Fair payments for effective environmental conservation

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Global efforts for biodiversity protection and land use-based greenhouse gas mitigation call for increases in the effectiveness and efficiency of environmental conservation. Incentive-based policy instruments are key tools for meeting these goals, yet their effectiveness might be undermined by such factors as social norms regarding whether payments are considered fair. We investigated the causal link between equity and conservation effort with a randomized real-effort experiment in forest conservation with 443 land users near a tropical forest national park in the Vietnamese Central Annamites, a global biodiversity hotspot. The experiment introduced unjustified payment inequality based on luck, in contradiction of local fairness norms that were measured through responses to vignettes. Payment inequality was perceived as less fair than payment equality. In agreement with our preregistered hypotheses, participants who were disadvantaged by unequal payments exerted significantly less conservation effort than other participants receiving the same payment under an equal distribution. No effect was observed for participants advantaged by inequality. Thus, equity effects on effort can have consequences for the effectiveness and efficiency of incentive-based conservation instruments. Furthermore, we show that women exerted substantially more conservation effort than men, and that increasing payment size unexpectedly reduced effort. This emphasizes the need to consider social comparisons, local equity norms, and gender in environmental policies using monetary incentives to motivate behavioral change.

payments for ecosystem services | climate change | biodiversity | behavioral economics | environmental justice

The ambitious scope of global conservation and carbon sequestration goals and limited funding dedicated to their implementation (1–3) necessitate increasing the cost-effectiveness of conservation policy instruments. Incentive-based policy instruments are at the forefront of global efforts to meet these goals (4–6). Conservation incentives aim to achieve multiple goals of sustainable development, including biodiversity preservation, human well-being, and social equity (7, 8). In low-income regions where local livelihoods often depend on natural resources, payments complement restrictive conservation measures, such as protected areas (9). Whether incentives can achieve these multiple goals and what trade-offs among them are unavoidable are important unanswered questions (10, 11).

Efficiency and equity are often portrayed as competing policy goals, based on the concern that equitable redistribution might consume resources and undermine the power of incentives to motivate behavior (11, 12). For instance, it can be efficient to pay recipients more for the conservation of areas that are larger, more threatened, or of higher ecological value, but this may disadvantage those endowed with less land or land of lower conservation value, even if they bear similar personal costs of conservation (13, 14). As another example, many programs incentivize groups or communities rather than individuals to reduce transaction costs. Improved cost-effectiveness may be undermined by privileged demographic groups capturing most of the benefits rather than households that contribute the most to conservation (15, 16).

Equity concerns and social norms of fairness strongly influence human behavior (17–21). Such effects are often asymmetric; disadvantageous inequality has a greater impact than advantageous inequality (17, 18, 20, 21). As a consequence, equity could affect conservation effectiveness and efficiency (22–24), particularly among disadvantaged recipients. This raises the question of whether social equity and environmental conservation might be codependent rather than competing goals. For example, inequity might weaken recipients' morale to exert conservation efforts, thereby undermining environmental effectiveness (25–27). Consequently, addressing fairness may achieve better environmental outcomes and even improve cost effectiveness (26, 28, 29).

Although it is a prominent conjecture in the literature, systematic evidence on how fairness affects an incentive-based policy's environmental effectiveness is scarce (8, 30, 31), due in part to methodological challenges. This leaves policymakers in the dark about how much equity matters from an effectiveness or efficiency perspective. To address this knowledge gap, we undertook this study of causal links between equity in environmental incentives with conservation effort outcomes.

We used real-effort field experiments with a total of 443 land users from 14 randomly selected villages near a national park in the Vietnamese Central Annamites, a global biodiversity hotspot. Although local deforestation has become less severe in recent years, the region's native forests are now at risk of reduced regeneration due to defaunation caused by hunting and human-induced habitat fragmentation (32, 33). This poses a threat to rainforest stocks, local livelihoods (34), and species

Significance

Incentive-based measures are increasingly popular to alleviate ongoing biodiversity loss and greenhouse gas emissions from land use change. However, effectively using scarce conservation funds remains a major challenge. Using behavioral economic experiments in the buffer zone of a Vietnamese national park, we show that unfair payment distributions that are beyond land users' control can reduce the environmental effectiveness of incentives, and that women exert more effort. Our study region is threatened by forest degradation and is part of the nationwide Vietnamese Payments for Forest Ecosystem Services program, making it an important and relevant context for improving the effectiveness of conservation measures. These results show that policymakers aiming for effective and efficient programs should pay close attention to fairness and gender.

