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Collective action when public good returns are heterogeneous

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Abstract

We adopt a mixed methods approach to investigate whether and how heterogeneity in individual returns to a public good affects contributions. We engage smallholder farmers in Sri Lanka in: a one-shot, framed, lab-in-the-field experiment, within which the farmers' rates of return to the public good are exogenously varied; and a survey including a question about their willingness to contribute time to the construction of a specific, relevant to them public good. In the former, we find weak evidence that heterogeneity in individual returns increases contributions. In the latter we find that those facing higher returns contribute more. We conclude that heterogeneity in returns does not explain why collective action remains a challenge in farming communities in developing countries.

JEL Classification: C93, D81, O12

Keywords: lab-type behavioural experiment, collective action, heterogeneity, public goods

Centre for Research in Economic Development and International Trade, University of Nottingham

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Outline

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1. Introduction

Multilateral organisations now consider the level of community involvement to be a key project evaluation criterion in interventions aimed at generating and maintaining local public goods. The Bank asserts that giving communities more agency through such projects is an important vehicle for inclusive growth, empowerment, social capital mobilisation, better governance and poverty reduction (World Bank, 2001). Reflecting this stance, Salomonsen and Diachok (2015) note that over the past 10 years the World Bank community-based development (CBD) and community-driven development (CDD) initiatives have constituted between 5 and 10 percent of World Bank lending.

While there is merit to the arguments in favour of community involvement in public goods provision, fostering collective action in communities is proving difficult. One possible reason for this is heterogeneity among those who need to act collectively. There is evidence that heterogeneity in terms of power, influence, and social position is bad for collective action. However, scant attention has been paid to the effects of heterogeneity in returns from public goods across individuals. If some individuals benefit from the public good more than others, the concern is that individuals who benefit relatively little may be disinclined to contribute. Knowing this, individuals who benefit relatively more may also be disinclined to contribute. If the positive effect of their higher return from the good is outweighed by the negative effect of their concerns about others free-riding on their efforts, the heterogeneity in returns could undermine the success and sustainability of public goods provision.

Most studies which examine the willingness-to-pay (WTP) for the provision of a public good focus on heterogeneity in individual preferences, wealth and social capital. Very few studies investigate the impact of variations in returns from the public good. The small number of studies involving public goods experiments provide conflicting evidence. Fisher *et al.* (1995) and Fischbacher *et al*. (2014) find that heterogeneity in individual returns from the public good lowers average contributions, Reuben and Riedl (2013) and Marwell and Ames (1981) find the opposite.

We apply variants of both these methods in a field study aimed at producing a robust-to-method conclusion about how heterogeneity in public good returns impacts on public good contributions. Specifically, our data generation methods include a one-shot, framed, lab-in-the-field, public goods experiment (PGG) designed to reveal subjects' willingness to contribute to public goods in the presence of exogenously-imposed heterogeneous returns from the public good; and a survey including a hypothetical contribution question (HCQ) where subjects state time contributions to the construction of a public good that is likely to benefit them to varying degrees depending on their circumstances in everyday life. We examine at the group-level, whether local public goods provision is compromised when the returns from the public good vary across group members; and whether an individual's willingness to contribute to the public good depends on his/her return from the public good.

We do this within the context of Sri Lanka's Human-Elephant Conflict (HEC) where smallholder farmers suffer from elephant-related crop-damage. The hypothetical local public good that the research subjects were invited to focus on is an electric fence. The research subjects were smallholder farmers in 16 rural communities which are highly exposed to the HEC in Wellawaya, south-east Sri Lanka. The hypothetical community-wide electric fence would mitigate exposure to the HEC risk for all community members by deterring elephants from encroaching on farmland. The fence is a non-excludable and non-rival local public good designed to encompass an entire village and its surrounding cultivated lands. Provision and maintenance of the fence is subject to the free-rider problem which is well-documented in the microeconomics, behavioural economics, environmental economics and development economics literatures: egoists in the community may not contribute to either its maintenance or construction but still enjoy the benefit of lower risk exposure arising from others' contributions. The social optimum is for all individuals to contribute to the public good and for benefits to accrue equally to all. However, if everyone behaves egoistically, the fence will not be provided.

Our two chosen methodologies have different strengths and weaknesses. In the experimental PGG we can exogenously manipulate returns to the public good, while controlling other aspects of the decision-making environment. Moreover, the PGG is incentivised so that the strategic component of decision-making about public good contributions is rendered highly salient to the subjects. The main weakness of the PGG is that the decision-making scenario may appear abstract and many steps removed from the reality of everyday life to the subjects. The experimental stakes are small relative to the cost of the real life public good and the strategic component may carry too high a cognitive weight in subjects' minds, potentially distracting them from other aspects of the public good such as its technological novelty and the associated risks.

The main strength of the hypothetical contribution question is that it is less abstract. However, the HCQ is associated with less control and provides no opportunity to exogenously vary public good returns. It is also unincentivised, so more likely to suffer from hypothetical bias, and the subjects are likely to place less, possibly too little, cognitive weight on the strategic component of provision. Thus, the methods are complementary. One, the PGG, offers control and is ideal for studying the strategic aspect of public good provision. The other, the HCQ, allows for a better match to context. If both methods generate the same, or at least non-contradictory, findings, those findings can be viewed as providing a strong foundation for policy advice.

The paper is organised as follows: in Section 2, we review the literature on heterogeneity in public goods experiments and in willingness-to-pay studies; in Section 3, we present our experimental and survey designs; in Section 4, we describe our subject sample; in Section 5, we list our specific research questions; in Section 6, we present our empirical results; and in Section 7, we summarise and discuss our findings before concluding in Section 8.

