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## Tensions Between the Resource Damage and the Private Benefits of Appropriation in the Commons

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# **Tensions Between the Resource Damage and the Private Benefits of Appropriation in the Commons**

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## **ABSTRACT**

This study examines appropriation decisions in a linear appropriation game setting with variations in the resource damage from appropriation and simultaneous variations in the resource damage and the opportunity cost of conservation, where the ratio of these two variables is held constant. In symmetric and asymmetric group contexts, subjects make decisions without feedback from a menu of seven decision situations. In summary, individual appropriation levels are found to be inversely correlated with the ratio of marginal resource damage from appropriation to the marginal private benefit of appropriation and no significant differences are observed in individual appropriation levels across treatments where this ratio is equal. Moreover, among subjects facing the same marginal incentives, no significant differences are found between decisions of subjects in symmetric and asymmetric groups. Finally, using forecasts of others' appropriation decisions; we find evidence of both a direct effect from changes in marginal monetary incentives and an indirect effect associated with changes in subjects' first order beliefs of the appropriation decisions of others. These findings are consistent with previous evidence for public goods games supporting the relevance of the marginal per-capita return and conditional reciprocity in explaining variations in cooperation levels.

Keywords: common-pool resources; asymmetry; resource damage; private benefits; laboratory experiments.

Classification-JEL: D7; D3; C90.

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## **I. Introduction**

Previous literature has provided extensive field and experimental evidence on the usage and management of common pool resources. This research has been instrumental in understanding under what conditions communities of users can develop institutions that facilitate cooperation in resource use (Agrawal 2001; Anderies 2011; Baland and Platteau 1996; Ostrom 1990; Ostrom et al. 1999; Wade 1988). This prior research highlights the importance for understanding the role of variations in contextual variables and alternative institutional arrangements for sustainable collective action in CPR settings. Pertinent to this study, the prior research points to the possibility of significant differences in the level of negative externalities associated with appropriation or resource use, varying from very small externalities that may not significantly alter the resource to large externalities that destroy the productive capacity of the resource. The magnitude of these externalities depends on the physical nature of the resource, the form and levels of appropriation or use. Fisheries offer a good example. Depending on appropriation levels or technologies, fishery populations may suffer little harm in some fisheries, while in other situations the fisheries are appropriated to near extinction (SOFIA 2012, Tierney 2000). Of course, there are situations where different users of a single CPR vary in the level of damage resulting from their appropriation. For example, successful self-governance of CPRs can be threatened by the introduction of commercial users who generally receive higher monetary benefits from appropriation, and utilize appropriation technologies that can lead to greater resource damage. One example includes large fishing trawlers in the national waters of developing countries, who have contracted for appropriation rights through bilateral agreements (New York Times, 2008; The Guardian, 2012).<sup>1</sup> Such agreements have the unintended consequence of creating asymmetries among users in resource degradation and appropriation benefits, in particular among commercial users and local users who use technologies that often lead to smaller resource damage. This example illustrates how variations in the form of resource use, including

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<sup>1</sup> The interested reader can find information on the US bilateral fishing agreements is the link <http://www.state.gov/e/oes/ocns/fish/bilateral/index.htm> and that for EU in the link [http://ec.europa.eu/fisheries/cfp/international/agreements/index\\_en.htm](http://ec.europa.eu/fisheries/cfp/international/agreements/index_en.htm)

differences in appropriation technologies, leads to asymmetric damage to the resource and asymmetric benefits to users.

In most cases, appropriation from common pool resources confronts users with a tension between the private benefits received from units appropriated and the negative externality imposed on others from appropriation. Understanding how resource users respond to variations in resource damage and private benefits from appropriation, as well as asymmetries across users, has important behavioral implications for the long term sustainability and efficiency in use of the commons. Unlike the experimental literature on public goods provision, the literature on the study of appropriation in CPR settings has focused significantly less on how decision makers respond to such variations in incentives and asymmetries across users. The central question we address in this study is to what extent users of CPRs incorporate in their appropriation decisions the magnitude of negative externalities created by their appropriation and its interaction with the private benefits, holding constant appropriation capacity across users. Clearly, the potential to destroy rents is most prevalent when these externalities increase. Ultimately, the question is whether appropriation levels are dampened by the magnitude of the externality and the extent to which efficiency in use of the resource is affected.