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Data deposition: The data supporting the findings of this study and all analysis scripts are available at https://github.com/stefgehrig/fairconservation.

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diversity (32), ultimately affecting globally-desired carbon sequestration and biodiversity outcomes (35). The Vietnamese national Payments for Forest Ecosystem Services (PFES) program has been in place here since 2011, but doubts about its social equity have been raised (34), making the region particularly relevant for our research questions.

Methods and Data

Conceptual Background on Equality and Equity. While the concept of equity in policymaking has multiple dimensions (26, 36, 37), here we focus on distributional equity. Personal accountability is central to theories of fairness developed by scholars from diverse disciplines, including philosophy (e.g., ref. 38), economics (e.g., ref. 39), political science (e.g., ref. 40) and psychology (e.g., ref. 41). According to these theories, a distribution is fair if, under equal opportunities, individual rewards are proportional to input factors that people are responsible for, such as effort, but do not depend on circumstances beyond their control, such as luck. Thus, as the seminal article by Adams (41) put it, when "outcomes and inputs are not in balance in relation to those of others, feelings of inequity result" (p. 280). The "accountability principle" (39, 42), also called "liberal egalitarianism" (43), distinguishes equity from equality, because whether (in)equality is equitable depends on whether the input that people can "reasonably influence" is equal (39). There is ample evidence that people prefer distributions that follow relative deservingness rather than strict equality or chance (41–46), even across culturally distant societies (40), and have strong moral disapproval of luck-based inequality (47). By following the accountability principle as a concept of distributional equity, we can test the general implications of equity for outcomes of incentive-based conservation policies in an experiment: When all relevant variables that the beneficiary can influence are kept constant, recipients should receive an equal share of the total reward. This opens a path for experimental manipulation of equity.

Experimental Design and Data Collection. Following the push to address human behavior and psychology in development and sustainability policy research (48, 49), we used economic laboratory-in-the-field experiments, a valuable tool in conservation planning (23, 24, 50, 51). For transparency, we preregistered our main hypotheses and analytical methods before data collection (http://aspredicted.org/blind.php?x=k4ij32).

Our experiment was based on a real-effort task (52): for a piece-rate payment, participants filled biodegradable bags with fertile soil to grow seedlings for reforestation in cooperation with local forest rangers (see Fig. 2*A*). Non-governmental organizations or tree nurseries in the study region typically hire seasonal workers for this activity to restore forests. Such reforestation activities can help rebuild natural habitats, contributing to biodiversity conservation (53, 54). Activity-based measures are part of many PES programs (55), including those in Vietnam (34, 56), China (57, 58), Mexico (4, 59), and Ethiopia (60), and contribute to climate change mitigation (61) (*SI Appendix*, section 1.1.1). This adds an important layer of realism to the experimental task, making it akin to a small intervention with tangible environmental benefits. From the pool of villages with >250 inhabitants in and near Bach Ma National Park in central Vietnam and enrolled in the national PFES scheme, 14 villages and 1 pilot village were selected at random to take part in the experiment (Fig. 1; village details in *SI Appendix*, section 1.4). Ethics of the experiment were approved by the German Association for Experimental Economic Research (*SI Appendix*, section 1.4).

Thirty-two participants were enrolled in each village on the day of the activity from the community's public area (participant data summarized in *SI Appendix*, section 1.5). The total number of participants was based on an a priori power calculation (*SI Appendix*, section 1.4).