2. Literature Review

A key aspect of many development interventions includes widespread use of community involvement in public good provision. In a critical review of the literature on community-based (CBD) and community-driven development (CDD) initiatives, Mansuri and Rao (2004) draw on numerous studies and conclude that while community participation often induces better community infrastructure, participation in itself does not always directly translate to improvements in development outcomes. Comparing community participation-oriented infrastructure projects with government-backed projects in Pakistan, Mansuri and Rao (2013) find community-based projects have a higher level of quality in their design, construction and maintenance, but that there is evidence of resource capture (theft and corruption) by more powerful and influential community members. Elsewhere, Humphreys *et al*. (2015) examine the effect of a four-year long Community Driven Development initiative to promote democratization across 1,250 communities in the eastern Democratic Republic of Congo, and find almost no significant effect of the external intervention on local governance structures.

An overarching finding in both the CBD and CDD literature and in willingness-to-pay studies is that heterogeneity matters. Discussion on effectiveness of such interventions has focussed on economic heterogeneity of communities, in terms of differences in income and wealth; and social heterogeneity, in terms of leadership versus marginalised community members.

In the willingness-to-pay (WTP) studies heterogeneity in user preferences has been seen as key to intervention outcomes. These studies find that individuals who derive a higher return from an often non-marketed, publicly-provided good, or specific attributes relating to that good, have a higher willingness to pay. Moreno-Sanchez *et al.* (2012) use contingent valuation methods (CVM) to measure smallholder farming households' and recreational households' WTP for incremental changes in water usage. They find most respondents stated a preference for a fee differentiated according to water consumption levels. However, neither the subjects' declared water consumption levels nor its interaction with stated preferences for a differentiated usage fee have a significant effect on estimated WTP. Loomis and White (1996) conduct a meta-analysis of WTP studies concerned with preservation of threatened and endangered wildlife species in the USA. They find that WTP for preservation is greater for respondents who are visitors than non-visitors.

In experimental studies, the identified effects of heterogeneity in returns to the public good across group members have varied. Marwell and Ames (1981) found that mean contributions were greater when either resources or the returns to the public good were heterogeneous. In the experiment most similar to ours, Fisher *et al*. (1995) found that subjects in heterogeneous returns groups contributed insignificantly less, while at the individual level those who were assigned a higher return contributed more than those assigned a lower return. Reuben and Riedl (2013) found that average contributions under a heterogeneous returns treatment were greater than under homogeneous returns, but, like Fisher *et al*. (1995), found that those for whom the return was higher contribute more. Finally, Fischbacher *et al*. (2014) found that subjects contributed significantly less in the presence of heterogeneous returns.

3. Experimental and Survey Designs

3.1 The Public Goods Game (PGG)

In the PGG designed for this study each subject has to decide whether to contribute or not contribute to the public good and each public good group was made up of 16 individuals. The individual payoff, in Sri Lankan Rupees, from the PGG is $\pi_i = 400(1 - x_i) + m_i(x_i + \sum_{j \neq i} x_j)$, where $x_{i,j} \in (0,1)$ and $m_i \in (40,60,80)$. Subject *i*'s payoff is determined by his/her contribution decision (x_i), which takes the value 1 if *i* contributes and zero if *i* does not contribute, the contribution decisions of his/her co-players ($x_{j \neq i}$) and his/her individual return from the public good (m_i). The individual return m_i varies according to the PGG treatment. The summation of $x_{j \neq i}$ is a count of how many of the other 15 subjects in the group contribute.

The PGG was framed as follows. A farming community which borders a nature reserve has an electric fence installed around the village to protect its crops from elephants, the farmers are responsible for its upkeep and each farmer in the community must decide whether or not to contribute to the maintenance of the fence. If the fence is poorly maintained, then it is more likely to break down and the farmers are likely to incur elephant-related crop damage. If all farmers contribute, then it will be well maintained. If one farmer decides not to contribute, (s)he will still benefit from the contributions of others, but if most of the farmers decide not to contribute, all farmers will suffer the consequences of being less well protected.

3.2 Treatments

The subjects' individual returns (m_i) from contributing to the group account varied depending on the treatment. We conducted three treatments under which all of the subjects in a group face the same, i.e., homogeneous, returns, *hom40, hom60*, *hom80*, and one treatment under which the subjects in a group face different, i.e., heterogeneous, returns, *het*. Under the *hom40* treatment m_i =40, under *hom60,* m_i =60 and under *hom80*, m_i =80. Under each of these treatments the social optimum is for all subjects to contribute to the group account. Under *hom40*, *hom60* and *hom80* respectively, if all contribute, each subject earns R640, R960, R1,280, compared to R400 if none contribute.

Under the *het* treatment, half of the subjects in the group are assigned a low individual return (m_i =40) and half are assigned a high return (m_i =80). Below, we refer to these two sub-samples of subjects as being assigned to the *het40* and *het80* sub-treatments. Under *het*, if all contribute, each *het40* subject earns R640 and each *het80* subject earns R1,280, compared to R400 if none contribute. Subjects know that they are playing the PGG with other subjects, some of whom have different individual returns to their own, but do not know the proportion of subjects who have been assigned high(low) returns.

3.3 Subjects and treatment assignments

We engaged members of 16 communities spread across six administrative areas of Wellawaya Divisional Secretariat, Moneragala District, Sri Lanka in the study. We conducted 30 experimental sessions, either one or two per community, in which the PGG described above was played.[1] Treatments were assigned at the session level with the aim

1 In two others sessions, we conducted a similar PGG but with a different frame.

of ensuring balance on community characteristics. In communities were two sessions were conducted, different treatments were assigned to each session.

