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**Working Paper**

## Appropriation in the commons: variations in the opportunity costs of conservation

Working Papers in Economics and Statistics, No. 2012-25

**Provided in Cooperation with:**

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*Suggested Citation:* Blanco, Esther; Lopez, Maria Claudia; Walker, James M. (2012) : Appropriation in the commons: variations in the opportunity costs of conservation, Working Papers in Economics and Statistics, No. 2012-25, University of Innsbruck, Research Platform Empirical and Experimental Economics (eeecon), Innsbruck

This Version is available at:

<https://hdl.handle.net/10419/73893>

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2012-25

**University of Innsbruck**  
**Working Papers in Economics and Statistics**

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## **Appropriation in the commons: variations in the opportunity costs of conservation**

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**Abstract:** This study examines individual and group behavior in a linear appropriation game setting. Subjects make decisions from a menu of eight games, without feedback. Four treatment conditions vary the magnitude of the opportunity cost of conservation, including symmetric and asymmetric treatments. A parallel set of four treatments implement the same parameter variations in a setting where probabilistic degradation of the commons is linked to group appropriation. Thus, this setting introduces uncertainty in the value of the opportunity cost of appropriation. In summary, subjects respond systematically to changes in the marginal incentives and to the possibility of degradation. These responses are shown to be related to a direct effect of changes in marginal monetary incentives and to an indirect effect associated with changes in subjects' first order beliefs of the appropriation decisions of others.

**Keywords:** common-pool resources · asymmetry · cooperation · laboratory experiments

**JEL Classification:** D7 · D3 · H4 · C90

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## 1. Introduction

Appropriation from common-pool resources (CPRs) generally leads to heterogeneous benefits to users. In the extreme case, commons may exist where appropriation is necessary for survival for some users, while providing a low benefit for others. For example, wildlife conservation programs must often balance the needs of local communities and outsiders. For local communities, wildlife may be a crucial source of protein, while such areas have leisure value for outsiders who enjoy hunting for wild game. Such asymmetries may have important behavioral implications for appropriation decisions by high- and low-incentive users.

For simplicity and control purposes, early experimental studies on CPRs focused primarily on parameterizations with symmetric benefits to appropriation (Ostrom et al. 1994). More recently, a few CPR studies have begun to examine situations with asymmetric appropriation capacity. For example, Hackett et al. (1994) and Holahan (2011) examine CPR settings where subjects have communication or voting opportunities to facilitate cooperation, where subjects receive differential returns from agreements. In this study, we add to this literature by examining an experimental design that allows for within-group symmetric and asymmetric variations in the opportunity cost of conservation (marginal benefit from appropriation), while keeping constant the benefit of conserving the CPR.

The literature on public goods provision provides a useful background for examining issues of asymmetries in the commons. Early experimental papers explored voluntary provision of public goods in settings in which group members received symmetric benefits that were linear in the level of provision (referred to as VCM games). A primary focus of this literature was the impact of the marginal per-capita return (MPCR) on cooperation, where the MPCR is defined as the marginal benefit from the public good relative to private provision costs. In summary, holding group size constant, a positive relationship was found to exist between efficiency in provision and the MPCR (see, for example, Isaac et al. 1994; Ledyard 1995; Brandts and Schram 2001).

Previous studies addressing the influence of *asymmetric* manipulations of MPCRs in public goods provision settings find support for either no effect on average contributions (Fisher et al. 1995) or a

“poisoning of the well,” where average group contributions for asymmetric groups are lower than in symmetric groups (Bagnoli and McKee 1991; Chan et al. 1999; Fischbacher et al. 2012; Fisher and Schatzberg 1988; Tan 2008). The path by which heterogeneity reduces cooperation varies across studies. For example, Fisher and Schatzberg (1988) find that subjects with higher incentives cooperate less in asymmetric games in comparison to their counterparts in symmetric games, while subjects with lower incentives do not behave significantly different. Fischbacher et al. (2012) and Tan (2008), however, find that subjects with lower incentives cooperate less, and this reduction is not balanced by subjects with higher incentives cooperating more.<sup>1</sup>

This study examines behavior using a menu of eight treatments, where the opportunity cost of conservation is systematically varied in both symmetric and asymmetric group settings. More specifically, the design includes within-subject one-shot experimental decision settings where individual valuations of the *units appropriated* from the CPR vary. We incorporate a baseline parameterization, as well as situations with a higher value, a lower value, and asymmetric values for group members. In the asymmetric treatment, half of the subjects receive the higher marginal value of appropriation; the other half receives the lower value; such that the group average value is the same as in the baseline. We explore these effects in situations where there is certainty over opportunity costs of conservation from the CPR (four treatments), and where there is probabilistic degradation linked to the level of appropriation (additional four treatments). The probability that degradation occurs depends on an exogenously imposed probability factor and endogenous extraction decisions, similar to Walker and Gardner (1992). In addition, similar to several recent studies related to public goods provisions (Offerman et al. 1996; Brandts and Schram 2001; Fischbacher et al. 2012), we incorporate incentivized belief elicitation for other subjects’ appropriation for each of the decision situations.

Our baseline game is the linear CPR appropriation game developed in Cox et al. (2012). In this decision environment, users of the CPR appropriate from the resource, gaining private value from

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<sup>1</sup> In a somewhat different setting, two studies increase the marginal value of the public good to a level where it is a dominant strategy to cooperate. However, they find that subjects in this role do not respond with full contributions to the public good (Marwell and Ames 1979; Reuben and Riedl 2009).

subtractable units and value from units left in the CPR. The decision situation can be viewed as one in which units of the resource are rival/subtractable in consumption (see Ostrom et al. 1994 for further discussion) and at the same time the resource itself has the properties of a public good that yields positive value to users, such as varied types of ecosystem services (e.g., esthetics or climate change mitigation). The design investigated includes multiple one-shot treatments, without feedback across decision situations. Unlike much of the literature on social dilemma settings, this decision environment does not allow for reputation building and does not include a rich institutional setting that might facilitate cooperation. In this sense, the study strictly examines the effect on appropriation decisions of pecuniary changes in incentives and subsequent changes in first-order beliefs within the CPR game.

Arguably, in many field settings, there may be incomplete information regarding the value of appropriation by others. For experimental control, however, we examine situations where the opportunity costs of conservation and the probability factor linked to CPR degradation are common information. This is consistent with situations where groups of users of CPRs, governments, or NGOs have the ability to adopt policies that provide potential users with information (propaganda) related to the value and use-dependency of resources. Such policies can be used to generate common information of the implications of resource appropriation. Gaining an understanding of individual responses in such contexts to manipulations of the relative value of the resource and the fragile nature of the resource (probabilistic degradation) is fundamental in designing programs whose intention is to ameliorate CPR inefficiencies in use.

## **2. The game settings**

We investigate behavior in what we refer to as the “CPR” game and the “CPR-degradation” game. The structure of each game, experimental parameters, and behavioral hypotheses are discussed below.

### **2.1. The CPR game**

In this game, groups of  $n$  agents face allocation decisions between a “Group Fund” and an “Individual Fund.” Each group begins with a Group Fund endowment of  $t$  tokens, and each agent begins the game

with zero tokens allocated to their Individual Fund. Agents simultaneously and privately decide how many tokens to move from the Group Fund to their Individual Fund. Each token in an agent's Individual Fund has a value of  $h$  ECUs (Experimental Currency Units) for the agent, and each token remaining in the Group Fund has a value of  $g$  ECUs for the group. Parameter  $h$  is therefore the marginal value of appropriation, which we manipulate to generate variations in the opportunity cost of conservation. Each token left in the Group Fund has a value of  $g/n$  ECUs for each group member. The games are parameterized such that  $g > h$  and  $g/n < h$  to recreate a social dilemma. Agents have an equal capacity of  $e$  tokens to withdraw from the Group Fund, so that full extraction by all subjects in a group results in a final Group Fund of zero tokens.

In summary, letting  $z_i$  denote the amount appropriated from the Group Fund by agent  $i$ , the payoff to agent  $i$  in ECUs can be represented as:

$$\pi_i = h z_i + \frac{g}{n} (t - \sum_{i=1}^n z_i) \quad z_i \in (0, e)$$

Assuming agents are rational, make decisions based on own income maximization, and this is common information, each agent has a dominant strategy to withdraw  $e$  tokens from the Group Fund. The game represents a social dilemma, however, in that the social optimum is for all agents to withdraw zero tokens from the Group Fund.

## 2.2 The CPR-degradation game

This decision setting adds probabilistic degradation to the CPR game, implemented as a hazard rate that depends on the aggregate group number of tokens moved from the Group Fund. In this game, there is an endogenous probability of “degradation” of  $p(\sum_{i=1}^n z_i)$ . Each token appropriated from the Group Fund increases by  $p=1\%$ , the probability that the value of the final Group Fund is reduced by 50%.<sup>2</sup> The resulting payoff to agent  $i$  once degradation is introduced is:

$$\pi_i = h z_i + \frac{g}{n} [1 - 0.5p(\sum_{i=1}^n z_i)] (t - \sum_{i=1}^n z_i) \quad z_i \in (0, e)$$

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<sup>2</sup> A 50% reduction in the value of the Group Fund was implemented to avoid the extreme case of a 100% reduction, while maintaining a reduction that had important implications for experimental earnings.



With the game parameters discussed below, and risk-neutral agents, this implementation of degradation does not change the equilibrium predictions or the social optimum with respect to the games studied.<sup>3</sup>

### 2.3. Game parameters

Eight treatments, utilizing four parameter variations of the CPR game, and a parallel set of four parameter variations of the CPR-degradation game, were examined. The primary motivation behind the design and changes in the game parameters was to examine three “contextual variables” that have been shown to affect behavior in prior experimental studies of public goods and/or common-pool resource games: (1) the marginal value of appropriation, (2) asymmetry in appropriation values across group members, and (3) probabilistic degradation.

