PES and crowding-out effects: A framed forest experiment in Tanzania

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Abstract
Do small payments crowd out intrinsic motivations for natural resource conservation? This paper presents findings from framed field experiments (FFE) conducted with local forest users in Tanzania. The experiment has field context in sample, task, commodity and setting, and is thus aiming to capture also other factors that influence forest use than strict material concerns. The pay-off structure represents a common-pool resource situation (public goods game with negative contributions), where participants' payoffs depend on the number of trees harvested. Four levels of individual payment for environmental services (PES) are tested in a between-group design: no (0%), low (20%), medium (60%) and full (100%) PES, where the level is relative to the value of a harvested tree. Under both no and low PES, payoff-maximizers should maximize harvest. Under medium PES, the prediction depends on other players' harvesting decisions. Under full PES, the prediction is to not harvest.

We observe lower than theoretically predicted harvest rates at no, low and medium PES, while the opposite is true at full PES. Low PES possibly has a weak negative effect on harvest rates (c. 16% lower harvest rates than no PES) driven by male participants, while medium and full PES give a strong reduction in harvest rates (c. -43% and -75%). The results do not support the "crowding-out of intrinsic motivation hypothesis" at low PES levels, but possible for higher levels of PES. Increasing payments have a negative effect on harvest rates, but the effect is decreasing with increasing payment levels.

JEL codes: C93, Q23

Keywords: field experiment, PES, crowding-out, forest management, Tanzania

1 Introduction

A long-standing hypothesis – supported by some empirical studies – is that introducing pecuniary incentives can crowd out intrinsic motivation for pro-social behaviour. Acts motivated by the inherent value of the act itself (intrinsic motivation) will become less attractive when an external intervention reduces the inherent value (Frey and Oberholzer-Gee 1997, Ryan and Deci 2000). Examples include incentivised volunteering (Gneezy and Rustichini 2000), blood donations (Titmuss 1970, Le Grand 2006), accepting the building of a nearby nuclear waste repository (Frey and Oberholzer-Gee 1997) and helping a fellow student load a sofa into a van (Heyman and Ariely 2004). The argument remain, nevertheless controversial and some have questioned its universal validity (e.g., Le Grand 2006).

The hypothesis is also relevant for payment for environmental services (PES). PES is a voluntary transaction of at least one seller and at least one buyer contingent upon the provision of a well-defined environmental service (Wunder 2007), and is in effect a pecuniary incentive at the individual level (Pattanayak et al. 2010). The original idea of REDD+ (Reducing Emissions from Deforestation and forest Degradation, and enhance forest carbon stocks in developing countries) was to create a multi-level PES scheme, whereby pecuniary incentives, also at local levels, are provided to enhance the carbon services provided by forests in developing countries (Angelsen and Rudel 2013).

Local uses of forests are not only affected by material benefits and costs, but also by moral, ethical and cultural considerations that provides inherent values to local forest related acts (Ostrom et al. 1994, Levitt and List 2007, Henrich et al. 2010, FAO 2012). Therefore, REDD+ as extrinsic motivation can potentially crowd out existing intrinsic motivation in local forest users and produce adverse effects (Muradian et al. 2013). Small payments could, therefore, make things worse by crowding out intrinsic motivations while not providing sufficiently large pecuniary incentives. The relationship between payments and pro-social behaviour might therefore be non-linear; e.g., the S-shaped form suggested by Le Grand (2006). Related, the recommendation by Gneezy and Rustichini (2000) is expressed in the title of their paper: "pay enough or don't pay at all".

Research exploring the potential adverse behavioural effects of pecuniary incentives in local natural resource use is limited (Muradian et al. 2013, Wunder 2013). Even though experimental studies tend to find crowding-out effects of punishments (Cardenas et al. 2000, Vollan 2008), the results of payments is more ambiguous (Vollan 2008, Narloch et al. 2012, Muradian et al. 2013, Wunder 2013, Rode et al. 2014). Narloch et al. (2012) find possible crowding-in effects of individual payments, while a possible crowding-out effect is observed for collective payments. This paper aims to investigate the issue of how much is enough in the case of local tropical forest use and REDD+. Specifically, how is local forest use affected by (i) trivially low PES, (ii) medium PES where predicted impact depends, *inter alia*, on beliefs about the forest use of others, and (iii) full PES where there are no material incentives for local forest use?

The paper proceeds as follows. Section 2 describes the study area and the experiment conducted, including the treatments (different levels of PES payment). Section 3 presents the results, and analyses how behaviour and treatment response differ by gender, and how experimental

behaviour corresponds with self-reported forest use (external validity). Section 4 discusses the results in relation to the literature on crowding-out effects, and raises some critical methodological issues. Section 5 concludes with suggestions for further experiments.

2 Method

2.1 Data collection and sampling

The experiments were conducted in the Tanzanian regions Geita, Kilimanjaro and Lindi in September-November 2015. 15 villages were selected in collaboration with local experts to ensure variation in location, local forest conservation initiatives, population size, major sources of livelihoods, distance to forest frontier, and market access and distance to closest town. The villages and their attributes are listed in Table 8 in Section 7. Within each village, 32 participants were randomly selected by drawing from village household books.[1] The participants were randomly allocated to four groups (à eight participants); each group constitutes an experiment session with a randomly predetermined treatment.