In each community, a random sample of 32 household heads was drawn from the electoral register and each of these was invited to attend or send another senior household member to attend a day-long workshop. Each workshop was comprised of two experimental sessions and two survey-completing sessions. On arrival at a workshop each subject randomly selected a badge on which was printed an ID number and an indication of whether they were to attend the morning experimental session followed by the afternoon survey-completing session or vice-versa.

The aim was to have 16 subjects in each experimental session, all playing as a single PGG group. However, not all the invited household heads showed-up or sent someone in their stead. Four sessions were so poorly attended that the PGG no longer represented a social dilemma and, so, had to be dropped from the analysis. The number of participants in the remaining 26 sessions varied between 16 (22 sessions) and 12. In total, 404 smallholder farmers participated in the experiments. Table 1 presents the numbers of sessions and subjects per PGG treatment that we include in our analysis.

Table 1: Sessions and Subjects per treatment

	Sessions	Subjects
Hom40	6[#]	96
Hom60	6	92
Hom80	7	105
Het	7[##]	111

Notes: # one less than planned; ## three less than planned.

3.4 Implementation

The experiments and survey were conducted in Sinhala (the local language) with the assistance of local field researchers. The PGG began with a field researcher describing the game to the group of subjects in a session following a script written in Sinhala. Several examples were used to explain the maths of the game and, under the *het* treatment, the payoff structure was explained to high-return subjects and low-return subjects simultaneously to ensure complete comprehension. Each subject was then given a token on which they had to indicate their decision by circling one of two symbols printed on one side of the token (see Appendix, Figures A.1 and A.2). PGG earnings were calculated and paid at the end of the workshop. The average payoff in the PGG was Rs.624, which was equivalent to almost one day's farm wage at the time when the experiments were conducted.[2]

3.5 The Hypothetical Contribution Question (HCQ)

In the individual-level survey, we asked a hypothetical contribution question (HCQ) regarding subjects' willingness to contribute time (in hours) to the construction of an electric fence. Focusing on time spent is salient in the HEC scenario given previous community-level interventions by NGOs in Wellawaya, and is relevant to the literature relating to community-driven development. In this hypothetical scenario, a NGO provides the subjects' communities with the financial resources, construction materials and technical assistance necessary to construct an electric fence. Subjects decide how much time they are willing to provide to construct the fence. Subjects are given approximately five minutes to reflect on the scenario and to choose their time

2 All subjects were also paid a show-up fee of Rs.250 and their payoffs from the GC and and risk and sharing game (written up elsewhere). No breakdown was given.

contribution from a menu of choices ranging from zero hours to more than twenty hours in two-hour intervals (see Appendix, Figure A4).

3.6 Individual returns and heterogeneous returns in the HCQ

In the HCQ analysis, we proxy for individual returns from the collectively-owned electric fence using two survey variables. The first is *crop damage*, a four-year average of instances per month of HEC-related crop damage over the period 2011-14. The rationale is that those who have experienced more damage in the past will experience a greater reduction in damage once the fence is in place. The second variable is *proportion of income from farming*, which is the proportion of total annual household income in 2013/14 generated from agricultural activities. The reasoning is that those who rely more heavily on farming are, ceteris paribus, more exposed to the risks associated with the HEC and will therefore benefit more from the fence.

We proxy for heterogeneous returns from the electric fence using the variance of *crop damage* and the variance of *proportion of income from farming* within village, across households. These are denoted *var*(*crop damage)* and *var*(*proportion of income from farming)*, respectively.

3.7 Control variables

When public goods involve technologies that are new to communities, investment in those public goods may be perceived as risky. The existing literature provides evidence of the negative effect of risk aversion on technology adoption in developing countries (Rosenzweig and Binswanger, 1993; Fafchamps, 2003; Foster and Rosenzweig, 2010; Dercon and Christiaensen, 2011). Only 10 per cent of our sample currently owns a small-scale electric fence around the perimeter of their farms. In addition to this technological risk, given the public good nature of the hypothetical fence that we invited our subjects to think about, the impact of strategic risk on decision-making needs to be considered. So, to control for the potential impact of households' perceptions regarding the riskiness of adopting new technologies we include a measure of risk aversion in our analysis.

We elicited the subjects' levels of risk aversions by engaging them in a Binswanger-type (1980) gamble choice (GC) task (visual aid in Appendix, Figure A.3). In this task each subject had to choose one out of six gambles. Every gamble yielded either a high or low payoff, each with probability 0.5. The payoff from the chosen gamble was determined by playing a which-hand-is-it-in game that involved the subject guessing which of the researcher's hands contains a blue rather than a yellow counter. Table 2 presents the six gambles, their expected values, and payoff standard deviations.

Table 2: Gamble Choice Task Choices

Gamble	**Low payoff (Rs.)**	**High payoff (Rs.)**	**Expected value (Rs.)**	**Standard deviation (Rs.)**
A	200	200	200	0
B	180	380	280	100
C	160	480	320	160
D	120	600	360	240
E	40	760	400	360
F	0	800	400	400

In addition, we control for HEC prevention effort using the variable *watch-huts*, which is the total number of watch-huts owned by a household. Inclusion of *watch-huts* allows us to investigate whether households who are more invested in the time-consuming, perilous, established approach of surveying their farmlands from watch-huts respond to the provision of the electric fence, which represents a potentially newer and more efficient approach to HEC management. Finally, we also control for each subject's gender, age, years of schooling, marital status, whether the subject is a household head, household size, total household income, and whether the household head is a farmer.