The decision setting for this study extends the linear appropriation game developed in Cox et al (2012). In an earlier study, hereafter BLW, Blanco, Lopez, and Walker (2012) examined behavior in this same game across treatments where the marginal benefit of appropriation from the commons varied in both symmetric and asymmetric treatments. BLW found that lower marginal private benefits of appropriation systematically led to lower levels of appropriation and increases in economic efficiency.

Parameter changes in this study focus primarily on the effect of variations in the resource damage from appropriation. Manipulations include a set of treatments where the degree of resource damage is varied, keeping all other parameter values constant and a second set of treatments where the resource damage and the private benefit change simultaneously so that their ratio remains constant. Both set of treatments include symmetric and asymmetric decision situations. Thus, particular focus is placed on how the relative magnitude of these two marginal effects impacts appropriation decisions. This approach is

closely related to the emphasis in the voluntary public goods literature (VCM games) on the ratio of marginal benefits from provision of the public good to marginal private opportunity costs of making contributions to the public good (MPCR). The MPCR has been shown to systematically impact the efficiency in provision of public goods (see for example, Isaac et al 1994, Ledyard 1995, and Brandts and Schram 2001). Similarly, several studies in the public goods literature address the influence of *asymmetric* manipulations of the MPCR. In summary, these studies find support for either no effect on average contributions (Fisher et al 1995) or a "poisoning of the well", where average cooperation for asymmetric groups is lower than in symmetric groups (Bagnoli and McKee 1991; Chan et al 1999; Fischbacher et al 2012; Fisher and Schatzberg 1988; Tan 2008).

The game setting examined in this study complements the CPR decision environments discussed by Ostrom et al. (1994) and used extensively thereafter (see a review in Ostrom 2006). In the decision environment studied here, users of the CPR make appropriation decisions, gaining private value from units appropriated, as well as value from units remaining 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 which yields positive value to group members, such as ecosystem services (e.g. esthetics or ecosystem resilience). Thus, appropriation induces damage of the resource that affects all group members by reducing the final value of the shared resource.

Arguably, in many field settings, including the examples provided above, users of CPRs often lack detailed information regarding the resource damage caused by individual user's appropriation, as well as private benefits derived from appropriation. For experimental control, however, we examine situations where resource damage and private benefits from appropriation are common information. This greatly simplifies the decision environment and analysis. As in BLW, this aspect of the experimental design is partially motivated by situations where groups of users of CPRs, governments, or NGOs have the ability to adopt policies that provide potential users with information (propaganda) to generate common information of the implications of resource appropriation. Understanding individual responses to

changes in damage created by appropriation and its interaction with group asymmetries provides a foundation for designing programs whose intention is to promote greater efficiency in use of the commons.

## II. The Game Setting

In the appropriation game, groups of  $n$  individuals face allocations decisions between a “Group Fund” and an “Individual Fund.” Each group begins with a Group Fund endowment of  $t$  tokens and each individual begins the game with 0 tokens allocated to their Individual Fund. Individuals simultaneously and privately decide how many tokens to move (appropriate) from the Group Fund to their Individual Fund. Each token left in the Group Fund has a value of  $1/n$  for each group member. Each token an individual appropriates from the Group Fund yields a private benefit increasing the value of his/her Individual Fund by  $PB_i$  and reduces the value of the Group Fund, generating a resource damage of  $RD_i$ . Thus, each token an individual removes from the Group Fund results in a net benefit to that individual of  $(PB_i - RD_i/n)$ . Individuals can withdraw up to a maximum of  $e$  tokens from the Group Fund. The decision situations are parameterized such that if subjects respond only to individual incentives the group outcome is sub-optimal, creating a social dilemma.<sup>2</sup>

In summary, letting  $z_i$  denote the amount individual  $i$  moves from the Group Fund, the payoff to that individual in tokens can be represented as:

$$\pi_i = PB_i \cdot z_i + (t - RD_i \cdot \sum_{i=1}^n z_i)/n \quad z_i \in (0, e)$$

Assuming individuals make decisions based on own income maximization, and this is common information, each individual has a dominant strategy to move  $e$  tokens from the Group Fund. The outcome that maximizes group earnings, however, is for all individuals to move 0 tokens from the Group Fund.