2.2 Framed field experiment

The experiment builds on the design and pay-off structure of Handberg and Angelsen (2015)[2] and is a framed field experiment (Harrison and List 2004). Each experiment group is endowed with a stock of 80 cardboard trees. Each tree (6 cm tall, depicted in Figure 1) pays TZS 100 (c. USD 0.06) to the participant if harvested. In each round, the participants privately decide how many trees to harvest, with five trees being the technical upper limit.[3] The approximate sustainable level is two trees per round (depending on forest size). The aggregate harvest in the round is revealed to the group at the end of each round. Afterwards the stock grows by two trees for every ten standing trees. This is repeated for nine rounds, or until the stock depletes to less than 8 trees. The participants are perfectly informed about the parameters. Taken together, the structure and payoff in the experiment create a collective action dilemma.

Figure 1: Tree used as token

2.3 Treatments

One of four levels of PES is introduced randomly in each session. The PES is a payment for *not* harvesting at the technical upper limit, e.g., harvesting 3 trees from a forest of 40 trees or more gives an extra payment of 5-3=2. The magnitude of the PES is represented by the fraction of the value of a harvested tree (TZS 100), with treatments set at 0%, 20%, 60% and 100% PES.

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[1] A coin flip decided if the male or female household leader was invited, if applicable.

[2] Which again draws on Ostrom et al. (1994), Cardenas (2000), Cardenas (2004) and Rodriguez-Sickert et al. (2008).

[3] If the forest decreases to below 40 trees the technical upper limit is given by the maximum harvest table presented in Section 8.2. The decisions are made sequential, but as if simultaneous in each round because the participants face the same forest size.

If participants only maximise their individual payoffs, the optimal strategy in the first two treatments (0% and 20%) is maximum harvest, while it is zero harvest in the 100% PES treatment. With intermediate level of PES (60%), the optimal solution depends on several factors, including the strategy of others. Section 6 gives the theoretical predictions for optimal harvest rates under different treatments.

In a similar experiment design, Handberg and Angelsen (2015) observed harvest levels in the zero payment case to be about half of the predicted harvest level (which was to maximize harvest), suggesting that there are non-pecuniary (pro-social or altruistic) considerations entering participants' decision making.

3 Results and discussion

3.1 Non-parametric tests

The dependent variable, *harvest rate*, is a participant's harvest as a fraction of the technical upper limit (expressed in the [0-1] interval or as percentage). This decision might be influenced by previous decisions of the participant and the other participants in the same session. For example, a participant might harvest more if the aggregate harvest in the previous round was high. Therefore, the following tests will focus on *mean harvest rate* of the eight participants constituting a session. Later analyses of individual decision in each round will try to control for confounding factors.

Under 0% PES the observed harvest rate is 57% (Table 1), substantially and significantly lower than the individually pay-off maximizing strategy ("selfish strategy") of 100%. Still, about 26% of the individual decisions follows this strategy). 24% of the decisions harvest no trees.

Under 20% PES the observed harvest rate is 48% (Table 1), which is also substantially and significantly lower than the selfish strategy. As Figure 2 illustrates, the deviation of the mean harvest rate from the selfish strategy is largest in this treatment. 20% of the decisions under 20% PES follow a maximum harvest strategy. 29% of the decisions harvest no trees. The harvest rate is not, however, significantly different from under 0% PES.

Under 60% PES the observed harvest rate is 33% (Table 1), significantly lower than the Nash equilibrium and significantly lower than the 0% and 20% PES treatments. 9% of the decisions follows the maximum harvest strategy. 36% of the decisions harvest no trees.

Under 100% PES the observed harvest rate is 14% (Table 1), significantly higher than the Nash equilibrium and significantly lower than the 60% PES treatment. 4% of the decisions follows the maximum harvest strategy. 67% of the decisions is at the Nash equilibrium of no harvest.

Table 1: Comparing mean harvest levels in neighbouring PES levels

PES level	Harvest rate	Difference from harvest rate of the row above	Fraction max. harvesters	Fraction zero harvest
0%	0.570	-	26%	24%
	(0.06)			
20%	0.481	0.089	20%	29%
	(0.041)	(0.07)		
60%	0.326	0.155***	9%	36%
	(0.031)	(0.051)		
100%	0.142	0.184***	4%	67%
	(0.022)	(0.039)		
Standard errors in parentheses. ***,**,*: significant at the 1, 5 or 10% level				

Figure 2 compares the predicted harvest rates under the four PES levels (see Section 6) and the observed mean harvest rates.[4] With the exception of 100% PES, the observed mean harvest rate is lower than the predicted harvest rate, i.e., the participants are not selfish payoff-maximisers, as is generally acknowledged in the literature (e.g., Andreoni 1990, Bolton and Ockenfels 2000, Fehr and Gächter 2000).