4. Descriptive Statistics

Table 3 presents descriptive statistics for the sample. The variable *contribute in PGG* equals one if a subject decided to contribute their token to the public good. In the PGG, 41 per cent of subjects chose to contribute. The variable *HCQ contribution* is the number of hours a subject states that (s)he is willing to contribute to construction of the electric fence. 48.3 per cent of subjects were willing to provide at least 20 hours to constructing the electric fence (see Appendix, Figure A4). On average, respondents were willing to contribute 14.24 hours.

During the period 2011-2014, the average household experienced 0.77 instances of crop damage per month (*crop damage*) with the within-village variance of crop damage instances across households varying from 0.09 to 9.17. The average proportion of income from farming is 57 per cent with the within-village variance of *proportion of income from farming* varying from 12 to 23 per cent. Subjects in this sample are on average 44 years old, have 9 years of schooling, and live in households with 4 members. Two-thirds of the sample comprises females, 87 percent of subjects are married, and 96 percent are household heads. Farming is reported as the main activity for 76 percent of the sample. On average, they earn 57 per cent of their household income from agricultural activities and occupy 1.64 farm plots (*number of plots*).

Table 3: Variable Description and Descriptive Statistics from the PGG and HCQ Sample

Variable Name	Variable Description	Obs.	Mean	Standard deviation	Min	Max
PGG contribution	1 if *i* contributed to the public good, 0 otherwise	404	0.413	0.493	0	1
HCQ contribution	Time *i* is willing to contribute to the construction of an electric fence (in hours, 0-20+, 20+ coded as 21)	404	14.238	6.423	0	21
Individual return	Individual return in PGG (=40, 60 or 80)	404	60.495	17.591	40	80
Het	1 if *i* is in the *het* treatment, 0 otherwise	404	0.275	0.447	0	1
Crop damage	Average crop damage instances per month in 2011-2014	404	0.768	1.754	0	16.099
Proportion of income from farming	Household *i*'s agricultural income as a proportion of total household income in 2013/2014 (multiplied by 10)[10]	398	5.700	4.117	0	10
Var(crop damage)	Within-village variance of average monthly crop damage instances between 2011 and 2014 across households	404	3.048	3.291	0.086	9.167
Var(proportion of income from farming)	Within-village variance of agricultural income as a proportion of total household income in 2013/2014 (multiplied by 10) across households	404	15.687	2.353	12.109	22.688

10 The actual figures for proportion of income from farming lie between 0 and 1 but we multiply each figure by 10 to ensure the magnitudes for the *proportion of income from farming* and *crop damage* and *HCQ contribution* are comparable.

Total household income	Log of sum of agricultural income from maha season 2013/14, yala season 2013, non-agricultural income in 2013 and remittances in 2013; annual figure	404	11.525	1.845	0	14.691
Watch-huts	Number of watch-huts on plots occupied by *i*'s household	404	0.688	0.706	0	4
Risk aversion	1 if *i* chose A or B in GC task, 0 otherwise	404	0.188	0.391	0	1
Age	*i*'s age in years	403	43.801	13.717	19	77
Female	1 if *i* is female, 0 otherwise	404	0.6756	0.469	0	1
Married	1 if *i* is married, 0 otherwise	404	0.876	0.330	0	1
Years of schooling	*i*'s total number of years of schooling	403	8.861	3.724	0	17
Household head	1 if *i* is the household head, 0 otherwise	404	0.963	0.189	0	1
Farming household head	1 if household head's main activity is farming, 0 otherwise	404	0.760	0.428	0	1
Household size	Total number of members in the household	404	3.864	1.342	1	8
Number of plots	Total number of farm plots occupied by each household	404	1.636	0.735	1	5

5. Research questions

The objectives of our analysis are to provide answers to the following four questions:

Question 1.1: Are contributions to the public good in the PGG lower when the returns to the public good are heterogeneous compared to when they are homogeneous?

Question 1.2: Are contributions to the public good in the PGG higher when the individual return from the public good is higher?

Question 2.1: Are contributions to the fence in the HCQ lower in villages where the cross-household variance in crop damage and reliance on farming for income is higher?

Question 2.2: Are contributions to the fence in the HCQ higher when the individual returns from the fence are higher?