All decision settings included groups of four, with an initial endowment of 100 tokens in the Group Fund from which each subject could move up to 25 tokens to their Individual Funds. Tokens in the Group Fund had a marginal value of 2 ECUs for all treatments, shared equally among group members. As shown in Table 1, all parameter variations arise from varying the value of  $h$ ; i.e., the marginal value of tokens in an agent’s Individual Fund. In summary, relative to what we will refer to as baseline decision settings (with and without degradation) where  $h=1$ , we examine cases where the value of  $h$  is increased ( $h=1.4$ ), lowered ( $h=0.6$ ), and asymmetric across agents. In games with asymmetric values, two group members receive the high value of  $h$  (1.4) and two receive the low value (0.6). Note that the average value of  $h$  for a group in this treatment (average  $h$  of 1) is the same as for the baselines with a medium value of  $h$ . These parameter manipulations combine the treatments in Fisher et al. (1995) and Fischbacher et al. (2012) for VCM games.<sup>4</sup> Fisher et al. (1995) compare the results for groups where all participants have a high MPCR and groups where all participants have a low MPCR with asymmetric groups, including high- and low-incentive subjects. Fischbacher et al. (2012) undertake a different comparison by including

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<sup>3</sup> By design, group earnings at the social optimum for the CPR game and the CPR-degradation game are constant across all decision settings. However, earnings at the Nash Equilibrium prediction vary across settings with different marginal values from appropriation.

<sup>4</sup> Other, less similar, experimental settings provide further evidence related to heterogeneities and levels of cooperation (see Marwell and Ames 1979; Bagnoli and McKee 1991; Chan et al. 1999; Ahn et al. 2007; Reuben and Riedl 2009).

symmetric groups where participants have an intermediate MPCR with asymmetric groups where half of the participants have a higher value and the other half a lower value, for an average group MPCR equal to that of the symmetric groups. Our experimental design combines these two approaches; it includes symmetric treatments with high and low incentives equal to those of high and low incentive subjects in the asymmetric treatments, as well as a symmetric treatment with medium incentives equal to the average of the high and low incentives subjects in asymmetric treatments. This enables us to better account for the individual responses to asymmetry.

(Table 1 about here)

In the baseline CPR game with a medium value of  $h$ , the marginal *net gain* from appropriation for each subject is 0.5 ECUs. Regardless of the appropriation decisions of other group members, for each individual, extracting one token implies gaining 1 ECU privately and foregoing 0.5 ECUs from maintaining the CPR ( $h - g/n$ ). As described above, since the marginal net gain from appropriation is positive, the Nash Equilibrium based on all subjects maximizing their own monetary gains is for all players to appropriate up to their individual capacity. Using the same logic for the other parameters investigated,  $h=1.4$  or  $0.6$ , the equilibrium prediction is not changed despite the change in the opportunity cost of conservation (marginal net gain from appropriation), which are 0.9 and 0.1, respectively. Relative to the CPR game, introducing the probability of degradation reduces the marginal *net gain* from appropriation (which is now  $h - (g/n)[1 - 0.5p(\sum_{i=1}^n z_i)]$ ), making conservation less costly. Further, in the CPR-degradation treatments, the opportunity cost of conservation is increasing in the level of appropriation by others. The more others appropriate, the higher the incentives for a player to appropriate.

## 2.4. Measurement of beliefs

After all subjects finalized appropriation decisions for all games, no further changes were possible. Before getting any feedback on decisions from other group members, each subject was asked to report a forecast of the average per-person appropriation level for members of their group, for each of the eight treatments. Belief elicitation was incentivized following Croson (2007). If a subject's forecast of the per-person

average number of tokens appropriated was equal to or not more than 1 token away from the actual average of the other group members, he/she earned an additional US\$4.5.<sup>5</sup> If the forecast was more than 1 token away from the average, he/she earned US\$1.7 divided by the (absolute) distance between the forecast and the actual average. For the asymmetric treatments, subjects forecasted the average per-person appropriation of high-*h* subjects and of low-*h* subjects separately, which was then used to construct the per-person forecast of other group members.

## 2.5. Behavioral conjectures

Numerous experimental studies conducted over the past several decades have demonstrated that individuals' decisions, in a variety of social dilemma situations, reflect complex and diverse motivations beyond simple self-income maximization (see research summarized in Camerer 2003; Camerer and Fehr 2006; Ostrom and Walker 2003). Extensive experimental research, replicated across multiple cultures, has led to the development of a wide variety of models designed to reflect such motivations. For example, based on social norms or social preferences (attributes of conditional cooperation, Fischbacher et al. 2001; inequity-aversion, Fehr and Schmidt 1999; revealed altruism, Cox et al. 2008), individuals may cooperate even in one-shot settings. This literature suggests several behavioral regularities relevant to this study summarized in Conjectures 1–4 below.

*Conjecture 1: Increasing (lowering) the marginal value of tokens in the Individual Fund will lead to greater (lower) individual appropriation from the Group Fund.*

Numerous studies examining behavior in linear VCM public goods games (e.g., Isaac et al. 1994; Ledyard 1995) have shown the MPCR to be instrumental in explaining variations in contributions across groups. The CPR game examined in this study is designed to further explore such behavioral regularities by manipulating the marginal net gain of appropriation.

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<sup>5</sup> Experimental earnings were in Colombian pesos. By the time of the experiment, one US dollar was valued at approximately 1,770 Colombian pesos.

*Conjecture 2: (a) in asymmetric treatments, appropriation by individuals with high values of tokens in the Individual Fund will be greater than those of individuals with low values; (b) appropriation in asymmetric and symmetric treatments will be the same for individuals having the same value of tokens in the Individual Fund; and (c) asymmetric and symmetric treatments with the same average value of tokens in the Individual Fund will have the same levels of group appropriation.*

Conjecture 2 follows from Conjecture 1 and is supported by the results reported in Fisher et al. (1995), where the authors found strong evidence in a VCM setting that an individual's *own* MPCR was the best predictor of contribution levels. Importantly, their data showed no strong evidence for a significant “poisoning of the well” or “seeding” models of behavior in groups with asymmetric values. On average, their asymmetric groups, which included both high- and low-incentive subjects, contributed at an intermediate level compared to the symmetric groups that included only high or only low MPCRs. Thus, the Fisher et al. (1995) study can be interpreted as supporting Conjectures 2a and 2b. Additionally, the authors interpreted their results in a manner that is supportive of Conjecture 2c. However, their study did not include a symmetric setting in which the MPCR equaled the average MPCR of the asymmetric groups. Focusing on that comparison, Tan (2008) and Fischbacher et al. (2012) found a negative effect of asymmetry on contributions in a VCM game. Hence, in VCM games, prior evidence is somewhat mixed as related to Conjecture 2c. Because our design incorporates symmetric settings where the marginal valuation is equal to the average of the marginal valuation in the asymmetric settings, as well as group settings with symmetric high and symmetric low values of appropriation, we are able to independently investigate and disentangle the three effects presented in Conjectures 2a-c.

*Conjecture 3: In treatments with the same value of tokens in the Individual Fund, individual appropriation levels in treatments with a degradation probability will be lower than in treatments without a degradation probability.*

Conjecture 3 parallels Conjecture 1. Relative to nondegradation settings with the same marginal values of  $h$ , introducing the possibility of degradation reduces the marginal net benefit from appropriation

and thus is conjectured to lower appropriation. Notice that for the same level of appropriation in games with probabilistic degradation and games without the possibility of degradation, expected efficiency will be lower in the probabilistic degradation games. The probability of degradation (which depends on group appropriation) introduces an additional cost of appropriation to the group that equals the expected reduction in the Group Fund to 50% of its final value. In a previous study, Walker and Gardner (1992) explored the effect of introducing a probability of degradation (up to full destruction) in a nonlinear repeated common-pool resource game and found that subjects consistently appropriated from the common-pool resource at a level well above the socially optimum solution, with investment efficiencies below 37%. An important difference in our design relative to Walker and Gardner is the implementation of nondegradation treatments for each value of  $h$  with which to compare the appropriation and efficiency levels with degradation. The focus of Conjecture 3 is precisely to compare the degradation and nondegradation treatments across paired settings where the value of the tokens in the Individual Funds is held constant.

*Conjecture 4: There will be a positive correlation between individual appropriation levels and individuals' forecasts of others' appropriation levels.*

Croson (2007) presents an insightful discussion of the comparative static predictions of three competing theories to explain cooperation in social dilemmas (specifically in VCM games): commitment, altruism, and reciprocity. Consistent with theories of reciprocity, the Croson study finds a significant and positive relationship between an individual's level of cooperation and beliefs of cooperation of others in the group. In addition, closely related to our study, Fischbacher et al. (2012) estimate belief-independent reactions to heterogeneous changes in the valuation of the public good in a VCM game by asking subjects to make decisions conditional on the average contribution of other group members. They interpret their results to suggest that the negative effect of asymmetry on contributions is due to pessimistic beliefs of

others' contributions in asymmetric settings.<sup>6</sup> By including belief elicitation as a control variable in the analyses, we aim to test whether the effect of asymmetry on subjects' decisions in the appropriation setting is exclusively explained by changes in beliefs of others' decisions, as Fischbacher et al. suggest for VCM games, or whether a direct pecuniary effect of asymmetry on behavior persists after controlling for changes in beliefs.

### **3. The experimental decision setting**

The experiment consisted of eight sessions conducted in the spring of 2012 with a total of 128 university students. At the start of each session, subjects were presented with a packet that included initial instructions, a consent form, and instructions for each of the treatments with subject-specific parameters. The initial instructions informed the subjects of the general structure of the decision situations. Each subject would make choices in each decision situation, but their compensation would be based on the outcome of one of the decision situations chosen randomly at the end of the experiment after all decisions were final. The decision situation chosen for compensation would be selected by picking a card out of a shuffled deck of cards numbered from 1 to 8, in public. Groups of four were created based on subject numbers that were assigned randomly at the beginning of the experiment. Cash earnings depended only on each subject's decisions and the decisions of the other three participants in their group. All decisions and earnings were private information. Decision situations were described in ECUs with a conversion rate of US\$0.34 for each ECU. After receiving this information, subjects were asked to read and sign the consent form if they were willing to participate in the experiment.