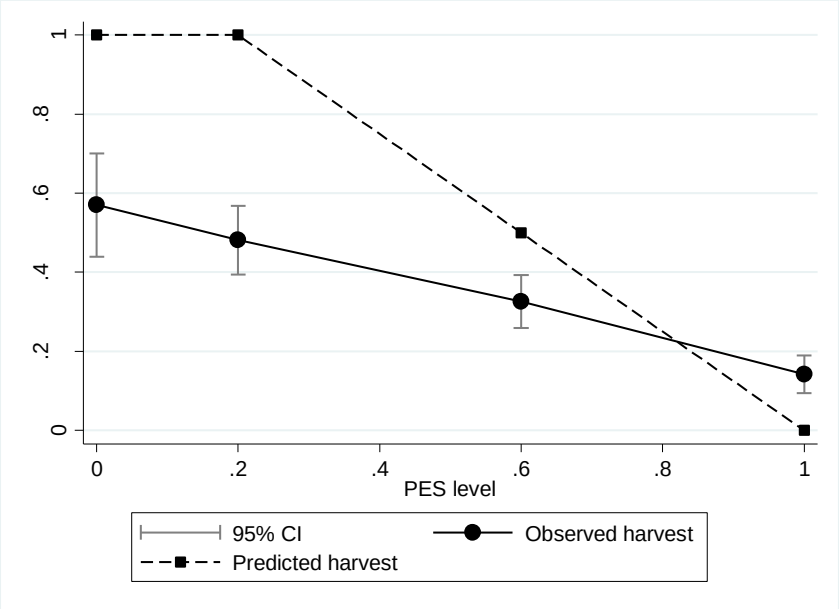

Figure 2: Game theoretically predicted harvest rates and observed mean harvest rates[5]

The slope of the observed harvest line is -0.42 implying that increasing PES by 1 percentage point (pp) lowers the harvest rate with 0.42 pp.[6] In other words, the return on PES is less than half in terms of decreasing harvest.

3.2 Regression analyses

The regression models presented in Table 2 control for the fact that a harvest decision could be influenced by the participant's earlier decisions and the aggregate decisions of others in earlier

[4] The predicted harvest rate under 60% PES assumes that the participant believes others to harvest at the observed harvest rate (0.33). Also, the mean harvest rate in round 1 of the 60% PES treatment is 0.3.

[5] Confidence interval (CI) is at session level.

[6] We assume linearity, and our results fit this assumption well.

rounds. Model (1) regresses the harvest rate of each participant decision on treatment and control variables, while model (2) regresses the mean harvest rate through the rounds of each participant on the treatment variables. In model (1) x_{it-1} is the lagged harvest decision, $\frac{\sum x_{j\neq i,t-1}}{7}$ is the lagged average harvest rate decisions of the other seven participants in the same session, and $\frac{1}{rounds}$ is a time trend. Also, since the treatments are unevenly distributed by villages, village fixed effects are included in both models to control for possible biases.

Table 2: Regressing harvest rates at two levels on treatments and controls

	(1) Choice level	(2) Individual level
20% PES relative to 0% PES	-0.032	-0.102
	(0.024)	(0.077)
60% PES relative to 0% PES	-0.066***	-0.262***
	(0.022)	(0.060)
100% PES relative to 0%	-0.113***	-0.432***
PES	(0.023)	(0.064)
$x_{i,t-1}$	0.646***	
	(0.039)	
$\frac{\sum x_{j\neq i,t-1}}{7}$	0.113	
	(0.068)	
$\frac{1}{rounds}$	-0.123***	
	(0.034)	
Constant	0.175***	0.579***
	(0.033)	(0.048)
R^2	0.466	0.250
N	3344	480

Robust standard errors in parentheses. ***, **, *: significant at the 1, 5 or 10% level.
Village fixed effects included but not reported.

Table 2 supports the results of Table 1 and Figure 2; 60% and 100% PES have negative impacts on harvest rates, while 20% PES has no significant impact. The decision in Model 1 is – not surprisingly - strongly dependent on the participant's decision in the previous round. The average decision of others in the same session is interestingly not significantly correlated to participants' harvest rate in the next round. Finally, harvest rates tend to decrease with rounds.[7]

3.3 Gender differences

Previous experimental studies find clear gender specific behaviour and treatment effects (Croson and Gneezy 2009, Cardenas et al. 2014, Handberg and Angelsen 2015). Related to forest use in Tanzania, gender roles are important as women tend to be responsible for household collection and use of forest products (Johnsen 1999, FAO 2001, World Bank 2010). In the related study of

[7] This could be due to the attrition bias created by high harvesting group depleting their forest quickly and dropping out of the sample. "Imputing" the average harvest rate of these groups in the rounds not registered does not substantially change this coefficient (nor the other coefficients).

Handberg and Angelsen (2015) women harvest significantly more than men, and the treatment effects are stronger among women than men.

