et al., 2020b). Evidence from cross-cultural psychology suggests that while some notions of fairness exhibit variability across cultures, others are notably consistent (Blake et al., 2015). Most relevant to our experiment is the finding that "disadvantageous inequity aversion"—which is analogous to our participants' apparent negative reaction to being paid a less-than-equal split of the payment—tends to be fairly consistent across societies (Blake et al., 2015). This implies that our results may hold in some local contexts other than those in which we performed our experiment. Still, the extent to which equity perceptions related to PES hold across contexts is an outstanding empirical question.

One potentially relevant feature of real-world PES contexts that this experiment does not capture is variations in the amount and type of information available to participants. In the experiment, opportunities for open communication in rounds 9–16 afforded participants opportunities to signal their own preferences for extraction or conservation, or discuss their individual strategies more explicitly. This means that participants gathered incomplete information on others' extraction decisions, either via heuristics and cues or because some members explicitly discussed their individual strategies. In real-world settings where community members extract trees and other forest products from shared forests, community members will often have incomplete information on the extraction decisions of others, since a community member will not be able to observe the extraction decisions of all other households. Nonetheless, the amount of incomplete information that real-world PES participants have varies according to features of the local context that are not captured in our experiment, such as social capital and local institutions for monitoring among forest users. The availability of information also varies according to the livelihood activities that are common in a particular place and the associated threats to shared forests, since agricultural encroachment is often more visible and easier to attribute to individual households than is the extraction of timber and other forest products. Relatedly, some community members may lack information on the PES program altogether, as previous studies have shown in some real-world programs (Hayes et al., 2019).

We acknowledge that the role of the leader in shaping equity perceptions may vary in part based on the amount of information available to participants, and that the generalizability of our results to real-world PES programs may depend in part on the information available to community members. For example, in a context where forest users have a high degree of information on other users' decisions due to well-developed local institutions for monitoring, the leader may play a larger, more visible role in resolving conflicts and ensuring that benefit-

sharing is related to conservation effort, compared to in our experiment. Additionally, in settings where many community members lack access to information about the PES program, the leader may play an important role in providing that information. Future experiments should seek to better understand how the availability of information shapes fairness perceptions in PES, whether leaders play important roles in providing information about PES programs, and whether information moderates the effects of local leader involvement (or other PES program characteristics) on fairness.

Another aspect of real-world contexts that our experiment cannot capture is variation in the opportunity costs associated with PES participation and conservation decisions. Within some communities, opportunity costs for conservation vary substantially among community members, whereas our experimental design did not vary these opportunity costs. It is possible that in communities where opportunity costs vary widely, community members are less likely to perceive unequal payments as inequitable, compared to in settings where opportunity costs vary less. Future research should therefore examine whether variability in the opportunity costs associated with conservation moderates the effects of local leader involvement on equity perceptions.

The potential importance of local context is further underscored by the fact that the three countries appear to have varied noticeably in terms of equity perceptions among experimental participants. In our experiment, about 17% of participants in Tanzania perceived the payment distribution to be unfair, compared to only about 12% of participants in both Indonesia and Peru. The key endogenous predictor of equity perceptions in our results—leaders' decisions to award a less-than-egalitarian share of the payment to some participants—appears to vary similarly across countries in our data. About 55% of participants assigned to the internal leader discretion design in Tanzania were awarded a less-than-egalitarian share of a payment, compared to about 27% of such participants in Peru. In Indonesia, leaders in the game always chose to distribute the payments in an egalitarian fashion.

How do leaders make their distributive decisions, and why might this decision process vary across local contexts? Since leaders' distributive decisions appeared important for explaining equity perceptions in our experiment, future research should also seek to better understand how leaders make such decisions in PES scenarios. For example, do some leaders distribute payments unequally in an attempt to sanction groups exhibiting high levels of defection from PES agreements? Descriptive data on distributive decisions among our analytic sample of participants assigned to the internal leader discretion design make this strategy appear possible. Following rounds with perfect cooperation (operationalized as no tree extraction by any group members), 93% of payments awarded by the leader to individual group members were equal to the egalitarian split of 20 tokens. Following rounds when groups deviated from perfect compliance, only 60% of payments awarded to individual group members were equal to the egalitarian split. However, our research design was not explicitly focused on studying the decision processes that leaders used to make their distributive decisions, and future research should explore the relationship between PES compliance and leaders' distributive decisions, with a particular focus on how the availability of information shapes this relationship. Furthermore, because members of the same family were prohibited from participating in the same game session together (see Appendix A), and because we do not have data on participants' personal networks, we are unable to

explore whether leaders' distributive decisions are shaped by their personal relationships. However, it is possible that this is the case, and this seems like an important area for future study.³