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<sup>2</sup> In the literature on provision of public goods in symmetric VCM games, the marginal per capita return (Isaac, et al, 1994) is defined as the ratio of the individual’s marginal return from the public good relative to the individual’s marginal private cost of contribution to the provision of the public good. In the appropriation game setting of this paper, the corresponding measurement is  $(RD/n)/PB$ .



### ***Game Parameters***

All decision settings included groups of 4, with an initial endowment of 400 tokens in the Group Fund from which each individual could appropriate up to 25 tokens to their Individual Funds. Seven decision-making situations, utilizing independent and combined parameter variations of  $RD_i$  and  $PB_i$  were implemented (see Table 1). The primary motivation behind the changes in the game parameters was to examine the effects on appropriation of: a) the resource damage resulting from individual appropriation ( $RD_i$ ), (b) the ratio of the resource damage to the marginal value of appropriation ( $RD_i/PB_i$ ), and c) asymmetry in  $RD_i$  and the ratio  $RD_i/PB_i$  across group members.

One subset of treatments allows for examining subjects' responses to changes in  $RD_i$  in symmetric and asymmetric settings. In particular, decision situations  $H^{RD-L^{PB}}$ ,  $M^{RD-L^{PB}}$ ,  $L^{RD-L^{PB}}$  hold constant the value of  $PB_i$  at 1 while varying  $RD_i$ , with values of 3.6, 2.4 and 1.2 respectively. Decision situation  $Asy^{RD-L^{PB}}$  creates asymmetries across subjects by parameterizing two subjects with  $RD_i=3.6$  and two subjects with  $RD_i=1.2$  (for an average group  $RD$  of 2.4).

A second subset of treatments allows for examining subjects' responses to changes in both  $RD_i$  and  $PB_i$  holding the ratio of  $RD/PB$  constant at a value of 1.2. Treatments  $H^{RD-H^{PB}}$ ,  $M^{RD-M^{PB}}$  and  $L^{RD-L^{PB}}$  vary both  $RD_i$  and  $PB_i$  whereby higher private benefit from appropriation is associated with higher resource damage to the group. Decision situation  $Asy^{RD-Asy^{PB}}$  is an asymmetric decision situation, where both  $RD_i$  and  $PB_i$  differ across player types, parameterizing two subjects with high resource damage and high private benefits from appropriation ( $RD_i=3.6$  and  $PB_i=3$ ) and two subjects with low resource damage and low private benefit from appropriation ( $RD_i=1.2$  and  $PB_i=1$ ), yielding average group incentives at an intermediate level (average group  $RD$  equals 2.4 and average group  $PB$  equals 2).

Note, based on the parameters chosen, if subjects appropriated to their full capacity, in no decision situation would the Group Fund be reduced to zero (or become negative). This design feature allowed us to hold constant the value of the Group Fund at the social optimum. This implies, however, that at the Nash Equilibrium, where subjects appropriate up to capacity, the remaining value of the Group

Fund varies depending on the value of  $RD_i$ . Consequently, across treatments, total earnings at the Nash equilibrium will vary with  $RD_i$  and  $PB_i$ , but not at the social optimum.<sup>3</sup>

To our knowledge, this is the first study to systematically examine the effect on appropriation decisions from manipulations in the marginal resource damage from appropriation. The asymmetric group parameterizations are related to those found in BLW where asymmetries were created by varying the private benefit of appropriation, and also to the manipulations in Fisher et al (1995) and Fischbacher et al (2012) for public goods games.