This study find no gender difference in harvest rates without treatment, as reported in Table 3. Further, the treatments effects are stronger among men than among women. Among men (at the individual level), 20% PES lowers the harvest rate by 19 pp (significant at the 5% level); 60% and 100% PES lowers the harvest rate by 29 pp and 45 pp respectively (significant at the 1% level). Among women (at the individual level), the effect of 20% PES is not present, 60% PES lowers the harvest rate by 23 pp (significant at the 10% level) and 100% PES lowers the harvest rate by 42 pp (significant at the 1% level).[8]

Table 3: Regressing harvest rates on treatments, individual characteristics and stated forest use

	(1) Choice level	(2) Individual level
20% PES relative to 0% PES (men)	-0.064**	-0.191**
	(0.029)	(0.081)
60% PES relative to 0% PES (men)	-0.085***	-0.287***
	(0.026)	(0.059)
100% PES relative to 0% PES (men)	-0.124***	-0.452***
	(0.026)	(0.051)
Gender (1=woman)	-0.014	-0.030
	(0.020)	(0.043)
20% PES relative to 0% PES *women	0.052	0.160
	(0.047)	(0.094)
60% PES relative to 0% PES*women	0.028	0.056
	(0.040)	(0.089)
100% PES relative to 0% PES *women	-0.004	0.028
	(0.025)	(0.059)
$x_{i,t-1}$	0.619***	
	(0.042)	
$\frac{\sum x_{j\neq i,t-1}}{7}$	0.120	
	(0.073)	
$\frac{1}{rounds}$	-0.123***	
	(0.034)	
Age	-0.002	-0.003
	(0.001)	(0.003)
Age^2	0.000**	0.000**
	(0.000)	(0.000)
Relative forest use (middle third relative to bottom third)	0.016	0.036
	(0.011)	(0.025)
Relative forest use (upper third relative to bottom third)	0.046**	0.094**
	(0.019)	(0.038)

[8] The treatment effect on women is found by combining row two with row six, row three with row seven, and row four with row eight.

Absolute forest use	0.008*	0.026**
	(0.004)	(0.010)
Commercial forest user	0.045**	0.106**
(1=yes)	(0.018)	(0.039)
Constant	0.194***	0.530***
	(0.043)	(0.087)
R^2	0.479	0.338
N	3340	479

Robust standard errors in parentheses. ***,**,*: significant at the 1, 5 or 10% level. Village fixed effects included but not reported.

Figure 3 depicts the harvest rates for women and men separately for the four levels of PES. As indicated above, the main difference between the genders is the effect of 20% PES. An *F*-test of equality of harvest rates between the genders reveals that the hypothesis of equality at 20% PES can be rejected (*p*-value 0.03). Equality of harvest rates between the genders at 0%, 60% and 100% PES cannot be rejected (*p*-values at 0.85, 0.86 and 0.4 respectively). 20% PES thus has an impact on male, but not female, harvest rates, while the other PES levels have similar impacts on men and women.

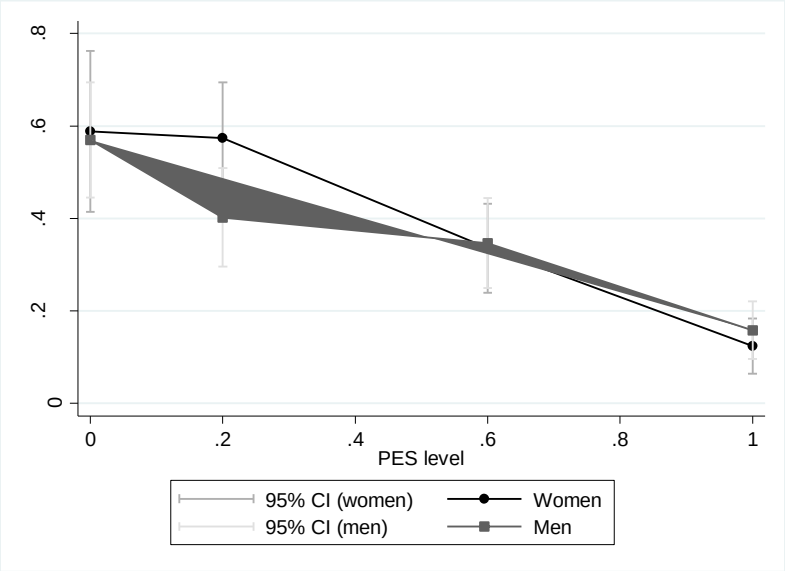

Figure 3: Harvest rates under the four PES levels by gender[9]

Also revealed by Table 3, age has no clear impact on harvest rates, unlike Handberg and Angelsen (2015). The lagged variables and the time trend in model (1) report similar coefficients as in Table 2.

3.4 External validity

The main test conducted for external validity is the degree to which behaviour in the experiment corresponds with self-reported forest use. In a post-experiment interview, participants were asked about their relative forest use (if the household collects less, about the same or more forest products than other households in the village), absolute forest use (number of times per week

[9] Confidence interval (CI) is at session level.

the household collects forest products) and commercial forest use (if the household sells forest products or not).