After completing the initial instructions, and following completion of consent forms, the experimenters reviewed instructions for each decision situation. As discussed above, in all treatments

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<sup>6</sup> In other relevant studies, Brandts and Schram (2001) control the amount of information that subjects receive in both partners' and strangers' designs when making repeated decisions for different MPCRs in a VCM setting, showing that the behavior of some subjects is influenced by that of other participants. Offerman et al. (1996) explore the influence of incentivized elicitation of beliefs of others' decisions on the reaction of subjects to increases in the value of the public good in a repeated threshold public goods game. They find a positive relation between the subjective probability of being decisive in providing the public good and the propensity to contribute.

each group began with a Group Fund of 100 tokens and each token in the initial Group Fund was worth 2 ECUs. Each group member began with an Individual Fund containing zero tokens. Each person's decision task was to decide privately and independently whether to move up to a maximum of 25 tokens (0,1,2,3,4,5,..., 20, 21, 22, 23, 24, or 25) from the Group Fund to his/her own Individual Fund. Each token that a person moved from the Group Fund increased the value of his/her own Individual Fund by 1 ECU for the Med-*h* treatment. The additional CPR game decision situations were identical to the Med-*h* situation except for the value of tokens moved to a group member's Individual Fund as described in Table 1. The resulting treatments for the CPR game are High-*h*, Low-*h*, and Asym-*h*. In each group of four, an individual's earnings was the sum of the value of that person's Individual Fund plus an equal share ( $\frac{1}{4}$ ) of the value of the final Group Fund for their group; meaning each subject received a return of 0.5 ECUs from each token in the final Group Fund.

In the CPR-degradation games, subjects received additional instructions that explained "For each token removed from the initial Group Fund by a four person group there is a 1% chance that the value of the final Group Fund is reduced by one-half." The same variations in the value of tokens in the Individual Fund were applied in the CPR-degradation games, resulting in the corresponding D-Med-*h*, D-High-*h*, D-Low-*h*, and D-Asym-*h* treatments (see Table 1).

The instructions for the Med-*h* and D-Med-*h* treatments included parallel examples to illustrate the implications of possible choices. In addition, all decision situations included a "quiz" to reinforce subjects' understanding of the games. After reading the instructions for each decision situation, the experimenters gave time for the subjects to complete the quiz. The answers were displayed with a projector, and questions were answered in private (see Appendix A for a translation of instructions).

After the instructions were reviewed for all decision situations, the experimenters displayed the parameters for the decision situations using a projector. Concurrently, decision sheets were distributed to subjects, who then completed two copies: one to hand back to the experimenter once all decisions were final and one to keep until the end of the session. As in Brandts and Schram (2001), it was the subjects'

choice to determine the order in which he/she made decisions in the eight treatments. Importantly, the decision for any situation could be revised as long as all decisions had not been finalized.

At the end of the experiment, after all appropriation decisions were finalized and one copy of the decision sheets was collected from each participant, and before receiving any feedback information, subjects were informed of the forecasting task. While making their forecasts of the average decision of others in their group for each decision situation, subjects had their copy of the decision-making sheets. As noted above, forecasts were incentivized and were presented as “bonus questions” that would be added to their earnings from the randomly chosen decision situation. Only the forecast corresponding with the decision situation chosen for computing game earnings was used for the bonus payment.<sup>7</sup>

#### **4. Results**

Because the decision situations are one-shot and subjects did not receive feedback information until all decisions were final, the presentation of results is primarily based on individual decisions as opposed to group decisions. We begin with an overview of summary statistics and relevant pairwise tests based on the conjectures presented above. This discussion is followed by regression analyses including all treatments, as well as investigating behavior related to forecasts and two demographic variables.

##### **4.1. Summary statistics and pairwise tests related to conjectures**

Table 2 presents average individual and group appropriation, and average forecasts of others’ appropriation for each treatment, while Table 3 provides nonparametric Mann-Whitney tests and t-tests for the pairwise comparisons of individual behavior between treatments. The discussion below focuses on those comparisons related to Conjectures 1 to 3. In addition, data is provided in Table 2 that measures economic efficiency (E) in each treatment, calculated at the group level. For this purpose, in the nondegradation game situations, efficiency is defined for treatments  $j=1,...,4$  as:

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<sup>7</sup> Average earnings (in US\$), including the forecast bonus, were for the CPR games 13.96 (Baseline), 14.83 (High-*h*), 13.40 (Low-*h*), 16.22 (Asym-High-*h*), and 11.36 (Asym-Low-*h*). For games with degradation, average earnings (in US\$), with the forecast bonus, were 9.71 (D-Baseline), 11.61 (D-High-*h*), 9.36 (D-Low-*h*), 11.71 (D-Asym-High-*h*), and 7.44 (D-Asym-Low-*h*). In addition to these experimental earnings, subjects received a show-up payment of US\$2.83.



$$E_{j=1,\dots,4} = (P_j - \min P_j) / (\max P_j - \min P_j)$$

where  $P_j$  is the average group payoff in game  $j$ ;  $\min P_j$  is the minimum possible payoff in  $j$ , which corresponds to the payoffs at Nash Equilibrium; and  $\max P_j$  is the maximum possible payoff in  $j$ , the social optimum, which is constant across all games.<sup>8</sup> For the treatments that included probabilistic degradation, one must account for the potential probabilistic loss of earnings resulting from aggregate group appropriation. Thus, in these games, efficiency is calculated using:

$$E_{j=5,\dots,8} = (E[P_j] - \min P_j) / (\max P_j - \min P_j)$$

where  $E[P_j]$  is the expected payoff based on average group appropriation (which defines the probability of degradation). Note that at the social optimum, the probability of degradation is zero. At the Nash Equilibrium there is a 100% probability of degradation; but because the Group Fund is fully exploited, the degradation is irrelevant.

(Tables 2 and 3 about here)

As shown in Table 2, there are clear differences in efficiencies across treatments, ranging from a low of 10% in D-High- $h$  to a high of 62% in Low- $h$ . Consistent with behavior observed in VCM settings, efficiency levels are generally well above 0%, the efficiency predicted by the Nash Equilibrium, but also well below the social optimum.<sup>9</sup> As one might expect, symmetric lower (higher) marginal benefits from appropriation result in higher (lower) efficiency in CPR games and CPR-degradation games. Moreover, the probability of degradation leads to reductions in efficiencies when comparing CPR-degradation games to CPR-games, despite the lower average appropriation in the degradation games. As noted above, this

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<sup>8</sup> Note that this measure of efficiency accounts for variations in earnings of subjects in each treatment as well as variations of earnings at the Nash Equilibrium that result from changes in the value of  $h$  across treatments. All efficiency calculations derive from average appropriations reported in Table 2.

<sup>9</sup> Using our notation, the baseline appropriation game of Cox et al. (2012) is parameterized with  $h=1$  and  $g=3$ . Based on the relative value of  $g/h=3/1$ , our treatment condition Low- $h$  (where  $g/h= 2/0.6=3.33$ ) comes closest to matching the marginal incentives in their appropriation game. Cox et al. observe an average individual appropriation rate of 38.1% of maximum appropriation capacity, nearly identical to the 37.8% observed in Low- $h$  treatment in our study.

finding derives from the reduction in efficiency imposed by the expected degradation of the Group Fund in the CPR-degradation games.

We now move to the analysis of differences in average individual appropriation decisions. Recall that Conjecture 1 proposes a positive relationship between the level of appropriation and the marginal value associated with appropriation in the symmetric settings. For treatments of the CPR game, this implies that one should observe, relative to Med- $h$ , an increase in appropriation in High- $h$  and a decrease in Low- $h$ . As shown in Table 2, the data is consistent with this conjecture. The average appropriation in Med- $h$  is 11.27 tokens, High- $h$  is 14.07 tokens, and Low- $h$  is 9.44 tokens. As noted in Table 3 (cells in bold represent key comparisons relevant to conjectures), the differences with Med- $h$  are both statistically different using the Mann-Whitney tests and t-tests, at the 5% level for Med- $h$  and High- $h$  comparison and at the 10% level for the Med- $h$  and Low- $h$  comparison. Similarly, for treatments of the CPR-degradation game, Conjecture 1 implies, relative to D-Med- $h$ , an increase in appropriation in D-High- $h$  and a decrease in D-Low- $h$ . As shown in Table 2, the average individual appropriation in D-Med- $h$  is 9.80 tokens, D-High- $h$  is 12.03 tokens and D-Low- $h$  is 7.86 tokens. As noted in Table 3, the averages for D-High- $h$  and D-Low- $h$  are both statistically different from the D-Med- $h$  average, at the 5% and 10% levels, respectively.

Conjecture 2a states that, in treatments with asymmetric marginal values of the Individual Fund, appropriation levels by individuals with high  $h$  values will be greater than those of individuals with low  $h$  values. From Table 2, the average appropriation level for Asym-High- $h$  subjects is 14.45 tokens, while the average for Asym-Low- $h$  subjects is 9.97 tokens. As noted in Table 3, this difference is statistically significant at the 1% level. From Table 2, the average appropriation level for the D-Asym-High- $h$  subjects is 12.66 tokens, while the average for the Asym-Low- $h$  subjects is 8.97 tokens, statistically significant at the 5% level (see Table 3).