In each session, we briefly introduced the task to all participants, sought the participants' informed consent, and conducted a 5-min unpaid training run to teach participants how to prepare the soil bags (Fig. 2*A*). We recorded the number of bags that each participant filled during training as a proxy for skill. Enumerators were randomized to groups and were blinded to treatment while giving the general task instructions (full instructions in *SI Appendix*, section 1.2). Five participants withdrew during the experiment and left with only the show-up fee (*SI Appendix*, section 1.2.7), leaving a sample size of $n = 443$.

Fig. 1. Study area. Fifteen visited villages in Nam Đông District in the buffer zone of Bach Ma National Park (*Lower Right*), of Thừa Thiên-Huế Province (*Upper Right*), Vietnam (*Left*). See *SI Appendix*, section 1.4 for details on villages.

Fig. 2. Experimental setup. (*A*) The real-effort task. Participants filled biodegradable bags with fertile soil to be used by forest rangers to grow seedlings for local reforestation. (*B*) Example of experimental implementation in one of the villages. Thirty-two participants were assigned at random to four groups of eight (two with equal pay, two with unequal pay), with all groups seated separately during payment assignment, task instructions, training run (5 min), and the incentivized experiment (60 min). The clothing colors of high-paid/low-paid participants illustrate the random seating within the unequal groups.

Participants had 60 min to perform the task and could freely communicate within, but not among groups (see below). The experiment was concluded by a short survey and a debriefing with a group discussion. Participants received a show-up fee of 30,000 Vietnamese dong (equal to 1.29 USD at the time of the study) plus their earnings from the real-effort task (total mean earnings 3.01 $\pm$ 0.52 USD, roughly 175% of the median daily income reported in the survey).

We applied four treatments in a 2 $\times$ 2 design (Fig. 2*B*). Subjects were either paid a low (400 VND/piece = 0.017 USD/piece) or a high (600 VND/piece = 0.026 USD/piece) per-piece rate and were either seated in a group with an equal (all receiving the same rate) or an unequal (one-half receiving the high rate and the other half the low rate) distribution. Each group had eight participants. In each village, there were two groups with equal distributions (one low rate, one high rate) and two groups with unequal distributions. We counted the number of soil bags for reforestation produced by each participant within the fixed time, which is our measure of conservation effort.

Subjects were paid based on individual effort; the group only served as a frame for distributional fairness, and others' performance did not affect individual payoffs. Participants drew a number for random assignment to a group, where they took a seat. Treatments were revealed to participants in their groups after the training run. Enumerators randomly distributed envelopes with the piece rate to everyone, and it was common knowledge within a group, but not among groups, how many people in the group earned the high pay rate and how many received the low pay rate (but who received what was not known to enumerators or to other subjects in the group unless they disclosed it themselves during the task).

The starting conditions and opportunities in the experiment to generate income were kept equal except for the exogenously and randomly determined distribution of piece rates, creating a setting in which, according to the accountability principle, pay rate equality should be perceived as equitable. Subjects had no reason to believe that their peers deserved a different pay rate, arguably inducing inequity. The group with the same absolute piece rate but without inequality served as a control to estimate the causal effects of disadvantageous inequality (low pay in an unequal group) and advantageous inequality (high pay in an unequal group) on conservation effort, independent of absolute pay. Thus, within-group payment differences were a manipulation of incentive fairness (*SI Appendix*, section 2.1). Similar inequalities in pay for proactive conservation behavior can also be found in many real-world programs, such as Vietnam's PFES scheme, China's Sloping Land Conversion Program, and agri-environmental measures in the European Union (*SI Appendix*, section 1.1.2).

To test whether unjustified pay inequality indeed violated locally held fairness norms, we assessed participants' general endorsement of the accountability principle using four vignettes that describe scenarios of two people sharing the benefits of joint work (adapted from ref. 42; see *SI Appendix*, section 1.3). In each vignette, participants had to decide whether the described benefit-sharing scenario was fair or unfair; the number of responses conforming to the accountability principle yielded a score from 0 to 4 for each subject. To assess whether unequal pay in the experiment affected fairness perceptions, we recorded participants' judgment of their pay rate's fairness on a five-point scale and, in an open-ended follow-up question, asked them why and what they thought about it. More details on data collection and the survey questions are provided in *SI Appendix*, section 1.2.