Table 3 reports the correlation between the stated forest use variables on harvest rates in the experiment. The harvest rate of a households stating to be in the top third of forest products use in the village harvest 5-9 pp more than the bottom third, another weekly trip in the forest corresponds to a 1-3 pp increase in harvest rate, and commercial forest users harvest 5-11 pp more than others. There is no significant difference between the middle and bottom third relative forest users. Taken together, there is a correlation between stated forest use and forest use in the experiment, supporting the *behavioural validity* (cf. Handberg and Angelsen 2015) of the study. Notably though, the correlations are not as strong as in Handberg and Angelsen (2015), where the same questions are asked.

The behavioural validity is further supported by observations from the experiment sessions. Participants tended to harvest trees selectively as if practicing *thinning*. Also, after receiving the instructions, questions asked by the some of the participants indicate the ability to relate the session to the real life situation.[10]

A caveat regarding *treatment validity* (cf. Handberg and Angelsen 2015) is that the presented experimental design tests the possible crowding-in or crowding-out effects of pecuniary incentives in a pecuniary incentive framework. Like most economic experiments, the participants are rewarded in cash based on their decisions during the experiment sessions, also in the 0% PES case. Real life subsistence use of forest products in contrast is per definition cash-free. It could be that the possible crowding-out effect is not observed at 20% PES because intrinsic motivation is also crowded out in the comparison group (0% PES). The low mean harvest rate relative to the prediction indicates, however, that other regarding preferences is important in making harvest decisions also under 0% PES.

4 Discussion

The main findings of the paper is the difference between the predicted harvest rate and the observed harvest rate under no PES, the lack of difference between no PES and 20%, and the differences between the observed harvest rates under the four PES levels.

First, the harvest rate in the open access situation (no PES) is significantly below the payoff-maximizing strategy, indicating that other regarding preferences plays an important role in making forest related decisions. This is consistent with existing experimental literature on common pool resources (e.g., Cardenas 2000, Handberg and Angelsen 2015, Midler et al. 2015). The harvest rate is, however, significantly higher than the sustainable level (0.57 vs. 0.4). In this experimental setting, the mean harvest rate is thus not sustainable, calling for measures to decrease harvesting.

[10] Questions asked by participants include: "So if I want to grow maize I should just cut many trees to clear the land?" "What about people coming from Mwanza to cut our trees, how are they included?" "How is other services from the forest included? Like beekeeping?" "But cutting trees is illegal. You're asking us to harvest from the forest?"

The three levels of PES compared to the open access situation in the experiment (20%, 60% and 100%) produce significantly different impacts on the mean harvest rate. 20% PES has no significant impact on the mean harvest rate. As the PES level is sufficiently low to not alter the optimal strategy of payoff-maximizers, the lack of impact indicates that the payment does not in sum crowd out or crowd in intrinsic motivation. If anything, a crowding-in effect is observed. Further examining the effect reveals that the PES level significantly decreases the mean harvest rate among men, but not among women.

Under 60% PES the optimal decision of a payoff-maximizing participant is to decrease the harvest rate. The exact optimal decision depends on the decisions of the others. With the observed mean harvest rate (0.33), the optimal harvest rate is 0.5. As the aggregate harvest of the previous round is reported before each decision the information is available. Also, if the participants believes the others to also harvest at 0.5, the optimal harvest rate is 0.5 (see Table 6 in Section 6). The observed harvest rate is significantly below this prediction, indicating that other regarding preferences is still important. Importantly though, the difference between the predicted and the observed harvest is smaller than in the 0% and 20% PES levels.

Under 100%, the observed mean harvest rate (0.14) is significantly higher than the predicted harvest rate (0). Seen in connection with the other PES levels there is a trend in that the observed mean harvest rate decreases slower than the predicted harvest rate with higher PES levels. We propose to possible explanations for the diminishing difference between the observed and individually optimal harvest rate: (i) crowding-out of intrinsic motivation and (ii) framing effects.

The difference between the predicted and the observed harvest rate can be interpreted as other regarding preferences (Midler et al. 2015). The decreasing difference with higher levels of PES can be interpreted as a crowding-out effect, even though it is not observed when comparing 0% and 20% PES. If so, it contradicts Gneezy and Rustichini (2000) in that crowding-out effects is stronger with higher payments than lower payments.

Alternatively, framing effects could be an explanation of the trend. Even without pecuniary incentives (100% PES), participants harvest. The reason could be that there are strong framing effects: rural Tanzanian households rely on firewood and other products from the forest and brings this into the experiment, harvesting somewhat even without making any profit on the harvesting. This is also often heard in discussions on forest conservation and REDD+ with rural villagers: "even if you pay us to conserve the forest, we still need firewood".

The latter possible explanation has some interesting implications for the design of future experiments. A possible set minimum harvest level, irrespective of payments, could be important in understanding the behaviour of participants in common pool resource experiments.[11] This explanation also supports the external validity. Together with the correlation between stated

[11] By taking this understanding of the results, the harvest rate under 100% PES (0.14) is the set minimum level of harvest rate. Subtracting this number from the other harvest levels would then reveal forest use above the subsistence requirement.

forest use and harvest decisions in the experiment, this indicates the benefits of a clear framing of the experiment if researchers wants to make it useful for the design of real policy interventions.