6. Results

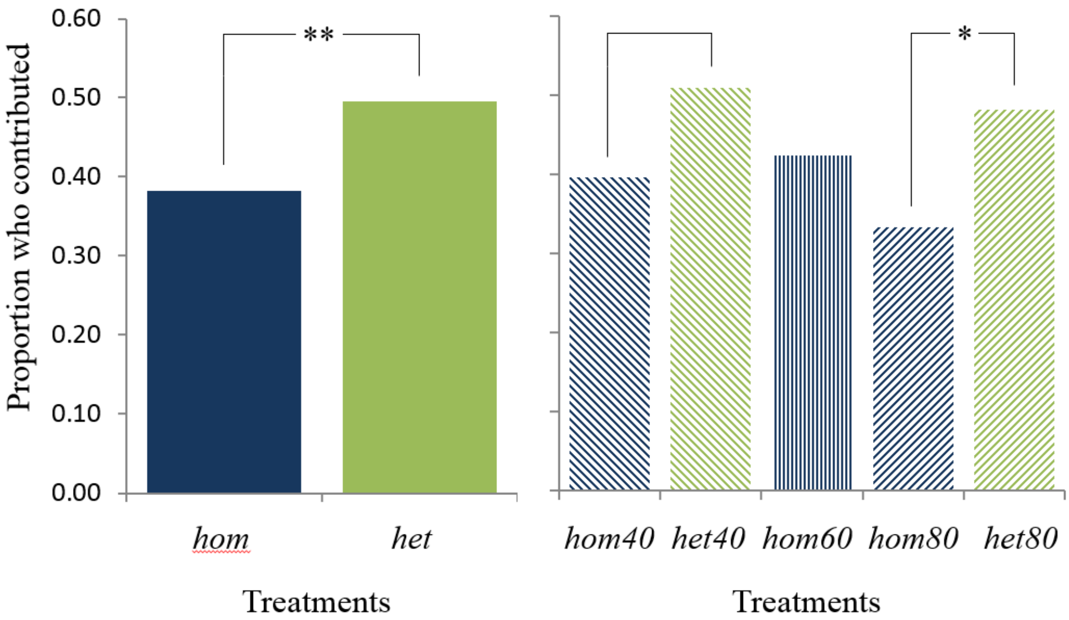
We begin by presenting mean treatment effects on PGG contribution decisions. Then, by estimating Logit and truncated Tobit models, we analyse whether individual and heterogeneous returns affect contribution decisions in both the PGG and HCQ contexts.

6.1 Contributions in the PGG

On average, 41 percent of the subjects chose to contribute their token to the PGG public good. The proportions across treatments lie in the range 0.33 to 0.51 (see Figure 1).

Result 1.1 (preliminary): Mean PGG contribution rates are higher when returns are heterogeneous. Two-sample independent t-tests and Mann-Whitney tests show that the difference in mean contributions between *hom*, the pooled sample including contributions made under *hom40*, *hom60*, and *hom80* (38.2 per cent) and *het* (49.5) is significant at the 5 per cent level (t=2.069(p=0.039); z=2.061(p=0.039)).[3]

Figure 1: Contribution rates across PGG treatments



Notes: Blue and blue-striped bars denote treatments where individual returns are homogeneous within-session; green and green-striped bars denote treatments where individual returns are heterogeneous within-session; ** difference significant at 5 per cent level. * difference significant at 10 per cent level.

3 If we exclude *hom60* from the sample and compare mean contribution rates between *hom* (*hom80* and *hom40* pooled) and *het*, we are still able to reject the null of no difference, but at the 10 per cent level.

The bar heights in Figure 1 suggest that both those facing the lower return, 40, and those facing the higher return, 80, respond positively to heterogeneity in returns. However, only the difference for high return subjects, i.e., between *hom80* and *het80*, is significant at the 10 percent level.

Result 1.2 (preliminary): The figure presents no evidence of the likelihood of contributing increasing with individual return from the public good.

6.2 Multivariate analysis of contributions in the PGG

Table 5 presents the marginal effects derived from two logit models each taking the PGG decision as the dependent variable. The dependent variable *PGG contribution* is equal to one if the subject contributed their token to the public good, and zero otherwise. In both estimations, non-independence within sessions is accounted for by adjusting the standard errors for clustering at the session level. In both models the explanatory variables of interest are *Het*, which equals 1 if the decision was made under the *het* treatment and zero otherwise, and *Individual return,* which equals 40, 60, or 80, depending on (sub-) treatment assignment.

Result 1.1 (continued): Heterogeneity in returns continues to have a positive and significant effect on PGG contributions when we control for individual characteristics and community fixed effects. However, the effect loses significance when we control for household and farm characteristics, even though those household and farm characteristics are jointly insignificant.

Result 1.2 (continued): Individual returns have no effect on PGG contributions.

Table 5: Marginal Effects for PGG Logit Models
Dependent variable = 1 if *i* contributed in PGG, 0 otherwise

	Model 1		Model 2	
Het (heterogeneous returns)	0.032		0.063	*
	(0.045)		(0.037)	
Individual return	$-2.40e^{-4}$		-0.001	
	(0.001)		(0.001)	
Female	-0.208	***	-0.185	***
	(0.053)		(0.046)	
Age	0.022		0.027	
	(0.020)		(0.019)	
Age squared	0.000		0.000	
	(0.000)		(0.000)	
Years of schooling	0.009		0.011	
	(0.007)		(0.008)	
Married	-0.062		-0.022	
	(0.086)		(0.083)	
Household head	0.027		0.103	
	(0.188)		(0.152)	
Risk averse	0.120	*	0.113	*
	(0.069)		(0.064)	
Total household income (log)	-0.024		-	
	(0.021)			
Household size	0.035		-	
	(0.025)			
Farming household head	0.070		-	
	(0.075)			
Number of plots	0.031		-	
	(0.048)			
Income from farming	-0.007		-	
	(0.007)			
Crop damage	-0.015		-	
	(0.012)			
Watch-huts	0.024		-	
	(0.036)			
Community fixed effects (CFEs) included	yes		yes	
Joint sig. of individual chars (p-value)	<0.001		<0.001	
Joint sig. of household chars (p-value)	0.583		-	
Joint sig. of CFEs (p-value)	<0.001		<0.001	
Pseudo R-squared	0.124		0.115	
Observations	397		402	

Notes: Marginal effects, evaluated at the mean, and standard errors, clustered at the session level, presented; *** p<0.01, ** p<0.05, * p<0.1.

In Model 1, we control for an extensive set of individual characteristics, household and farm characteristics, including the ones that we will use as proxies for individual returns in the analysis of the HCQ, and community fixed effects. In this model neither *Het* nor *Individual returns* bears a significant coefficient, the individual characteristics are jointly highly significant, as are the community fixed effects, and the household and farm characteristics are individually and jointly insignificant.