Hypotheses. We hypothesized that an unequal distribution decreases conservation effort, and does so more strongly for low-paid (disadvantaged) individuals than for high-paid (advantaged) individuals. We also hypothesized that larger payments lead to greater effort independent of distribution effects (see preregistration, *SI Appendix*, section 1.4). Concerning participants' perceptions, we further expected that they would endorse the accountability principle of fairness, and that the inequality treatment would negatively affect judgment of payment fairness (but hypotheses for survey results were not preregistered).

Statistical Analysis. Task outcomes were analyzed using linear mixed-effect models with the package *lme4* (62) in R version 3.6.2 (63), specifying village as a random effect to control for within-village correlation in individuals' conservation effort (*SI Appendix*, sections 2.1.3 and 2.1.5). Following our hypotheses, we show models for the effect of inequality among low-paid participants only (Table 1, models 1 and 2), among high-paid participants only (models 3 and 4), and for the interaction of pay rate with inequality among all participants (model 5). Fairness perceptions were analyzed using ordinal logit mixed-effects models in the package *ordinal* (64). Following our preregistered

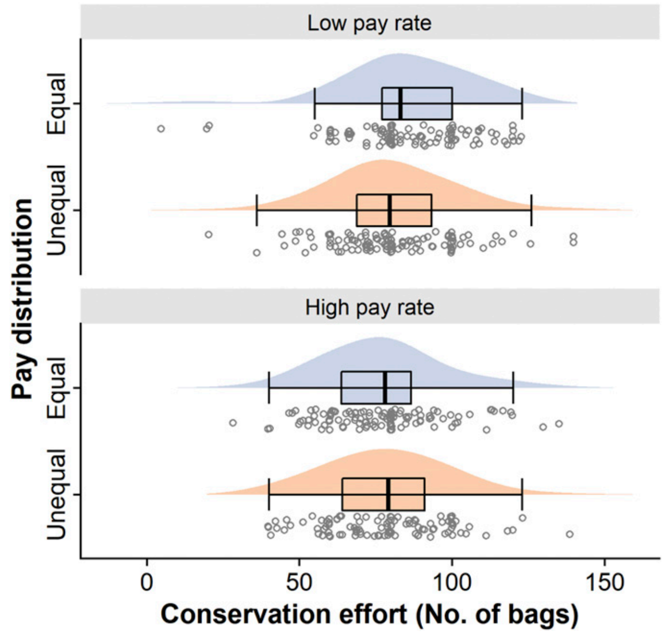

Fig. 3. Conservation effort as a function of pay distribution (equal vs. unequal) and pay rate (low vs. high). Effort was measured as the number of soil bags that participants prepared for reforestation in 60 min. Observations outside the whiskers are treated as outliers following the preregistered procedure (*SI Appendix*, section 1.5) and are not included in models reported in Table 1, but are included in *SI Appendix*, section 2.1.3. The figure is based on ref. 67.

robustness procedure, we conducted all regression analyses both with and without a predefined set of control variables (Table 1 and *SI Appendix*, section 2.1.3), as well as with and without outliers beyond 1.5 times the interquartile range (10 outliers; see observations beyond the boxplot whiskers in Fig. 3; more details in *SI Appendix*, section 1.6). Given that performance in real-effort tasks typically shows exceptionally high variance (65), removing extreme values can increase statistical precision. Notably, most outliers were participants whose behavior was peculiar to enumerators in the field, and all outliers were overly influential in regression models (Cook's distance > N/4; *SI Appendix*, section 1.6), suggesting that they might also bias estimation of average effects. Thus, we report outlier-adjusted results (n = 433) for all analyses of conservation effort. We report the same analyses including outliers (n = 443) in *SI Appendix*, section 2.1.3. In addition, the robustness of regression-based inference for the treatment effects was assessed with exact P values from randomization tests (66) (*SI Appendix*, section 2.1.2). Models were also run with additional random intercepts for group ID and SEs clustered at the group level (*SI Appendix*, section 2.1.3). The conclusions are qualitatively robust to differences among these analyses.