5 Conclusions

The presented framed field experiment conducted with local forest users in Tanzania eludes the topic of possible effects of payments for PES in forest conservation – in addition to anticipated price effects. The results report no crowding-out effects of low levels of payments for environmental services (PES), and rather a crowding-in effect among male participants. At higher levels of PES other regarding preferences is less important in determining harvest decisions, possibly indicating crowding-out effects with increasing payments.

The framing of the experiment and the use of a relevant sample could explain the importance of other regarding preferences in determining harvest decisions. The participants are on average more pro-social under low and medium levels of PES and less pro-social under full PES. Correlation between participants' stated forest use and harvest decisions in the experiment sessions, questions asked and behaviour exhibited during the sessions, and harvesting of forest products even without pecuniary incentives further support the behavioural validity of the experiment. Treatment validity remains untested and the treatments effects may be affected by the pecuniary framework economic experiments operate within.

Other important caveats of the experimental study include a rather individual focus on making forest decisions. Decisions made by the community (or groups within a community) is not observed in the experiments. Also larger actors than local household users in deforestation and forest degradation is not regarded.

The paper contributes to the existing literature by supporting previous experimental findings rejecting the hypothesis of crowding out of intrinsic motivation under low levels of PES in nature conservation. Furthermore, the paper finds that increasing the level of PES has a negative effect on forest use, but that the effect is decreasing with increasing PES (with slope -0.42), possibly indicating crowding-out effects at higher levels of PES. Lastly, the paper aims to show that specific framing is important in experimental investigations of local natural resource use.

6 Appendix I: Game theoretical predictions

The following tables reports the outcome for a given participants after the nine rounds of a session, given specific strategies of the participant and the other participants in the same session. The numbers are the TZS participant i earns in the session given her/his strategy and the mean strategy of the others x_j. The red squares indicates the highest payoff and thus the optimal strategy given the aggregate strategy of the others. Table 4 reports the potential outcomes under no PES, Table 5 for 20% PES, Table 6 for 60% PES and

Table 7 for 100% PES.

Table 4: Optimal harvesting strategies x for individual i under no PES given the strategies of others x_j

x_i / x_j	Max(x_i)	Max(x_i)/1,5	Max(x_i)/2	Max(x_i)/2.5	Max(x_i)/3	Min(x_i)
Max(x_j)	1220	880	820	626	550	173
Max(x_j)/1.5	1964	1508	1290	1076	1024	408
Max(x_j)/2	2741	2190	2095	1800	1678	746
Max(x_j)/2.5	3747	3185	2731	2568	2318	1250
Max(x_j)/3	4613	3899	3446	3088	2865	1598
Min(x_j)	7230	5857	5151	4740	4456	3065

Table 5: Optimal harvesting strategies x for individual i under low payment (20%) given the strategies of others x_j

x_i / x_j	Max(x_i)	Max(x_i)/1,5	Max(x_i)/2	Max(x_i)/2.5	Max(x_i)/3	Min(x_i)
Max(x_j)	1220	953	930	770	710	413
Max(x_j)/1.5	1964	1622	1470	1304	1291	848
Max(x_j)/2	2741	2357	2395	2160	2091	1446
Max(x_j)/2.5	3747	3425	3111	3060	2865	2150
Max(x_j)/3	4613	4186	3896	3628	3465	2498
Min(x_j)	7230	6157	5601	5280	5056	3965

Table 6: Optimal harvesting strategies x for individual i under medium payment (60%) given the strategies of others x_j

x_i / x_j	Max(x_i)	Max(x_i)/1,5	Max(x_i)/2	Max(x_i)/2.5	Max(x_i)/3	Min(x_i)
Max(x_j)	1220	1100	1150	1058	1030	893
Max(x_j)/1.5	1964	1848	1830	1760	1824	1728
Max(x_j)/2	2741	2690	2995	2880	2918	2846
Max(x_j)/2.5	3747	3905	3871	4044	3958	3950
Max(x_j)/3	4613	4759	4796	4708	4665	4298
Min(x_j)	7230	6757	6501	6360	6256	5765

Table 7: Optimal harvesting strategies x for individual i under full payment (100%) given the strategies of others x_j

x_j \ x_i	Max(x_i)	Max(x_i)/1,5	Max(x_i)/2	Max(x_i)/2.5	Max(x_i)/3	Min(x_i)
Max(x_j)	1220	1247	1370	1346	1350	1373
Max(x_j)/1.5	1964	2075	2190	2216	2358	2608
Max(x_j)/2	2741	3023	3595	3600	3745	4246
Max(x_j)/2.5	3747	4385	4631	5028	5052	5750
Max(x_j)/3	4613	5333	5696	5788	5865	6098
Min(x_j)	7230	7357	7401	7440	7456	7565

7 Appendix II: Village and region specific effects

Table 8: Summary of main village attributes.