In Model 2, from which we exclude the set of household and farm characteristics, the coefficient on *Het* is positive and significant at the 10 percent level, while that on *Individual returns* remains insignificant and close to zero.

That the household and farm characteristics are individually and jointly insignificant in Model 1 is worthy of note. It suggests that subjects do not bring their real-life farming and HEC context into the lab and their PGG decision-making. Among the individual characteristics, *Female* and *Risk averse* bear significant coefficients. Women are less likely to contribute and risk averse subjects are more likely to contribute. The second result is surprising. It could be owing to the frame; risk averse subjects may have a stronger preference for the security that the electric fence affords.

6.3 Results from the HCQ

Here, we use the responses made to the HCQ by the sample of subjects who also took part in the PGG to estimate a series of Tobit models of HCQ contribution behaviour. Recall that *HCQ contribution* is the number of hours which subjects are willing to contribute to construction of the hypothetical electric fence. It takes values from 0 to 20 in two-hour intervals with an additional option to indicate willingness to contribute more than 20 hours. 48.3 per cent of the farmers in our sample indicated that they would contribute more than 20 hours. We coded these "greater than 20" responses as 21 and then treat the dependent variable as truncated.[4]

Result 2.1: Cross-household variance in both crop damage and in reliance on farming has a positive but insignificant effect on HCQ contribution decisions;

Result 2.2: Individual returns have a positive and significant effect on HCQ contribution decisions.

Table 6 presents the marginal effects evaluated at the sample mean for each of the explanatory variables in the Tobit estimations. In Model 1, we include the two proxies for individual returns to the fence, *crop damage* and *proportion of income from farming,* and the community-level variances in these two variables to proxy for heterogeneity in individual returns. The coefficients on both proxies for heterogeneity in returns are positive but insignificant. We find positive and highly significant effects of *crop damage* and *proportion of income from farming,* our two proxies for real-life expected individual returns to the electric fence, on HCQ contributions.[5] These effects are robust across Models 1-3.

In Model 2, we also include *watch-huts* (HEC prevention) and individual and other household characteristics. The *watch-huts* variable has a positive and highly significant effect. *Risk aversion* has a negative effect on HCQ contributions, as do *female*, *age squared* and *number of plots*.

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4 If we transform the HCQ dependent variable to equal 1 if subjects are willing to contribute at least 20 hours to construction of the electric fence and zero otherwise, the results are effectively unchanged.

5 Using an alternative crop damage variable that equals 1 if a farmer reported any crop damage and zero otherwise yields very similar results.

Table 6: Marginal Effects for Truncated Tobit Models of HCQ contributions
Dependent variable=hours contributed to construction of hypothetical fence

	HCQ Model 1	**HCQ Model 2**	**HCQ Model 3**
Var (crop damage)	0.184	0.140	
	(0.114)	(0.133)	
Var (proportion of income from farming)	0.210	0.204	
	(0.138)	(0.157)	
Crop damage	1.158***	1.325***	1.320***
	(0.427)	(0.466)	(0.480)
Proportion of income from farming	0.388***	0.420***	0.404***
	(0.111)	(0.122)	(0.126)
Female		-2.519**	-2.445**
		(0.999)	(1.136)
Age		0.188	0.221
		(0.172)	(0.178)
Age squared		-0.003*	-0.003*
		(0.002)	(0.002)
Years of schooling		-0.085	-0.117
		(0.163)	(0.169)
Married		-0.640	-0.767
		(1.270)	(1.287)
Household head		-2.673	-4.250
		(3.137)	(3.183)
Risk averse		-2.285*	-2.372
		(1.369)	(1.461)
Household size		-0.375	-0.385
		(0.305)	(0.318)
Total household income (log)		0.047	0.214
		(0.576)	(0.537)
Farming household head		-0.916	-0.711
		(1.467)	(1.574)
Number of plots		-4.462***	-4.634***
		(0.869)	(0.878)
Watch-huts		2.834***	2.926***
		(1.068)	(1.018)
Community dummies?	No	No	Yes
Community dummies jointly significant?	-	-	Yes***
Variances jointly significant?	No	No	-
R-squared	0.014	0.039	0.045
Observations	398	397	397

Notes: Standard errors, in parentheses, clustered at the session level; *** p<0.01, ** p<0.05, * p<0.1; Tobit upper limit truncated at 21 hours. Applying OLS yields similar results. Inferences about returns and risk aversion are robust to the exclusion of the *watch-huts* variable.

The two proxies for heterogeneity in returns, *var(crop damage)* and *var(proportion of income from farming*), are insignificant in Models 1 and 2. The two measures are negatively and significantly correlated with each other at the 1 per cent level. However, an F-test indicates that they are jointly insignificant in both models and including just one or other proxy in the models also yields insignificant results.

In HCQ Model 3 we replace the proxies for heterogeneity with a full set of community fixed effects. These are jointly highly significant and, so, this is our preferred model for the purposes of interpretation. A one-unit increase in average crop damage per month increases the HCQ time contribution by 1.32 hours. A one-unit increase in the proportion of income generated through farming increases the time contribution by 0.40 hours. Watch-hut ownership has a large, positive and significant effect on HCQ contributions to the electric fence: each additional watch-hut owned increases the HCQ time contributions by 2.93 hours. Each additional plot occupied by a household leads to a 4.63 hours reduction (at the mean) in the HCQ time contribution.