The data that support the findings of this study and all analysis scripts are publicly available at https://github.com/stefgehrig/fairconservation (68).

Results

Disadvantaged Participants Work Less in Unequally Paid Groups. Among participants who earned the low pay rate, those in unequal-payment groups exerted significantly less effort than those in equal-payment groups (Fig. 3). The estimated reduction in effort was 0.42 SD (95% confidence interval [CI], 0.19 to 0.66) and varied between 0.29 and 0.42 SD for different specifications (Table 1, models 1, 2, 5; raw statistics on conservation effort by treatment and their paired comparisons are provided in *SI Appendix*, sections 2.1.1 and 2.1.2). These effects held, although with smaller effect sizes, in otherwise identical models without outlier adjustment (0.16 to 0.25 SD; *SI Appendix*, section 2.1.3). In summary, low-paid participants reduced their effort when other peers in their group earned more for the same work due to luck during randomization. For participants earning the high pay rate, there was no difference in effort between the equal and unequal conditions (Table 1, models 3 and 4). This means that only disadvantageous and not advantageous payment inequality decreased the conservation effort, with the difference itself being significant (interaction effect; Table 1, model 5).

Unequal Pay Is Viewed as Unfair. Responses to the vignettes on social norms of benefit sharing show high endorsement of the accountability principle (i.e., accountability should depend on effort and not on external influences on outcomes) and thus of equality of pay rates as an equitable distribution mechanism. A significant majority of participants gave at least three out of four vignette responses consistent with the accountability principle (85% vs. 31.25% expectation by chance alone; binomial test, P < 0.001) (Fig. 4*A*); detailed vignette results in *SI Appendix*, section 2.5). The scenarios presented in the vignettes were not related to the content of the experiment, and results did not differ between the equal and unequal conditions ($\chi^2_{df=3} = 3.4$, $P = 0.33$). Thus, as intended, our random assignment of lower payment rates in the unequal condition violated local equity norms.

Participants in the equal-pay groups tended to judge their own payment as fairer compared with those in unequal-pay groups (Fig. 4*B*). The odds ratio for giving a lower fairness rating in the unequal condition compared with the equal condition was 1.42 (95% CI, 0.99 to 2.03; P = 0.053, ordinal logit mixed-effect model controlling for absolute pay rate with random intercepts for village; n = 442) (*SI Appendix*, section 2.4). In contrast to the effect on effort (see above), participants' evaluation of the fairness of the inequality treatment did not differ between subjects with different (high/low) pay rates (interaction effect, P = 0.52). Overall, fairness ratings were surprisingly high: three out of four participants across all treatments rated their payment as either "very fair" or "somewhat fair." However, in the open-ended follow-up question, the proportion of participants who gave a lower fairness rating ("undecided," "not so fair," or "not fair at all") explicitly due to considerations of others' pay rates was higher in unequal groups (14% vs. 7%; $\chi^2_{df=1} = 4.0$, P = 0.045) (more details and analyses in *SI Appendix*, section 2.6). Participants in unequal groups were significantly more likely to refer to pay rates of other participants in their response to this question (24% vs. 12%; $\chi^2_{df=1} = 10.0$, $P = 0.002$). This means that even though participants generally regarded the experimental payments as fair, our inequality treatment successfully reduced participants' fairness judgments, and for the expected reasons.

Interaction and mediation analyses showed no association of the presented individual-level survey responses (score for endorsement of accountability principle, fairness judgment) with the effect of inequality on effort (*SI Appendix*, section 2.1.4). Note, however, that our study was neither intended nor powered to detect such effects.

Higher Pay Rate Reduces Conservation Effort. Contrary to our expectations, people who received the high pay rate in equal groups worked less than those receiving the low pay rate in equal groups (Table 1, model 5). The effect was sizeable, with an estimated 0.45 SD (95% CI, 0.27 to 0.63) reduction in effort for the higher pay rate.