Taken together, the theoretical discussion above suggests that there may be local settings in which leaders are not associated with perceptions of inequity, such as settings in which leaders are highly effective at using their distributive decisions to manage the problems of heterogeneous opportunity costs or free-riding, or settings where leaders rarely deviate from egalitarianism due to social norms or other constraints. For these reasons, our results should not be interpreted to mean that local leaders should never be involved in the administration of collective PES programs. However, there are other reasons to avoid this interpretation of our results. PES programs have multiple policy goals other than perceived equity, and that the involvement of local leaders in the administration of these programs may generate other important benefits. Other experimental research suggests that local leader involvement promotes cooperation in PES programs (Gatiso et al., 2018), and can enhance the efficiency of such schemes (Rodríguez et al., 2021).⁴ More generally, there is evidence that local leaders are often popular and perceived as fair, and that these public perceptions often align with leader's actual behaviors (Vollan et al., 2020). Furthermore, local involvement in the administration of collective PES programs is widespread, and likely important to the functioning of many existing and future programs (Hayes et al., 2019). Devolving some decision power to local leaders or groups may alleviate some of the informational problems that occur when an outside actor attempts to administer a program across a large number of communities. Finally, local leaders' involvement in the administration of conservation programs may be viewed as a type of local empowerment or autonomy, and may therefore be desirable in its own right.

The immediate policy implication of this research is that there may often be important equity trade-offs associated with devolving control over distributive decisions to local leaders. However, such trade-offs need not be inevitable. The most promising finding from our study is that perceptions of equity did not appear to be affected negatively by the presence of leaders when those leaders chose to distribute the payment equally. Given the importance of local involvement in the administration of PES programs, future work should seek to better understand how leaders make distributive decisions in such scenarios, and to explore the potential heterogeneity in the effects of leader involvement on equity based on the real-world contextual factors already mentioned. There is also a role for future policy experimentation to understand how programs can be designed to facilitate the participation of local leaders while preserving a sense of fairness among community members. For example, when local leaders have a large degree of discretion over the distribution of payments, it may be helpful for some PES implementers to monitor equity perceptions among program participants. The importance of monitoring in PES programs has received considerable attention, but this attention has primarily focused on the necessity of monitoring conservation decisions and environmental outcomes to

³ Another potential pattern that we explored is whether leaders strategically kept a disproportionate share of the payment in the final round in which the payment was offered. However, in our data, the number of times that leaders kept a disproportionate share of the payment (>20 tokens) in the final round in which the payment was offered was the same as the number of times that this occurred in the first three rounds in which the payment was offered, which suggests that this decision process did not differ in the last round compared to in earlier rounds of the game.

⁴ The data from our experiment do not suggest that groups randomly assigned to have local leaders involved in payment distribution conserved more trees, earned more money by the end of the game, or met the conditionality criterion (and were successfully awarded the PES) more times than groups assigned to the 'egalitarian' program (see Appendix E). Nonetheless, we do not rule out fact that giving local leaders discretion is important for these policy outcomes or others.

ensure that the programs are having an effect (Chan et al., 2017; Rodríguez et al., 2019; Tuanmu et al., 2016), despite the fact that effectiveness, efficiency, and equity ("3E") have all been regarded as important evaluative criteria for PES programs (Angelsen and Wertz-Kanounnikoff, 2008; Naime et al., 2022). Policy experiments related to the monitoring of equity perceptions, or other policy experimentation to encourage equitable decision-making when leaders play a role, is important in light of growing debates about the equity implications of PES programs.

Declaration of Competing Interest

None.

Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.crsust.2023.100212>.

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