Conjecture 2b states that for the same average value of  $h$ , appropriation by individuals in asymmetric and symmetric games will be equal. Turning to Tables 2 and 3, the following comparisons are relevant: High- $h$  (14.07) vs. Asym-High- $h$  (14.45), Low- $h$  (9.44) vs. Asym-Low- $h$  (9.97), D-High- $h$

(12.03) vs. D-Asym-High- $h$  (12.66), and D-Low- $h$  (7.86) vs. D-Asym-Low- $h$  (8.97). Consistent with Conjecture 2b, in all pairs, the differences in average appropriation are quite low and not statistically significant.

Conjecture 2c states that holding the *average* value of  $h$  constant, average appropriation in asymmetric treatments (including high- and low-incentive subjects) will equal that of symmetric treatments with medium incentives. This implies that the per-person average appropriation will be equal in the Med- $h$  and the Asym- $h$  treatments, as well as in the D-Med- $h$  and the D-Asym- $h$ . From Table 2, the Med- $h$  treatment led to an average per-person appropriation of 11.27 tokens, while the Asym- $h$  treatment led to an average of 12.21 tokens. The D-Med- $h$  treatment led to an average per-person appropriation of 9.80 tokens, while the D-Asym- $h$  treatment led to an average of 10.81 tokens. Consistent with Conjecture 2c, these differences are not statistically significant.<sup>10</sup>

Conjecture 3 states that, controlling for  $h$ , probabilistic degradation will lead to a decrease in the level of individual appropriation. The ranking of average appropriation in our treatments is supportive of this conjecture. Relevant paired comparisons of average appropriation levels from Table 2 are: Med- $h$  (11.27) and D-Med- $h$  (9.80), High- $h$  (14.07) and D-High- $h$  (12.03), Low- $h$  (9.44) and D-Low- $h$  (7.86), Asym- $h$  (12.21) and D-Asym- $h$  (10.81). However, as shown in Table 3, none of the paired comparisons is statistically significant at the 5% level.<sup>11</sup>

## 4.2. Regression analyses

To complement the paired analysis presented in the preceding section, we conducted a more comprehensive analysis for the data from all eight treatments. More specifically, we examined the following model:

$$z_{ij} = \alpha_0 + \sum_{j=2}^8 \beta_j D_j + e_{ij} \quad \text{Model 1}$$

<sup>10</sup>  $t = -0.85$  ( $p = 0.40$ ) and  $z = -0.88$  ( $p = 0.38$ ) for Med- $h$  and Asym- $h$  and  $t = -0.96$  ( $p = 0.34$ ) and  $z = -1.03$  ( $p = 0.30$ ) for D-Med- $h$  and D-Asym- $h$ .

<sup>11</sup> The test statistics comparing Asym- $h$  and D-Asym- $h$  pooling high- and low-incentive subjects in the asymmetric treatments (not shown in Table 3) were  $t = 1.29$  ( $p = 0.20$ ) and  $z = 1.32$  ( $p = 0.19$ ).

where,  $z_{ij}$  is appropriation by subject  $i$ , defined for each treatment  $j$ , and  $D_j$  is a vector of dummy variables for each treatment, with Med- $h$  serving as the omitted treatment. Thus, the dummy variables coefficients allow for testing whether there are significant changes in average appropriation for treatments relative to Med- $h$ . The analyses shown were conducted using OLS, clustering on individuals. Tobit analyses, in Appendix B, were also included as a check for robustness. All results reported below are robust to the Tobit analyses.

The OLS results of Model 1 are presented in Table 4, with Table 5 containing a complementary set of Wald tests of paired comparisons.<sup>12</sup> In summary, the results show that the paired tests presented above are robust to this more complete analysis, with stronger significance in relevant differences. In particular, the Model 1 coefficients show a statistical difference at the 1% level between the Med- $h$  and the High- $h$  and the Low- $h$  treatments, with a positive sign for the former and a negative sign for the latter. These findings again support Conjecture 1. Similar results are observed for comparisons between the corresponding treatments with degradation (see Table 5).

(Tables 4 and 5 about here)

Regarding Conjecture 2a, comparisons of Asym-High- $h$  with Asym-Low- $h$  and D-Asym-High- $h$  with D-Asym-Low- $h$  are both significant at the 1% level (Table 5), where the former of each pair of comparisons extracts more (Table 4). In addition, differences relevant for Conjecture 2b between High- $h$  vs. Asym-High- $h$ , D-High- $h$  vs. D-Asym-High- $h$ , and D-Low- $h$  vs. D-Asym-Low- $h$  are not statistically significant, in accordance with the conjecture. The only exception is the difference between Low- $h$  vs. Asym-Low- $h$ , significant at the 10% level, where the symmetric Low- $h$  treatment leads to lower appropriation than the corresponding treatment with asymmetry. In additional analyses relevant for Conjecture 2c (available upon request to the authors), decisions from the high- and low-incentive subjects in Asym- $h$  and in D-Asym- $h$  were pooled. Average appropriation in the asymmetric treatments is higher than in the corresponding baseline treatments (Med- $h$  and D-Med- $h$ ) with differences being significant at

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<sup>12</sup> Notice that treatment comparisons relevant for testing the behavioral conjectures include comparisons with the Med- $h$  condition, but also other pairwise comparisons. For this reason, both Tables 4 and 5 are necessary for examining the full set of relevant comparisons.

the 1% level. Thus, Conjecture 2c, which postulates no difference between symmetric and asymmetric situations, is not supported in Model 1.

Finally, consistent with Conjecture 3, the regression results suggest an overall negative and statistically significant effect on appropriation from the addition of probabilistic degradation (see Tables 4 and 5). For the relevant paired comparisons, the weakest effect, in terms of statistical significance, is for the Med-*h* and D-Med-*h* treatments, which are statistically different at the 10% level. The comparisons between High-*h* and D-High-*h* and Low-*h* and D-Low-*h* are statistically significant at the 1 and 5% level respectively. For the specification where high- and low-incentive subjects in the asymmetric treatments are pooled together (available upon request to the authors), all differences between CPR games and CPR-degradation games are statistically different at the 1% significance level.

#### 4.3. Forecasts and demographics

As one can see from Table 2, the mean forecasts of others' individual appropriation levels (potentially ranging between 0–25) are similar to average individual appropriation levels. However, across all treatments, there is a clear “upward shift” in average per-person forecasts relative to actual appropriation levels.<sup>13</sup> In order to examine the extent to which the forecasts explain variations in appropriation levels across treatments, we constructed the aggregate variable  $F_{ij}$ , the forecast for individual  $i$  of *aggregate* appropriation of *other group members* in treatment  $j$ .<sup>14</sup> For the treatments with asymmetry,  $F_{ij}$  was constructed for low-*h* (high-*h*) subjects aggregating individual forecasts of two high (low) and one low (high) incentive subject. Similar to Fischbacher et al. (2012), we incorporate the forecasts by interacting them with the treatment dummies. Thus, the interaction terms examine to what extent variations in subjects' forecasts within a treatment explain variations in appropriation decisions across subjects within

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<sup>13</sup> When making forecasts, all subjects had one of the copies of the decision sheet with their appropriation choices for each decision situation. Across all treatments, 18.26% of the forecasts of the per-person appropriation of other group members were identical to the decision makers' own decision.

<sup>14</sup> Thus, the potential range for  $F_{ij}$  is 0–75 tokens, not the whole 0–100 range of aggregate group appropriation.

the same treatment. Based on Conjecture 4, we expect subjects' own appropriation decision in each treatment to be positively correlated with their beliefs of others' appropriation levels.

In addition, our analysis includes a dummy variable “G” for gender taking the value 1 for women, and the variable “T” which is a trust variable taking values 1–4, where 4 represents high *disagreement* with the question, “Do you think most people would try to take advantage of you if they got a chance?”.

In summary, we examine the following model:

$$z_{ij} = \alpha_0 + \sum_{j=2}^8 \beta_j D_j + \beta_9 G_i + \beta_{10} T_i + \sum_{j=11}^{18} \beta_j F_{ij} D_j + e_{ij} \quad \text{Model 2}$$

Table 4 presents the results from an OLS analysis, clustering on individuals, with the Med-*h* as the omitted treatment. All interaction coefficients with the variable forecast are positive and significant at the 1% level, supporting Conjecture 4 of a positive correlation between individual appropriation levels and individuals' forecasts of others' appropriation levels for all treatments. Note that because average forecasts range between 31 and 46 tokens, the absolute impact on appropriation decisions is of a relevant size despite the coefficients being relatively small.<sup>15</sup> Thus, consistent with findings in Fischbacher et al. (2012), these results suggest a strong indirect effect from changes in the marginal value of appropriation that arises through changes in subjects' (pessimistic) expectations of appropriation by other group members.

After controlling for the indirect effect, the direct effect of pecuniary changes described for Model 1 is smaller or no longer significant in Model 2 for some treatments (see Tables 4 and 6). More specifically, for most of the symmetric treatments relevant for Conjectures 1 and 3, the primary effect of changing marginal incentives is captured through variations in forecasts of others' behavior. Interestingly, however, in asymmetric settings, the data still support a strong direct effect of the three components of Conjecture 2. In particular, Model 2 yields statistically significant differences in the appropriation decisions of high- and low-incentive subjects in the asymmetric treatments (Asym-High-*h* vs. Asym-Low-*h* at a 1% significance level and D-Asym-High-*h* vs. D-Asym-Low-*h* at a 5% significance level),

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<sup>15</sup> In this setting, a coefficient of 0.33 would imply an increase in appropriation of 1 token for a corresponding increase in the forecasted appropriation of each of the other group members; i.e. 3 tokens in total for others in the group.

supporting a direct effect for Conjecture 2a. Similarly, direct support is found for Conjecture 2b, whereby for the same value of  $h$ , decisions by individuals in the asymmetric treatments equal that observed in the symmetric treatments (Low- $h$  vs. Asym-Low- $h$ , D-High- $h$  vs. D-Asym-High- $h$ , D-Low- $h$  v. D-Asym-Low- $h$ ). The only exception is the 10% significant difference between High- $h$  and Asym-High- $h$ . In addition, further examination of pooled behavior in the asymmetric settings, as described in Conjecture 2c, supports the conclusion of both a direct effect of pecuniary changes and an indirect effect related to variations in forecasts of others' behavior (available upon request to the authors). Thus, somewhat contrary to Fischbacher et al. (2012), the data from this study support an effect of asymmetry per se on subjects' behavior.