In sum, the HCQ models indicates that variances in crop damage and in reliance on farm income, both of which proxy for heterogeneity in real-life returns from the electric fence, have no significant effect on HCQ contributions. Crop damage and reliance on farming income, which proxy for individual returns from the electric fence, have a positive and significant effect on HCQ contributions, as does ownership of HEC-preventative watch-huts.

7. Summary and discussion

Results 1.1 and 1.2: A simple comparison of mean PGG contributions suggests that heterogeneity in returns has a positive effect on PGG contributions. This effect is robust to the inclusion of individual characteristics and community fixed effects in the analysis, but is not robust to the inclusion of a set of household and farm characteristics, even though the latter are jointly insignificant.

Results 2.1 and 2.2: The Tobit analysis of the HCQ indicates that real-life proxies for heterogeneous returns from the public good, *var(crop damage)* and *var(proportion of income from farming)*, have no effect on HCQ contributions. However, the two proxies for expected individual returns from the electric fence have a positive and highly significant effect. The positive and significant coefficient on *watch-huts*, after controlling for exposure, is particularly interesting. It indicates that households who are more invested in an established approach to HEC management are more willing to invest in the new higher tech approach. This is consistent with these households perceiving the fence as a potentially less time-consuming and perilous approach to HEC management.

While the findings derived from our two methods are not the same, neither are they contradictory. Taken together, they suggest that heterogeneity in individual returns to public goods does not explain why public good creation and maintenance remains a challenge in communities across the developing world. Our data suggests that, in such circumstances, those expecting a high return from the public good step up and those expecting a low return do not step down.

Being risk averse had differing effects on PGG and HCQ contributions. In the PGG, being risk averse increases the likelihood of contributing. In the HCQ, being risk averse has a negative but insignificant effect on time contributions. In relation to the PGG, we speculated that the strategic risk associated with contributing to public good provision would receive a relatively high cognitive weight. Given this, we expected that the more risk averse would be less likely to contribute. That we find the opposite is consistent with the risk averse being used to coping with risk collectively and, so, choosing to contribute in the PGG, framed as contributing to a risk-mitigating public good, out of habit. In contrast, we speculated that in the HCQ decision-making process, a lower cognitive weight would be placed on the interactive aspect of the public good provision and a higher weight on the risk associated with the novel technology.

8. Conclusions

In conclusion, heterogeneity in individual returns to public goods does not explain why public good creation and maintenance remains a challenge to communities across the developing world. When returns to local public goods are heterogeneous, those expecting a high return from the public good step up and those expecting a low return do not step down.

These results should be encouraging for development practitioners, including those aiming to engage Sri Lankan communities in the construction of electric fences to mitigate the risk of the Human-Elephant Conflict.

From a methodological point of view, we find that mixing methods provides a more balanced account of communities' potential engagement in HEC-mitigating public goods.

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Appendix

Figure A.1: Token used in homogenous PGG treatments
(abbreviation for "individual" in Sinhala on left, "group" in Sinhala on right)

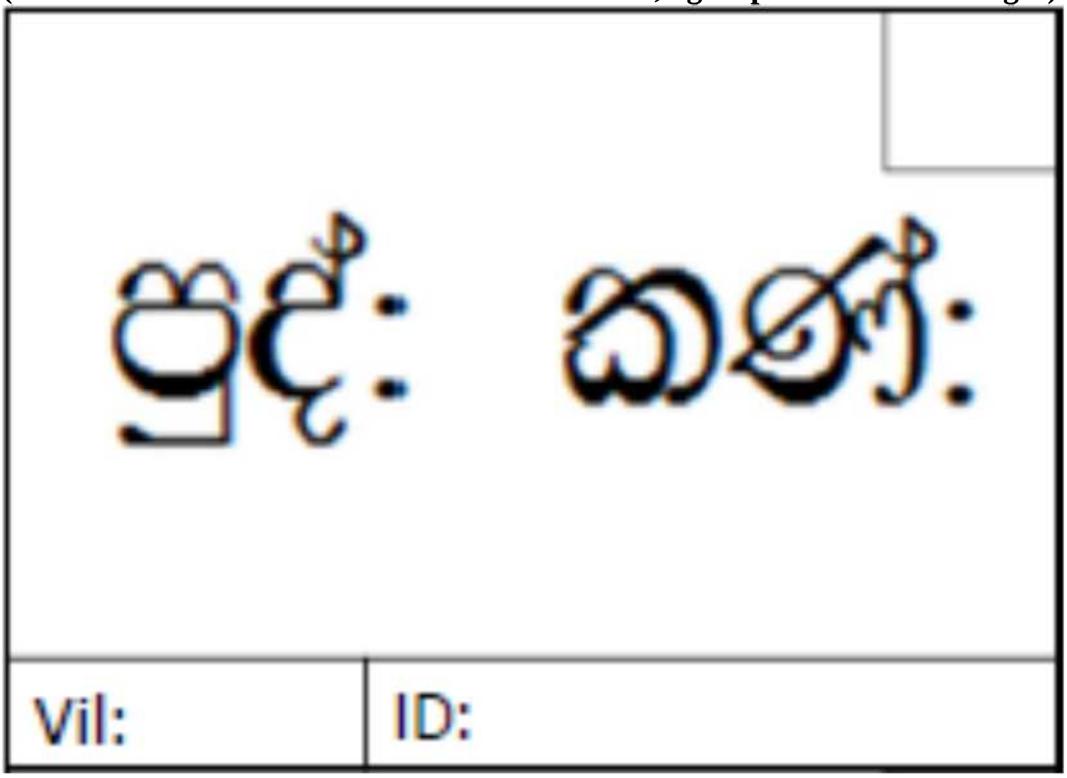

Figure A.2: Fronts of high- and low-return tokens used in heterogeneous PGG treatment