Women Exert More Conservation Effort. On average, women (60% of all participants) produced significantly more bags in the available time compared with men (Table 1). Importantly, the gender

Table 1. Linear mixed-effect models of the conservation effort

	Dependent variable: conservation effort (no. of bags)				
	Low pay rate		High pay rate		All
	Model 1	Model 2	Model 3	Model 4	Model 5
Unequal	−0.42 (0.12)***	−0.35 (0.09)***	0.06 (0.12)	0.12 (0.09)	−0.29 (0.09)***
Female		0.51 (0.10)***		0.37 (0.11)***	0.40 (0.08)***
Training run		0.59 (0.05)***		0.57 (0.06)***	0.58 (0.04)***
High pay rate					−0.45 (0.09)***
Unequal x high pay rate					0.41 (0.13)***
Additional controls	No	Yes	No	Yes	Yes
Observations	216	212	217	212	424
Marginal R^2	0.04	0.5	0	0.43	0.47
Conditional R^2	0.25	0.59	0.27	0.54	0.55
Log-likelihood	−905.8	−884.2	−912.2	−829.4	−1,654.9

The table shows the effect of unequal distribution for subjects with low payment (disadvantaged inequality) in models 1 and 2 and for subjects with high payment (advantaged inequality) in models 3 and 4. Model 5 includes all subjects and shows the effect of pay rate and the interaction between pay rate and unequal distribution. All models contain random intercepts for village. Dependent and independent variables (except dummy variables for treatments) are standardized to have a mean of 0 and SD of 1. Additional controls refer to survey responses on sociodemographic factors, environmental concern, and the task. *SI Appendix*, section 2.1.3 provides model coefficients, and *SI Appendix*, Table S4 provides summary statistics for these variables. Models without preregistered outlier adjustment are reported in *SI Appendix*, section 2.1.3. Marginal and conditional R^2 refer to explained variance excluding and including variance captured by random effects, respectively (50). Minor sample size variations are due to survey nonresponse.

*$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.

difference remained substantial when controlling for performance in the highly-predictive 5-min training period and for previous experience with the task (Table 1, model 5). This suggests that the observed gender difference is not due to an advantage for women in skill or experience in the task. After finding the gender effect, we explored interaction effects between the unequal treatment and gender and found no significant association (*SI Appendix*, section 2.1.4).

Discussion and Conclusion

Our study has empirically shown that disadvantageous inequity in payment distribution reduces effort in incentive-based conservation instruments. By using a randomized real-effort experiment that manipulates equity, we circumvent problems of confounding variables, reverse causality, or hard-to-appraise environmental effects of observational approaches. Thus, we provide evidence that equity is not merely a desirable side objective, but a central design feature of these instruments (69). In our experiment, participants who were disadvantaged by randomly-assigned unequal payments exerted significantly less conservation effort than participants receiving the same payment when peers earning more were absent, although the exact size of the effect is sensitive to outliers. In line with field experiment studies from more conventional labor markets (17–19), this suggests that dissatisfaction with unjustified payment inequality reduces working morale in the reforestation activity. Since our experimental design eliminates low pay as a cause per se, social comparisons and resulting emotions like anger, envy, or resentment are most likely the main psychological drivers of the effect (41). The reduction in effort has efficiency implications for conservation initiatives when fixed costs, such as setting up a bureaucracy or paying wages to ground staff, are considered. Other things being equal, a fixed conservation goal could be achieved faster with the same resources when payments are equitable. Efficiency gains should be expected if perceived equity can be improved without large additional costs.