(Table 6 about here)

Lastly, our results show some support for the conjecture that those who are more trusting of others will display more cooperative behavior. That is, the subjects showing higher levels of trust appropriate less on average, although, this variable is only significant at a 10% level of confidence. Gender is not statistically significant in explaining variations in appropriation levels.

## 5. Summary and conclusions

This study reports behavior from a linear appropriation game setting where subjects make decisions without feedback from a menu of eight treatments. Across treatments, the marginal benefit from appropriation was systematically varied in both symmetric and asymmetric group settings. In addition, decisions were made in settings where there was certainty over the opportunity costs of conservation, and where there was uncertainty resulting from probabilistic degradation linked to the degree of appropriation. After all decisions were completed, and before receiving any feedback, subjects provided forecasts of others' decisions in each of the decision situations, allowing us to disentangle both a direct effect (pecuniary) and an indirect effect (changes in forecasts of others' behavior) deriving from changes in marginal incentives to appropriate. The decision settings were one-shot games, without feedback. In this

sense, the study examined the effect of pecuniary changes in incentives in a setting that did not allow for opportunities for reputation building or signaling across decisions.

The results show that subjects responded systematically to changes in the marginal incentives to appropriate. The higher (lower) the private marginal incentives, the higher (lower) the *appropriation* levels. Subjects also responded systematically to the probability of resource degradation by lowering appropriations. An examination of economic efficiency across treatments, however, suggests that the decrease in appropriations in the degradation games was not sufficient to offset the loss in expected efficiency due to the probability of degradation.

In addition, we also identify a significant indirect effect linked to changes in subjects' forecasts of the appropriation decisions of others in their group as suggested by Fischbacher et al. (2012) for asymmetric VCMs. In our appropriation games, subjects have higher (lower) expectations of other group members' appropriation when the other group members have higher (lower) marginal incentives to appropriate. Moreover, consistent with models of reciprocity (Croson 2007), the data suggest a strong positive relationship between a subject's appropriation levels and that agent's first order beliefs of other's appropriation. Our results suggest that the increase in appropriation caused by higher private benefits from appropriation is partly due to overly pessimistic beliefs of increases in appropriation by other users. Similarly, overly pessimistic beliefs of others' responses to degradation play a role in subjects not responding sufficiently to degradation probabilities, leading to decreases in expected efficiency. Somewhat contrary to the finding of Fischbacher et al. (2012), in the asymmetric decision settings, changes in marginal benefits of appropriating have a significant direct effect, even after controlling for the indirect effect linked to changes in subjects' expectations of appropriation by others.

The decision settings examined here provide additional evidence on how individuals respond to changes in pecuniary incentives in social dilemma settings; in particular, appropriation settings where subjects make decisions regarding extractions from a shared resource. The results of this study complement a primary finding from the public goods literature, where a decrease (increase) in the MPCr leads to systematic decreases (increases) in contributions to a public good.



These results are relevant for understanding the implications of marginal incentives from appropriation in symmetric and asymmetric groups of users of shared resources when there is common information in a stark institutional setting where users are not capable of building institutions that might facilitate cooperation over time. Gaining an understanding of individual responses to manipulations of the relative value of the resource, and consequently the opportunity cost of conservation, as well as the fragile nature of the resource, is fundamental in designing programs whose intention is to ameliorate inefficiencies and or destruction of common-pool resources. Our findings stress that changes in appropriation can be related to both the opportunity costs of conservation and changes in forecasts of other's appropriation. Consequently, policies that allow for more accurate information regarding appropriation by others, or more complete information regarding the destructive nature of some forms of appropriation, may allow for more cooperation among resource users leading to greater conservation and economic efficiency in use.

**Acknowledgments:** Financial support was provided by the University of Innsbruck. The authors also acknowledge the support of the National Science Foundation (grant number SES-0849551). We are grateful to Paula Andrea Zuluaga and Adriana Beltran for their outstanding assistance, and to Glenn Dutcher, Brock Stoddard and participants in the Experimental Reading Group of the University of Innsbruck for comments on a previous version of this manuscript.

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**Table 1.** Treatment names and parameters

Treatment	Group Fund value: $g$	Private Fund value: $h$	Degradation	Order of presentation
Med- $h$	2	1	No	1
High- $h$	2	1.4	No	2
Low- $h$	2	0.6	No	3
Asym- $h$	2	1.4 or 0.6	No	4
D-Med- $h$	2	1	Yes	5
D-High- $h$	2	1.4	Yes	6
D-Low- $h$	2	0.6	Yes	7
D-Asym- $h$	2	1.4 or 0.6	Yes	8

**Table 2.** Individual-group level appropriation and forecasts

	Average individual appropriation (0–25 tokens)	Average group appropriation (0–100 tokens)	Efficiency (0–100%)	Forecast of individual appropriation (0–25 tokens)	Forecast of group appropriation of three other group members (0–75 tokens)
Med- $h$	11.27 (8.71)	45.09 (17.83)	54.91%	13.00 (6.75)	39.02 (20.25)
High- $h$	14.07 (8.96)	56.28 (21.34)	43.72%	15.28 (6.94)	45.83 (20.81)
Low- $h$	9.44 (8.95)	37.75 (16.39)	62.25%	10.38 (6.49)	31.14 (19.46)
Asym- $h$	12.21 (8.91)	48.84 (18.19)	54.74%		38.47 (18.66)
	for $h_i = 1.4$ 14.45 (8.44)			for $h_k = 1.4$ 15.15 (7.26)	
	for $h_i = 0.6$ 9.97 (8.86)			for $h_k = 0.6$ 10.57 (6.88)	
D-Med- $h$	9.80 (8.31)	39.22 (18.46)	36.94%	11.31 (6.55)	33.93 (19.66)
D-High- $h$	12.03 (8.59)	48.13 (17.93)	10.26%	13.16 (6.67)	39.47 (20.00)
D-Low- $h$	7.86 (8.29)	31.44 (16.83)	53.16%	9.76 (6.81)	29.27 (20.42)
D-Asym- $h$	10.81 (8.46)	43.25 (16.31)	35.15%		34.83 (19.31)
	for $h_i = 1.4$ 12.66 (8.11)			for $h_k = 1.4$ 13.27 (6.92)	
	for $h_i = 0.6$ 8.97 (8.46)			for $h_k = 0.6$ 9.67 (7.04)	

Standard deviations in parentheses

Group appropriation is based on groups formed randomly at the beginning of the experiment. Group composition is the same for all treatments

Appropriation “if  $h_i$ ” is the value of appropriation for the specified value of marginal benefit of appropriation for subject  $i$ . Forecast “if  $h_k$ ” is the value of forecast by individual  $i$  of appropriation behavior of individual  $k \neq i$  playing under the specified value of  $h$

**Table 3.** Paired tests of equality on mean individual decisions: nonparametric Z and t-tests

Individual decisions	Med- <i>h</i>	High- <i>h</i>	Low- <i>h</i>	Asym-High- <i>h</i>	Asym-Low- <i>h</i>	D-Med- <i>h</i>	D-High- <i>h</i>	D-Low- <i>h</i>	D-Asym-High- <i>h</i>
Med- <i>h</i>	-----								
High- <i>h</i>	<b>t= -2.53</b> <b>(0.012)</b> <b>z=-2.51</b> <b>(0.012)</b>	-----							
Low- <i>h</i>	<b>t=1.66</b> <b>(0.098)</b> <b>z= 1.81</b> <b>(0.071)</b>	t= 4.14 (0.000) z= 4.09 (0.000)	-----						
Asym-High- <i>h</i>	t= -2.41 (0.017) z=-2.43 (0.015)	<b>t= -0.28</b> <b>(0.776)</b> <b>z=-0.29</b> <b>(0.774)</b>	t=-3.73 (0.000) z=-3.79 (0.000)	-----					
Asym-Low- <i>h</i>	t= 0.97 (0.332) z= 1.01 (0.314)	t=3.000 (0.003) z=2.30 (0.003)	<b>t= -0.39</b> <b>(0.698)</b> <b>z=-0.47</b> <b>(0.639)</b>	<b>t=2.93</b> <b>(0.004)</b> <b>z= 2.97</b> <b>(0.003)</b>	-----				
D-Med- <i>h</i>	<b>t= 1.38</b> <b>(0.169)</b> <b>z=1.35</b> <b>(0.177)</b>	t= 3.95 (0.000) z= 3.79 (0.000)	t=-0.34 (0.734) z=-0.58 (0.560)	t= 3.63 (0.000) z= 3.54 (0.000)	t= 0.13 (0.900) z= 0.04 (0.970)	-----			
D-High- <i>h</i>	t= -0.70 (0.484 ) z=-0.72 (0.470)	<b>t=1.86</b> <b>(0.064)</b> <b>z= 1.86</b> <b>(0.062)</b>	t= -2.37 (0.019) z=-2.57 (0.010)	t=1.85 (0.066) z= 1.87 (0.061)	t=-1.55 (0.122) z=-1.61 (0.107)	<b>t= -2.11</b> <b>(0.036)</b> <b>z= -2.10</b> <b>(0.036)</b>	-----		
D-Low- <i>h</i>	t= 3.21 (0.001 ) z= 3.26 (0.001)	t= 5.75 (0.000) z= 5.52 (0.000)	<b>t= 1.46</b> <b>(0.145 )</b> <b>z= 1.39</b> <b>(0.165)</b>	t=5.16 (0.000) z= 4.97 (0.000)	t= 1.62 (0.106) z= 1.66 (0.096)	<b>t= 1.87</b> <b>(0.062)</b> <b>z= 2.07</b> <b>(0.039)</b>	t= 3.95 (0.000) z= 4.05 (0.000)	-----	
D-Asym-High- <i>h</i>	t= -1.06 (0.290) z= -1.12 (0.265)	t= 1.06 (0.289) z= 1.25 (0.210)	t=-2.42 (0.016) z=-2.71 (0.007)	t=1.23 (0.222) z= 1.36 (0.173)	t= -1.79 (0.076) z=-1.85 (0.065)	t=-2.26 (0.025) z= -2.38 (0.018)	<b>t= -0.48</b> <b>(0.629)</b> <b>z= -0.48</b> <b>(0.629)</b>	t= -3.80 (0.000) z= -3.94 (0.000)	-----
D-Asym-Low- <i>h</i>	t= 1.74 (0.083) z= 1.76 (0.079)	t= 3.79 (0.000) z= 3.68 (0.000)	t= 0.35 (0.728) z= 0.25 (0.803)	t= 3.67 (0.000) z= 3.58 (0.000)	t=0.65 (0.515) z= 0.65 (0.515)	t= 0.65 (0.514) z= 0.71 (0.479)	t= 2.34 (0.020) z= 2.37 (0.018)	<b>t= -0.87</b> <b>(0.387)</b> <b>z= -0.90</b> <b>(0.367)</b>	<b>t= 2.52</b> <b>(0.013)</b> <b>z= 2.60</b> <b>(0.009)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures