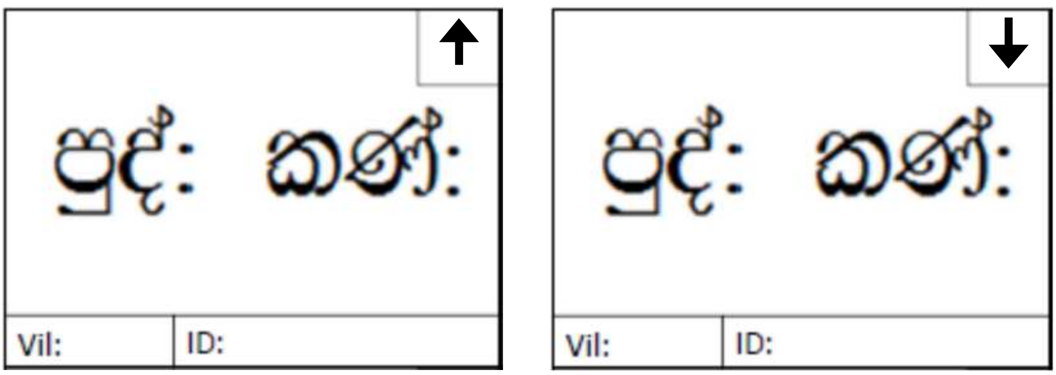

Figure A.3: Gamble choice task decision card

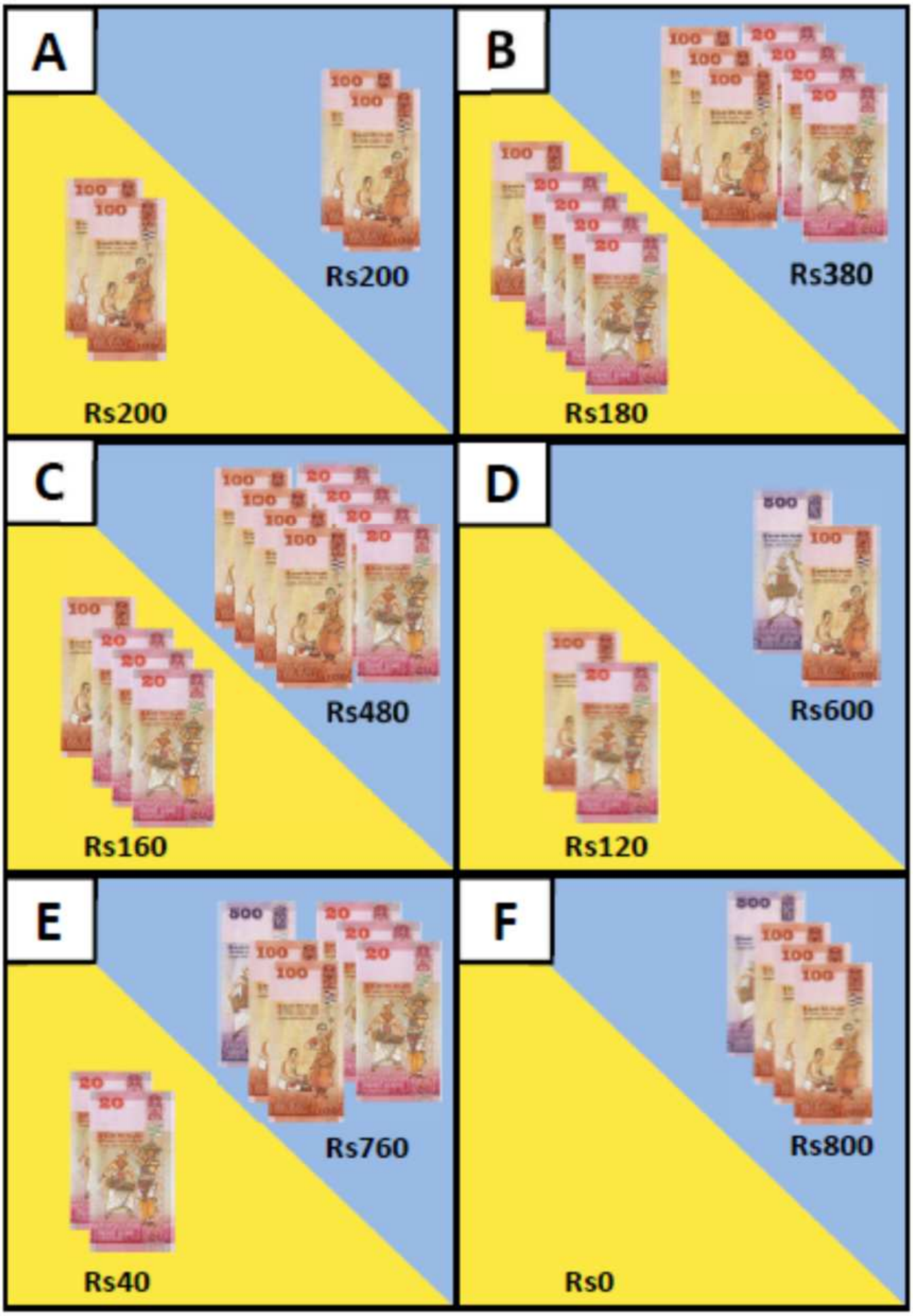

Figure A.4: Stated contributions, in hours, to construct the electric fence