Village	Region	Population	Km to nearest major road	Km to nearest town	Km to nearest forest	Access to public transport	Size of forest(s) (ha.)	External forest conservation project involved	Livestock
Bugulula	Geita	8012	2	10	1.5	Yes	15737	No	7022
Chibingo	Geita	6016	0	8	1.5	Yes	N/A	No	1280
Msasa	Geita	6587	8	12	4	No	47800	No	2856
Saragulwa	Geita	12047	12	36	0.5	Yes	47700	Yes	2725
Bugege	Geita	1899	2.5	2.5	1	No	400000	No	508
Kokirie	Kilimanjaro	3490	2	30	2	Yes	107828	Yes	N/A
Miwaleni	Kilimanjaro	1002	6.9	18	0.4	No	95	No	3037
Mandaka Mnono	Kilimanjaro	3600	7	7	4	No	2502	No	1160
Mtakuja	Kilimanjaro	5380	5	12.5	12.5	Yes	2505	No	N/A
Mande	Kilimanjaro	3100	4	7	1.5	Yes	8	No	584
Nndawa	Lindi	973	12	12	2	No	969	Yes	17
Namupa	Lindi	1462	8	8	3	No	325	Yes	3
Ntene A	Lindi	2299	25	83	2	Yes	19834	Yes	83
Rutamba ya Zamani	Lindi	1925	20	25	1	Yes	1326	No	337
Simana	Lindi	3345	5	8	1.5	No	320	No	80

Table 9: Selected attributes by region.[12]

Attribute\Region	Kilimanjaro	Lindi	Geita
Area (sq. km)	13 250	66 040	20 054
Population (no. of persons)	1 640 087	864 652	1 739 530
Average household size	4.3	3.8	6.1

[12] Sources: URT (2013, 2015)

Population annual growth rate	1.8	0.9	2.6
% of households who owns radio	75.6	52.8	60.1
% of households who owns cell. phone	79.1	43.2	65.6
% of households who owns bicycle	25.9	45.8	63.6
% of households who owns motorbike	7.5	3.1	4.2
% of households who owns TV	19.5	5.5	6.3
Primary school enrolment rate	94.1	73.5	62.2
Roof type: % thatch/ tin/ tiles/ other	7/ 91.8/ 0.3/ 0.9	66.3/ 33.1/ 0.1/ 0.5	33.4/ 66/ 0.1/ 0.5
Main source of cooking energy: % charcoal/ firewood/ non forest-products/ other	10.9/ 79.8/ 6.6/ 2.7	13.2/ 84.5/ 1.8/ 0.5	30.7/ 67/ 1.8/ 0.5

8 Appendix III: Experiment materials

8.1 Questionnaire

Basic information		
Participant no.		
Age		
Gender (1=female, 0=male)		
About forest use		
1	How many times per week do you go to the forest to collect forest products? (In the dry season and the rainy season)	 :_____  :_____
2	Have you sold any forest products during the last month? (1=yes, 0=no)	
3	How much forest products do you use compared to other families in the village? (1=less, 2=about the same, 3=more)	
4	How important is the forest to you? (1= not important, 2=important, 3=essential)	
5	Do you consider the happiness of others in the village when you harvest forest products? (1=yes, 0=no)	
About forest conservation and wealth		
7	If your religious leaders prohibit deforestation, would you reduce your use of the forest? (yes=1, 0=no)	
8	If payments for living trees are to be introduced, would you prefer the payments to be made to the community or directly to the individuals? (1=community, 0=individual)	
9	How many acres of land does your household own?	
10	How much livestock do you have? (number of cattle, goats, donkeys, sheep)	c:____ g:____ d:____ s:____
11	What type of material is (most of) your house's roof? (1=thatch; 2=wood ; 3=tin; 4=tiles; 9=other, specify)	
12	Do you have any particular position in the village leadership? (1=yes, 0=no) If yes, what?	
13	Has your household faced any major income shortfalls or unexpectedly large expenditures during the past 12 months? For example: death or serious illness in family, serious crop failure, lost wage employment, land loss or any other loss? (0=No, 1=yes but manageable, 2=yes severe)	

14	Can you get help from others in the village if you are in need? For example if you need extra money because someone in your family is sick? (0=no, 1=sometimes, 2=yes)	
15	Do you in general trust people in the village? (0=no, 1=sometimes, 2=yes)	
I will make some statements, please tell me to what degree you agree to each claim		5=Strongly agree/ 4=agree/ 3=ambivalent/ 2=disagree/ 1=strongly disagree
24	It is right that those who benefit from the clean air that our forests produce contribute to conserving the forest.	
25	It is not proven that paying for living trees decreases deforestation.	
26	Paying for living trees make other forest use considerations less important; like tradition, culture and religion.	
27	The village council is doing the best possible actions to improve the lives of its inhabitants.	
About the experiment		
28	I felt like I owned the forest.	
29	I felt like I owned the forest conservation project	
30	Did you participate together with any close friends or family in the experiment? (1=yes, 0=no) If yes, how many?	
31	Did you have any particular harvest strategy in the experiment? Why/why not?	
32	I am going to say four letters. Please indicate your first, intuitive reaction to them: rate them by likeability (5=strongly like, 4=like, 3=ambivalent, 2=dislike, 1=strongly dislike):	E:____ R:____ __:____ __:____ (1st letter of 1st name and one letter not in names)
33	Do you know how to read and write? (1=yes, 0=no)	