**Table 4.** OLS: dependent variable—individual appropriation

	Model 1		Model 2	
Intercept	11.27***	(0.77)	2.83	(1.87)
High- <i>h</i>	<b>2.80***</b>	<b>(0.57)</b>	<b>2.82**</b>	<b>(1.35)</b>
Low- <i>h</i>	<b>- 1.84***</b>	<b>(0.60)</b>	<b>-0.32</b>	<b>(1.24)</b>
Asym-High- <i>h</i>	3.18***	(0.94)	7.00***	(2.11)
Asym-Low- <i>h</i>	- 1.30	(0.97)	-1.00	(1.62)
D-Med- <i>h</i>	<b>- 1.47*</b>	<b>(0.75)</b>	<b>0.72</b>	<b>(1.15)</b>
D-High- <i>h</i>	0.76	(0.72)	2.10*	(1.24)
D-Low- <i>h</i>	- 3.41***	(0.82)	0.08	(0.97)
D-Asym-High- <i>h</i>	1.38	(1.03)	4.97***	(1.63)
D-Asym-Low- <i>h</i>	- 2.30**	(1.07)	0.58	(1.54)
Gender			0.51	(0.92)
Trust			-1.18*	(0.63)
F*Med- <i>h</i>			0.29***	(0.02)
F*High- <i>h</i>			0.25***	(0.03)
F*Low- <i>h</i>			0.32***	(0.03)
F*Asym-High- <i>h</i>			0.20***	(0.05)
F*Asym-Low- <i>h</i>			0.28***	(0.04)
F*D-Med- <i>h</i>			0.27***	(0.03)
F*D-High- <i>h</i>			0.26***	(0.03)
F*D-Low- <i>h</i>			0.27***	(0.03)
F*D-Asym-High- <i>h</i>			0.23***	(0.05)
F*D-Asym-Low- <i>h</i>			0.23***	(0.04)
Observations	1,024		1,008	
Clusters	128		126	
Prob. >F	0.000		0.000	
R <sup>2</sup>	0.055		0.435	

Standard errors in parentheses, \* significant at p=0.10, \*\* p=0.05, \*\*\* p=0.001

Med-*h* is the omitted treatment.

Models 2 and 3 have fewer observations than Model 1 due to two subjects not filling all the items in the post-experimental questionnaire. All analysis includes clusters on individual subjects.

Coefficients in bold highlight comparisons relevant to conjectures.

**Table 5.** Wald t-tests for paired-treatments—Model 1

<b>Individual decisions</b>	High- <i>h</i>	Low- <i>h</i>	Asym-High- <i>h</i>	Asym-Low- <i>h</i>	D-Med- <i>h</i>	D-High- <i>h</i>	D-Low- <i>h</i>	D-Asym-High- <i>h</i>
High- <i>h</i>	-----							
Low- <i>h</i>	35.53 (0.000)	-----						
Asym-High- <i>h</i>	<b>0.17</b> <b>(0.678)</b>	22.25 (0.000)	-----					
Asym-Low- <i>h</i>	15.48 (0.000)	<b>0.37</b> <b>(0.054)</b>	<b>8.58</b> <b>(0.004)</b>	-----				
D-Med- <i>h</i>	31.39 (0.000)	0.21 (0.648)	17.25 (0.000)	0.03 (0.872)	-----			
D-High- <i>h</i>	<b>9.70</b> <b>(0.002)</b>	8.94 (0.003)	5.27 (0.023)	3.29 (0.072)	<b>18.67</b> <b>(0.000)</b>	-----		
D-Low- <i>h</i>	46.89 (0.000)	<b>5.42</b> <b>(0.021)</b>	30.10 (0.000)	4.24 (0.042)	<b>12.60</b> <b>(0.001)</b>	31.81 (0.000)	-----	
D-Asym-High- <i>h</i>	1.87 (0.174)	7.82 (0.006)	3.60 (0.060)	3.20 (0.076)	9.95 (0.002)	<b>0.51</b> <b>(0.476)</b>	22.34 (0.000)	-----
D-Asym-Low- <i>h</i>	22.74 (0.000)	0.21 (0.644)	13.45 (0.000)	1.35 (0.225)	0.87 (0.351)	9.00 (0.003)	<b>1.40</b> <b>(0.238)</b>	<b>6.32</b> <b>(0.013)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures



**Table 6.** Wald t-tests for paired-treatments—Model 2

<b>Individual decisions</b>	High- <i>h</i>	Low- <i>h</i>	Asym-High- <i>h</i>	Asym-Low- <i>h</i>	D-Med- <i>h</i>	D-High- <i>h</i>	D-Low- <i>h</i>	D-Asym-High- <i>h</i>
High- <i>h</i>	-----							
Low- <i>h</i>	2.82 (0.095)	-----						
Asym-High- <i>h</i>	<b>3.64</b> <b>(0.059)</b>	11.81 (0.001)	-----					
Asym-Low- <i>h</i>	3.63 (0.059)	<b>0.17</b> <b>(0.680)</b>	<b>11.09</b> <b>(0.001)</b>	-----				
D-Med- <i>h</i>	1.37 (0.244)	0.73 (0.394)	8.55 (0.004)	1.61 (0.207)	-----			
D-High- <i>h</i>	<b>0.16</b> <b>(0.685)</b>	2.64 (0.107)	5.78 (0.018)	3.36 (0.069)	<b>1.31</b> <b>(0.254)</b>	-----		
D-Low- <i>h</i>	2.70 (0.103)	<b>0.13</b> <b>(0.717)</b>	10.32 (0.002)	0.64 (0.424)	<b>0.58</b> <b>(0.449)</b>	2.82 (0.096)	-----	
D-Asym-High- <i>h</i>	1.29 (0.258)	7.16 (0.008)	1.29 (0.259)	7.37 (0.008)	5.18 (0.025)	<b>2.66</b> <b>(0.105)</b>	7.79 (0.006)	-----
D-Asym-Low- <i>h</i>	1.19 (0.278)	0.27 (0.603)	7.00 (0.009)	0.94 (0.335)	0.01 (0.914)	1.15 (0.286)	<b>0.15</b> <b>(0.696)</b>	<b>3.86</b> <b>(0.052)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures

## **Appendix A: Instructions**

### **WELCOME**

The instructions which follow describe 8 decision making situations (1 to 8). Please read the instructions carefully, as your decisions and the decisions of others in the experiment will affect your final earnings.

### **No Talking Allowed**

Now that the experiment has begun, we ask that you do not talk. If you have a question after reading the instructions, please raise your hand and the monitor will approach you and answer your question in private.

After being seated a packet with instructions will be distributed to each person. In your packet you will find your **participant number**. Your number is your private information; do not display it to other participants.

### **Experiment Instructions**

In this experiment, you will make choices in 8 independent decision situations. After the experiment is over, we will **randomly pick only one of the 8 decision situations for computing your cash earnings**.

- You will receive specific instructions for each decision situation.
- Before making decisions for each decision situation, you will answer a short quiz designed to check your understanding of the decision situations. After all participants finish each quiz the monitor will provide the solutions in public and answer questions privately.
- At any point during decision-making, you will have the opportunity to review and (if you wish) change any of the choices that you have already made. After all participants have had time to finalize their decisions, the monitor will announce the end of the experiment, after which no one will be allowed to change their decisions.
- After all decisions are final, the monitor will **randomly pick one of the 8 decision situations** for computing earnings. The draw will be made by picking a card out of a shuffled deck of cards numbered from 1 to 8. The drawing will be made in public, at the front of the room.

- Groups of 4 persons have been randomly created based on participant numbers.
- Your cash earnings will depend on your decisions and the decisions of the other three participants with whom you are grouped.
- Your decisions and earnings are your private information. These decisions will be recorded only by your participant number and **not** your name. You will be informed of the decisions of the other participants for your group only for the decision situation chosen for computing earnings.  
However, you will **not know** the identities (names or numbers) of the participants who made those decisions.
- All decision situations are described in Experimental Currency Units (ECUs). At the end of the experiment you will be paid in cash at a rate of **600 pesos** for every ECU you earn.
- In addition to your earnings from the experiment, you will receive a “show-up” payment equal to 5000 pesos.
- You are free to leave at any point during the experiment, however if you decide to leave before the end of the experiment you will not be paid.
- If you agree to participate you will need to sign a consent form.
- At the end of the experiment, while we are calculating your earnings, you will be asked to **complete a short questionnaire.**
- The experiment will last approximately 2 hours.