Being advantaged by inequality did not affect conservation effort in either direction. This resonates with seminal behavioral economic research showing people to be less concerned about advantageous inequality compared with disadvantageous inequality (18, 20, 21). The average effect of the inequality treatment across both pay rates therefore trended nonsignificantly negative (*SI Appendix*, section 2.1). Because real-world inequalities are often larger than in our experiment and leave many underprivileged to the advantage of only a few, rather than

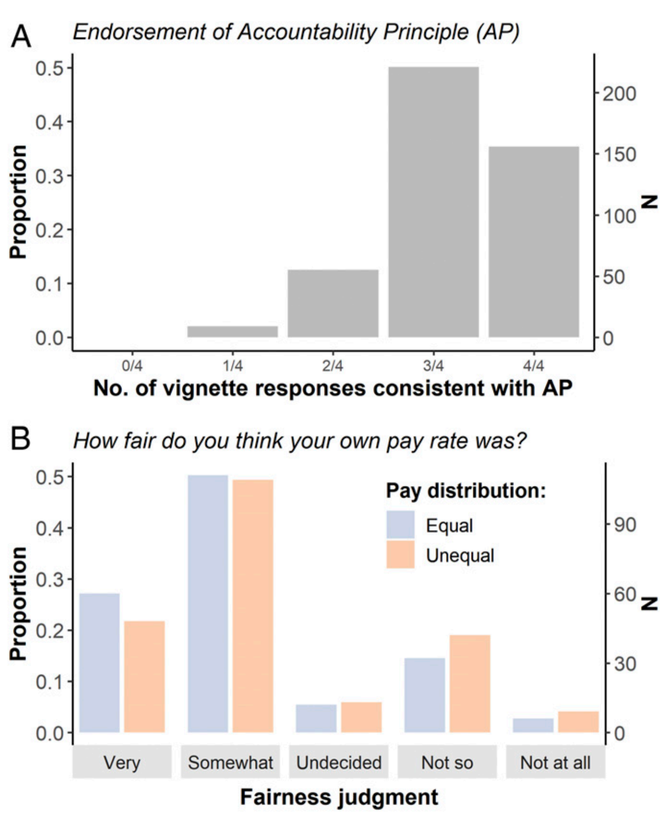

Fig. 4. Fairness perceptions. Survey responses on (*A*) participants' endorsement of the accountability principle of fairness, measured as the proportion of responses to the four vignette scenarios that satisfy the accountability principle and on (*B*) participants' judgment about the fairness of their own payment on a five-point scale, split by equal or unequal payment treatment.

a 1:1 ratio as in our inequality treatment, the aggregate effect of unfair payments across the advantaged and disadvantaged could be larger. These findings predict adverse consequences of real-world problems such as inequality in natural resource benefits due to elite capture or conservation programs that inadvertently benefit actors with preexisting land endowments or who come from advantaged ethnicities, castes, or other demographic categories. Such inequities are rampant in the PES program in the studied population (34) and are widespread globally (28, 29, 70) (*SI Appendix*, section 1.1.2).

Responses to the nonincentivized survey show that unequal payments were indeed perceived as less fair. This supports the view that the experimental outcome resulted from fairness violations leading to dissatisfaction and demotivation, particularly among low-paid participants (21). Participants overwhelmingly endorsed the accountability principle in the four vignettes, supporting the view that the unequal payment treatment violated local fairness norms by basing payments on luck rather than deservingness. Yet, the treatment effect on judgment about the fairness of one's pay was small (Fig. 4*B*). This may be due to overly positive reporting to please the experimenters or to the relatively high payment that participants received, even at the low payment rate. Experimental piece rates were 1.5 to 3 times the payment that regular tree nurseries pay for the same activity, and substantial relative to local average incomes. In the open-ended survey responses, participants often explained their fairness judgment with reference to pay rates or total payments in general (42%) rather than compared with other participants' pay rates in the experiment, or with the lightness, fun, or usefulness of the work (29%) (*SI Appendix*, section 2.6).

Future research should examine how these findings play out in other geographical and cultural contexts. For example, the implementation of an incentive-based program in Bolivia actually increased concerns for accountability as a fairness principle (71). The social expectation to be treated fairly is higher in Vietnam than in most other countries, according to World Values Survey data (*SI Appendix*, section 2.7), and motivational consequences of (un)fairness could be moderated by such cultural beliefs.