8.2 Maximum harvest table

Forest size	**Max. possible harvest**
40-160	5
32-39	4
24-31	3
16-23	2
8-15	1
0-7	0

8.3 Instructions

Thank you everyone for accepting this invitation. We will spend almost three hours explaining the activity, playing and conducting a short survey a[illegible]. Let's start!

The following exercise is a different and entertainin[illegible]ctively parti[illegible]roject about forests. Besides participating in this exercise and earning money, you will answer a few questions afterwards. The funds to cover the expenses have been donated by a scientific body.

The reason why we use money and paper trees is to create situations as similar to your real life situations as possible

The situation is one where a group, *you*, must make [illegible]bout the use of a forest. You have been selected and asked to participate in a random [illegible] a list of all families in this village. This is done to make sure that all have the same chance of participating.

This exercise is different than exercises in which other persons in this community or others may have played already. Therefore, comments you have heard from other persons do not necessarily apply to this exercise.

Please pay a lot of attention to the instructions. If you understand the instructions, you will be able to make better decisions in the exercise. Please, remain seated and *do not speak with other participants*. If you have a question, raise your hand and we will answer your question.

So to the experiment, let's pretend this group has a forest of initially these 80 trees [point to the paper trees]. For **9 rounds**, equivalent to for example years or wood harvest seasons, each of you will enter the forest and decide how many trees to harvest. You will each earn **100 shillings** for each tree you decide to harvest. Think of this as equivalent to firewood, charcoal, timber etc.

You can harvest a minimum of 0 trees from the forest and a maximum given by this table [Show the maximum harvest table]. You indicate how many trees you harvest by picking them [Show how trees are harvested]. The trees will be put up temporarily after you have harvested, such that each of you faces the same forest size.

After all of you have privately and anonymously harvested trees in one round, you are all gathered here and the total number of removed trees in that round is announced.

Then the forest grows: for every 10 standing trees, 2 trees are added. [Show how trees are added]

[If in treatment group 1-3:]

You will get an additional payment of your choice. There will be a referendum to ensure that you get the payment you want. You will get 3 minutes to discuss together. Then you will vote in in private on which payment you want.
You can choose between:
- Sell half of your trees. The 40 trees are valued at 2000 shillings, meaning you will be earn 250 shillings before the exercise starts. The forest is then decreased to 40 trees.

OR

- You will be paid for not harvested trees. Since another country also benefits from your forest they would like to contribute to forest conservation, and therefore offer you a forest conservation payment. In addition to earning what we have already said, you will get [20/ 60/ 100] shillings for each tree you decide not to harvest. Therefore, if you decide to harvest 2 trees and you could have harvested 5 trees you will earn 200 shillings for the harvested trees, as before. But in addition you will earn [60/ 180/ 300] shillings for the 3 trees you did not harvest.

[Leave the participants alone for 3 minutes. Then they indicate their choice in private. After the referendum is held:] you have chosen to introduce [chosen payment]. Why did you choose this payment and not the other? [Note reasons]

[If in treatment group 4-6:]

You will get an additional payment. Instead of selling trees you will get paid for not harvested trees. Since other countries also benefit from your forest they would like to contribute to forest conservation, and therefore offer you a forest conservation payment. In addition to earning what we have already said, you will get [20/ 60/ 100] shillings for each tree you decide not to harvest. Therefore, if you decide to harvest 2 trees and you could have harvested 5 trees you will earn 200 shillings for the harvested trees, as before. In addition you will earn [60/ 180/ 300] shillings for the 3 trees you did not harvest. You now get 3 minutes in private where you can discuss the exercise.

[If in control group (7):]

You now get 3 minutes in private where you can discuss the exercise.

An example [Show as you explain]: Suppose that each of you harvests 3 trees each. When all of you are gathered here we then see that 24 trees are removed, leaving 56 trees. You each earn 300 shillings from the 3 harvested trees.

[If in group 1-3:]

In addition, as you have decided: you will receive [40/ 120/ 200] shillings from the forest conservation project.

[If in group 4-6:]

In addition: you will receive [40/ 120/ 200] shillings from the forest conservation project.

Afterwards, the forest grows by 10 trees to 66. Round 1 **of a total of 9 rounds** is then completed. Remember that everything you do is anonymous, so nobody can find out how much you harvest. Any questions? [Answer all questions]

Let us try a practice round! This is just for learning so you will not earn anything from this round. [Complete a full round. Answer any further questions]

Ok, now we reset the forest to 80 trees, and start the real exercise. Anything you will earn from now on will be noted and paid to you in real money at the end of the exercise.

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