*You are participant \_\_\_\_\_ for all decision situations.*

## DECISION SITUATION 1

In today's experiment, you will have an *Individual Fund* and your group of four will have a *Group Fund*.

**STARTING BALANCES:** Each **group of four** begins with 100 tokens placed in their initial *Group Fund*. Each token in the initial *Group Fund* is worth **2 ECUs**. Thus, each group begins with an initial *Group Fund* worth **200 ECUs**. Each **person** begins with 0 tokens placed in his/her initial *Individual Fund*.

**DECISION TASK:** Each person will decide privately whether or not to move tokens from the initial *Group Fund* to his/her own *Individual Fund*.

Each person can move up to a maximum of 25 tokens from the initial *Group Fund* to his/her own *Individual Fund*. Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **1 ECU**. However, each token moved from the initial *Group Fund* reduces the value of the final *Group Fund* by 2 ECUs for his/her group. That is, the value of the final *Group Fund* is the result of subtracting from the initial *Group Fund* the sum of tokens removed by each participant in your group. Each person's decision must be in whole tokens (0,1,2,3,4,5,..., 20, 21, 22, 23, 24 or 25).

**EARNINGS:** In each group of four, an individual's earnings will be the sum of the value of that person's *Individual Fund* plus a fourth ( $\frac{1}{4}$ ) of the value of the final *Group Fund*; meaning each subject gets a return of 0.5 ECUs from each token in the final *Group Fund*.

Three examples to illustrate **individual earnings**:

- If a person moves 0 tokens from the initial *Group Fund*, that increases the value of his/her own *Individual Fund* by 0 ECUs and reduces the resulting value of the final *Group Fund* by 0 ECUs (0 tokens moved x 2 ECUs per token moved).
- If a person moves 10 tokens from the initial *Group Fund*, that increases the value of his/her own *Individual Fund* by 10 ECUs and reduces the resulting value of the final *Group Fund* by 20 ECUs (10 tokens moved x 2 ECUs per token moved).

- If a person moves 25 tokens from the initial *Group Fund*, that increases the value of his/her own *Individual Fund* by 25 ECUs and reduces the resulting value of the final *Group Fund* by 50 ECUs (25 tokens moved x 2 ECUs per token moved).

Three additional examples to illustrate **group earnings**:

- If a group moves 0 tokens from the initial *Group Fund*, that yields a final *Group Fund* with a value of 200 ECUs (200 ECUs minus 0 tokens moved x 2 ECUs per token moved).
- If a group moves 50 tokens from the initial *Group Fund*, that yields a final *Group Fund* with a value of 100 ECUs (200 ECUs minus 50 tokens moved x 2 ECUs per token moved).
- If a group moves 100 tokens from the initial *Group Fund*, that yields a final *Group Fund* with a value of 0 ECUs (200 ECUs minus 100 tokens moved x 2 ECUs per token moved).

**Quiz 1:**

- 1.1. In Decision Situation 1, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.
- 1.2. In Decision Situation 1, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.
- 1.3. In Decision Situation 1, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs.

## DECISION SITUATION 2

Decision Situation 2 is the same as Decision Situation 1, except for the following change: Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **1.4 ECU**.

### Quiz 2:

- 2.1. In Decision Situation 2, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.
- 2.2. In Decision Situation 2, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.
- 2.3. In Decision Situation 2, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs.

## DECISION SITUATION 3

Decision Situation 3 is the same as Decision Situation 1, except for the following change: Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **0.6 ECU**.

### Quiz 3:

- 3.1. In Decision Situation 3, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.
- 3.2. In Decision Situation 3, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.
- 3.3. In Decision Situation 3, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs.

## DECISION SITUATION 4

Decision Situation 4 is the same as Decision Situation 1, except for the following change: Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund*. For two

members of each group, tokens moved to the *Individual Fund* have a value of **0.6 ECUs**. For the other two members of each group, tokens moved to the *Individual Fund* have a value of **1.4 ECUs**.

**You will receive \_\_\_\_ ECUs for each token you move to your *Individual Fund*.**

#### **Quiz 4:**

4.1. In Decision Situation 4, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.

4.2. In Decision Situation 4, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.

4.3. In Decision Situation 4, group members have different values for tokens moved to their *Individual Fund*. For you and one other group member the value is \_\_\_\_ ECUs. For the other two group members the value is \_\_\_\_ ECUs.

4.4. In Decision Situation 4, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs.

#### **DECISION SITUATION 5**

Decision Situation 5 is the same as Decision Situation 1, except for the following change:

**For each token removed from the initial *Group Fund* by a member of your four person group there is a 1% chance that the value of the final *Group Fund* is reduced by one-half.**

##### **Two examples:**

- If 20 tokens were removed from the initial *Group Fund*, this would mean there is a 20% chance that the value of the final *Group Fund* will be 80 ECUs ( $\frac{1}{2}$  of 200 ECUs minus 20 tokens removed  $\times$  2 ECUs per token moved) and a 80% chance that the value of the final *Group Fund* remains at 160 ECUs (200 ECUs minus 20 tokens removed  $\times$  2 ECUs per token moved).
- If 60 tokens were removed from the initial *Group Fund*, this would mean there is a 60% chance that the value of the final *Group Fund* will be 40 ( $\frac{1}{2}$  of 200 ECUs minus 60 tokens removed  $\times$  2

ECUs per token moved) and a 40% chance that the value of the final *Group Fund* remains at 80 ECUs (200 ECUs minus 60 tokens removed x 2 ECUs per token moved).

Otherwise, all other aspects are the same as in Decision Situation 1. Thus, each token that you remove from the initial *Group Fund* increases the value of your *Individual Fund* by 1 ECU and reduces the value of the *Group Fund* by 2 ECUs.

After all decisions are made, **if Decision 5 is randomly drawn for determining cash earnings**, the following procedure will be followed.

- A deck of cards numbered 1-100 will be displayed and shuffled. One card will be drawn from the deck of cards by the monitor. The drawing will be made in public, at the front of the room.
- **For each group of four, if the card drawn is less than or equal to the number of tokens removed from the initial *Group Fund*, the value of the final *Group Fund* will be reduced by half ( $\frac{1}{2}$ ) of its ending value. If the card drawn is greater than the number of tokens removed from the initial *Group Fund*, then the value of the final *Group Fund* will not be reduced.**

**EARNINGS:** In each group of four, an individual's earnings will be the sum of the value of that person's *Individual Fund* plus a fourth ( $\frac{1}{4}$ ) of the value of the final *Group Fund* for his/her group; meaning each subject gets a return of 0.5 ECUs from each token in the final *Group Fund*.

**Three examples to illustrate group earnings:**

- If a group moves 0 tokens from the initial *Group Fund*, that yields a final *Group Fund* of value 200 ECUs. In this case we will not draw a card from the deck of cards. The value of the final *Group Fund* will remain at 200 ECUs.
- If a group moves 60 tokens from the initial *Group Fund*, that yields a final *Group Fund* with a value of 80 ECUs (200 ECUs minus 60 tokens moved x 2 ECUs per token moved). In this case,



we will draw one card from the deck of cards. **If the card drawn is less than or equal to 60** (number of tokens removed), the value of the final *Group Fund* will be reduced to 40 ECUs ( $\frac{1}{2}$  of its ending value, ( $\frac{1}{2}$  of 80 ECUs). **If the card drawn is greater than 60**, then the value of the final *Group Fund* will remain at 80 ECUs.

- If a group moves 100 tokens from the initial *Group Fund*, that yields a final *Group Fund* with a value of 0 ECUs (200 ECUs minus 100 tokens moved  $\times$  2 ECUs per token moved). In this case, we will not draw a card from the deck of cards. The value of the final *Group Fund* will remain at 0 ECUs.

### Quiz 5:

5.1. In Decision Situation 5 the starting value of your *Individual Fund* is \_\_\_\_ ECUs.

5.2. In Decision Situation 5, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.

5.3. In Decision Situation 5, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs. In addition, each token a group member removes from the initial *Group Fund* increases the chances that the final *Group Fund* will lose  $\frac{1}{2}$  of its value by \_\_\_\_ %.

## DECISION SITUATION 6

Decision Situation 6 is the same as Decision Situation 5, except for the following change: Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **1.4** ECUs.

**Remember: For each token removed from the initial *Group Fund* by a member of your four person group there is a 1% chance that the value of the final *Group Fund* is reduced by one-half.**

### Quiz 6:

6.1 In Decision Situation 6, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.

6.2. In Decision Situation 6, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.

6.3. In Decision Situation 6, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs. In addition, each token a group member removes from the initial *Group Fund* increases the chances that the final *Group Fund* will lose  $\frac{1}{2}$  of its value by \_\_\_\_ %.

## DECISION SITUATION 7

Decision Situation 7 is the same as Decision Situation 5, except for the following change: Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **0.6** ECUs.

**Remember: For each token removed from the initial *Group Fund* by a member of your four person group there is a 1% chance that the value of the final *Group Fund* is reduced by one-half.**

### Quiz 7:

7.1 In Decision Situation 7, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.

7.2. In Decision Situation 7, the starting value of the initial *Group Fund* is \_\_\_\_ ECUs.

7.3. In Decision Situation 7, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs. In addition, each token a group member removes from the initial *Group Fund* increases the chances that the final *Group Fund* will lose  $\frac{1}{2}$  of its value by \_\_\_\_ %.

## DECISION SITUATION 8

Decision Situation 8 is the same as Decision Situation 5, except for the following change: Each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund*. For two members of each group, tokens moved to the *Individual Fund* have a value of **0.6 ECUs**. For the other two members of each group, tokens moved to the *Individual Fund* have a value of **1.4 ECUs**.