We found that participants worked less when paid more, which is counterintuitive. Workers may have an aspiration level, pursuing a target income per unit of time beyond which more pay does not lead to more effort (72, 73). This would mean that highly-paid participants were more quickly satisfied with their session earnings. Alternatively, increasing financial rewards could have crowded out intrinsic motivation (74). However, in the classical model, this effect occurs when small incentives are introduced to an incentive-free setting (75, 76), which was not the case here. Backfiring "overpayment" is a possibility consistent with our results, with effort decreasing when already very high (compared with local earnings) payments are further increased, as in our experiment. For example, one participant stated in the open-ended survey question: "People who get a low pay rate try to fill the soil bags quickly, while people with a high pay rate slow down." This is an important finding, suggesting that investments in distributional equity in comparably high-paying programs could yield larger conservation gains than investments in even higher payment levels. However, it cannot necessarily be expected to apply when real-world programs pay relatively little. Given that real-world conservation payments usually do not exceed local wages, and that conservation incentives typically focus on the global poor, the target population's socio-economic standing should be considered when translating this finding into policy.

Gender had a large effect on conservation effort in our experiment. The finding that women contributed more to conservation concurs with data from the same task in another region of Vietnam (52) and with other experiments on conservation incentives from Indonesia, Peru, and Tanzania (24). Importantly, the effect remained large and significant when controlling for training performance or prior task experience. It is therefore unlikely that this result is due to mere activation of gender roles in the bag packing activity, stronger reactions to experimenter demand or higher ability, but rather is triggered by incentivization of reforestation efforts. This emphasizes that investing more responsibility and decision making power with women in incentive-based conservation instruments can enhance not only gender equity, but also overall effectiveness (see also ref. 24).

An integral part of the study design was that subjects experienced relative pay differences within groups. However, this means that performance of subjects under different pay rates in the unequal treatment were not fully independent. By working in the same group and observing others' effort, subjects could have influenced one another beyond the intended treatment manipulation, for instance, by conformity or competition. However, we cannot think of a compelling reason why this would lead to only low-paid workers in mixed groups adjusting to the (lower) effort of high-paid workers, but not vice versa. On the contrary, previous work suggests that workers under piece-rate pay, if anything, increase their own effort when observing low peer effort (77).

Finally, the external validity of experimental results to real-world programs is never fully guaranteed. We reduced this risk by using a conservation-related task with tangible benefits for tropical reforestation in a relevant target population (*SI Appendix*, section 1.1.1), while maintaining rigorous standards of randomization and field protocols. This represents an intermediate approach to the "internal–external validity tradeoff" that experimenters face (78). As in real conservation activities, participants could reduce their effort both on the extensive margin, by spending less time working and more time taking breaks, socializing, or snacking, and on the intensive margin, by working slower. We found that both were important; approximately 10% of the variation in experimental conservation effort was explained by self-reported working time ($P < 0.001$) (*SI Appendix*, section 2.3). In addition, a self-reported measure of real-world forest protection behavior as encouraged by the Vietnamese PFES program (e.g., active patrolling, firefighting) was weakly positively correlated with participants' effort in the task (*SI Appendix*, section 2.2).

We conclude that social comparisons and norms are forces to be harnessed for the design of successful conservation initiatives (49). Our findings are important for global conservation and sustainability goals, demonstrating the importance of payment design and nonenvironmental motivations in incentive-based conservation schemes and suggesting ways to increase effectiveness and efficiency. Policymakers should work to understand and use local equity norms, such as locally-preferred distribution criteria (52), in the design and implementation of conservation payments (13), particularly when developing targeting criteria, rules, and monitoring procedures to determine payments (69). Policy design should incorporate principles of accountability that reflect the conservation choices that land users make given their opportunities, not differences in exogenous characteristics such as previous land endowments, ethnicity, financial and administrative literacy, or power (26). In the same vein, policies aiming at high environmental returns should consider gender differences in the willingness to contribute to conservation, as demonstrated in this study, rather than reinforcing existing gender imbalances.

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