**You will receive \_\_\_\_ ECUs for each token you move to your *Individual Fund*.**

**Remember: For each token removed from the initial *Group Fund* by a member of four person group there is a 1% chance that the value of the final *Group Fund* is reduced by one-half.**

### Quiz 8:

8.1. In Decision Situation 8, the starting value of your *Individual Fund* is \_\_\_\_ ECUs.

8.2. In Decision Situation 8, the starting value of the *Group Fund* is \_\_\_\_ ECUs.

8.3. In Decision Situation 8, group members have different values for tokens moved to their *Individual Fund*. For you and one other group member the value is \_\_\_\_ ECUs. For the other two group members the value is \_\_\_\_ ECUs.

8.4. In Decision Situation 8, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ ECUs and reduces the value of the final *Group Fund* by \_\_\_\_ ECUs. In addition, each token a group member removes from the initial *Group Fund* increases the chances that the final *Group Fund* will lose  $\frac{1}{2}$  of its value by \_\_\_\_ %.

## BONUS QUESTION

In this section, you will be asked to forecast (for each decision setting) the per person **average number of tokens** (not including your decision) moved from the *Group Fund* to the *Individual Fund* (a number between 0 and 25). If you want, your forecast may include up to two decimals. In addition to your earnings from **one** of the 8 decision making situations, we will pay you an extra bonus depending on how close your forecast is to the actual average number of tokens moved to the Individual Fund by members of your group.

Your bonus earnings will be determined in the following way: If your forecast of the per person **average number of tokens** moved from the *Group Fund* to the *Individual Fund* (for the chosen decision situation) is equal to or not more than 1 token away from the actual average, you will earn an additional 8,000 pesos. If your forecast is more than 1 token away from the average you will earn 3,000 pesos divided by the (absolute) distance between your forecast and the actual average moved from the *Group Fund*.

Decision Situations	Per person average number of tokens moved by the other 3 members of your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (a number between 0 and 25)	
Decision 1	Per Person Average number of tokens moved in your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision)	_____
Decision 2	Per Person Average number of tokens moved in your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision)	_____
Decision 3	Per Person Average number of tokens moved in your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision)	_____
Decision 4	a) Per Person Average number of tokens moved from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision) by members of your group having an Individual Fund value of 0.6 UME b) Per Person Average number of tokens moved from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision) by members of your group having an Individual Fund value of 1.4 UME	_____ _____
Decision 5	Per Person Average number of tokens moved in your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision)	_____
Decision 6	Per Person Average number of tokens moved in your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision)	_____
Decision 7	Per Person Average number of tokens moved in your group from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision)	_____
Decision 8	a) Per Person Average number of tokens moved from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision) by members of your group having an Individual Fund value of 0.6 UME b) Per Person Average number of tokens moved from the <i>Group Fund</i> to the <i>Individual Fund</i> (not including your decision) by members of your group having an Individual Fund value of 1.4 UME	_____ _____

## Appendix B: Models and Wald-tests with Tobit Analysis

**Table B2.** Tobit: dependent variable—individual appropriation

	Model T1		Model T2	
Intercept	10.93***	(1.107)	-1.87	(2.895)
High- <i>h</i>	<b>4.19***</b>	<b>(0.826)</b>	<b>5.54***</b>	<b>(2.141)</b>
Low- <i>h</i>	<b>-2.99***</b>	<b>(0.914)</b>	<b>-1.45</b>	<b>(2.449)</b>
Asym-High- <i>h</i>	4.99***	(1.425)	11.99***	(3.164)
Asym-Low- <i>h</i>	-1.87	(1.362)	-0.36	(2.994)
D-Med- <i>h</i>	<b>-2.20*</b>	<b>(1.137)</b>	<b>1.10</b>	<b>(2.125)</b>
D-High- <i>h</i>	1.38	(1.034)	4.78**	(2.094)
D-Low- <i>h</i>	-5.16***	(1.276)	-1.30	(1.937)
D-Asym-High- <i>h</i>	2.03	(1.357)	9.57***	(2.314)
D-Asym-Low- <i>h</i>	-3.53**	(1.614)	1.08	(2.797)
Gender			0.94	(1.322)
Trust			-1.60*	(0.897)
F*Med- <i>h</i>			0.42***	(0.044)
F*High- <i>h</i>			0.33***	(0.046)
F*Low- <i>h</i>			0.48***	(0.054)
F*Asym-High- <i>h</i>			0.24***	(0.068)
F*Asym-Low- <i>h</i>			0.39***	(0.068)
F*D-Med- <i>h</i>			0.39***	(0.049)
F*D-High- <i>h</i>			0.33***	(0.047)
F*D-Low- <i>h</i>			0.44***	(0.054)
F*D-Asym-High- <i>h</i>			0.26***	(0.062)
F*D-Asym-Low- <i>h</i>			0.33***	(0.072)
Observations	1,024		1,008	
Clusters	128		126	
Prob. >F	0.0000		0.0000	
Pseudo R <sup>2</sup>	0.0105		0.0953	

Standard errors in parentheses, \* significant at p=0.10, \*\* p=0.05, \*\*\* p=0.001

Med-*h* is the omitted treatment.

Model 2 has fewer observations due to two subjects not completing relevant items in the post-experimental questionnaire.

Coefficients in bold highlight comparisons relevant to conjectures.

**Table B3.** Wald t-tests for paired-treatments—Tobit model 1

<b>Individual decisions</b>	High- <i>h</i>	Low- <i>h</i>	Asym-High- <i>h</i>	Asym-Low- <i>h</i>	D-Med- <i>h</i>	D-High- <i>h</i>	D-Low- <i>h</i>	D-Asym-High- <i>h</i>
High- <i>h</i>	-----							
Low- <i>h</i>	37.73 (0.000)	-----						
Asym-High- <i>h</i>	<b>0.36</b> <b>(0.549)</b>	24.75 (0.000)	-----					
Asym-Low- <i>h</i>	17.46 (0.000)	<b>0.74</b> <b>(0.390)</b>	<b>9.79</b> <b>(0.002)</b>	-----				
D-Med- <i>h</i>	30.41 (0.000)	0.43 (0.513)	17.78 (0.000)	0.05 (0.819)	-----			
D-High- <i>h</i>	<b>8.90</b> <b>(0.002)</b>	11.38 (0.000)	5.23 (0.022)	4.21 (0.041)	<b>20.52</b> <b>(0.000)</b>	-----		
D-Low- <i>h</i>	42.22 (0.000)	<b>4.14</b> <b>(0.042)</b>	29.50 (0.000)	4.66 (0.031)	<b>12.60</b> <b>(0.000)</b>	31.84 (0.000)	-----	
D-Asym-High- <i>h</i>	2.35 (0.125)	10.42 (0.001)	4.39 (0.036)	3.77 (0.053)	12.46 (0.000)	<b>0.31</b> <b>(0.577)</b>	25.33 (0.000)	-----
D-Asym-Low- <i>h</i>	22.66 (0.000)	0.13 (0.723)	14.68 (0.000 )	1.65 (0.200)	1.06 (0.304)	10.85 (0.001)	<b>1.42</b> <b>(0.234)</b>	<b>7.47</b> <b>(0.006)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures

**Table B4.** Wald t-tests for paired-treatments—Tobit model 2

<b>Individual decisions</b>	High- <i>h</i>	Low- <i>h</i>	Asym-High- <i>h</i>	Asym-Low- <i>h</i>	D-Med- <i>h</i>	D-High- <i>h</i>	D-Low- <i>h</i>	D-Asym-High- <i>h</i>
High- <i>h</i>	-----							
Low- <i>h</i>	5.39 (0.020)	-----						
Asym-High- <i>h</i>	<b>4.72</b> <b>(0.030)</b>	15.41 (0.000)	-----					
Asym-Low- <i>h</i>	3.55 (0.060)	<b>0.11</b> <b>(0.744)</b>	<b>10.46</b> <b>(0.001)</b>	-----				
D-Med- <i>h</i>	2.71 (0.100)	1.13 (0.289)	11.40 (0.000)	0.34 (0.558)	-----			
D-High- <i>h</i>	<b>0.10</b> <b>(0.751)</b>	5.25 (0.022)	6.24 (0.013)	2.85 (0.091)	<b>2.84</b> <b>(0.092)</b>	-----		
D-Low- <i>h</i>	7.14 (0.008)	<b>0.00</b> <b>(0.947)</b>	15.72 (0.000)	0.12 (0.729)	<b>2.29</b> <b>(0.130)</b>	7.71 (0.006)	-----	
D-Asym-High- <i>h</i>	2.69 (0.101)	13.31 (0.000)	1.04 (0.309)	8.32 (0.004)	10.10 (0.002)	<b>4.04</b> <b>(0.045)</b>	17.57 (0.000)	-----
D-Asym-Low- <i>h</i>	1.96 (0.162)	0.61 (0.436)	8.23 (0.004)	0.23 (0.630)	0.00 (0.994)	2.14 (0.144)	<b>0.98</b> <b>(0.323)</b>	<b>6.04</b> <b>(0.014)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures

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Esther Blanco, Maria Claudia Lopez, James M. Walker

Appropriation in the commons: variations in the opportunity costs of conservation

**Abstract**

This study examines individual and group behavior in a linear appropriation game setting. Subjects make decisions from a menu of eight games, without feedback. Four treatment conditions vary the magnitude of the opportunity cost of conservation, including symmetric and asymmetric treatments. A parallel set of four treatments implement the same parameter variations in a setting where probabilistic degradation of the commons is linked to group appropriation. Thus, this setting introduces uncertainty in the value of the opportunity cost of appropriation. In summary, subjects respond systematically to changes in the marginal incentives and to the possibility of degradation. These responses are shown to be related to a direct effect of changes in marginal monetary incentives and to an indirect effect associated with changes in subjects' first order beliefs of the appropriation decisions of others.

ISSN 1993-4378 (Print)

ISSN 1993-6885 (Online)