The game settings also included a forecasting decision task. After appropriation decisions for all decision situations were finalized, and before receiving feedback on decisions from other group members, forecasts for each decision situation of the average per-person appropriation level of other group members were made. As discussed below, belief elicitation was incentivized following Croson (2007).

### ***Behavioral Conjectures***

The objective of the study is to test several behavioral conjectures regarding the influence of manipulations in  $RD_i$  and  $PB_i$  for symmetric and asymmetric appropriation decision settings. The conjectures presented below are rooted in a single broad behavioral hypothesis organized around the ratio of  $RD_i$  to  $PB_i$ .

**Behavioral Hypothesis:** *Appropriation levels are inversely correlated with the ratio  $RD_i/PB_i$ , and equal across decision situations in which the ratio is held constant.*

The behavioral motivation for this hypothesis results from previous findings in BLW and from extrapolating, to an appropriation setting, previous evidence from VCM games on the relevance of the MPCR as driver of subjects' contribution decisions to a public good. Findings in BLW support the

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<sup>3</sup> In addition, in decision situation  $Asy^{RD}-Asy^{PB}$ , players with  $RD_i=3.6$  and  $PB_i=3$  have earnings at the Nash Equilibrium of 115 tokens, higher than their earnings at the social optimum which equal 100 tokens. However, decision situation  $Asy^{RD}-Asy^{PB}$  remains a social dilemma due to the fact that the combined earnings of the group at the Nash Equilibrium is lower than at the social optimum.

conjecture that reductions in the ratio  $RD_i/PB_i$  induced by increases in the private benefit from appropriation will lead to higher average individual appropriations.

The presentation of results is organized around three behavioral conjectures derived from the behavioral hypothesis:

Conjecture 1: *Ceteris paribus* increasing (lowering) the value of the resource damage results in lower (higher) average levels of appropriation from the Group Fund.

Conjecture 1 is relevant in exploring behavior in symmetric as well as in asymmetric treatments. More specifically, comparisons relevant to this conjecture include treatments  $H^{RD-L^{PB}}$ ,  $M^{RD-L^{PB}}$ ,  $L^{RD-L^{PB}}$  and also the comparison between appropriation decisions of subjects with high and low resource damage in treatment  $Asy^{RD-L^{PB}}$ .

Conjecture 2: Variations in resource damage and private benefits that yield the same ratio of  $RD_i/PB_i$  result in the same average levels of appropriation.

Based on our design, this conjecture is relevant for the analysis of treatment conditions in which the ratio  $RD_i/PB_i$  equals 1.2. Notice that this set of treatments includes symmetric and asymmetric decision situations, situations where the maximum group damage that derives from full-appropriation varies between the decision situations, and situations where the private benefits from appropriation vary across treatments (see Table 1). Despite these differences between decision situations, conjecture 2 predicts that subjects in  $L^{RD-L^{PB}}$ ,  $H^{RD-H^{PB}}$ ,  $M^{RD-M^{PB}}$ , and  $Asy^{RD-Asy^{PB}}$  will appropriate at levels that are not significantly different. A natural implication of conjecture 2 is that, for treatments with the same value of  $PB_i$  and  $RD_i$ , average appropriation by individuals in symmetric treatments will equal that observed in asymmetric treatments. This refers to the comparisons of high- $RD_i$  subjects in  $Asy^{RD-L^{PB}}$  with subjects in  $H^{RD-L^{PB}}$  and for low- $RD_i$  subjects in  $Asy^{RD-L^{PB}}$  and subjects in  $L^{RD-L^{PB}}$ ; as well as the comparisons  $Asy^{RD(1.2)-Asy^{PB(1)}}$  with  $L^{RD-L^{PB}}$  and  $Asy^{PR(1.2)-L^{PB}}$  and of  $Asy^{PR(3.6)-Asy^{PB(3)}}$  with  $H^{RD-H^{PB}}$ .

Similarly, for the same value of marginal incentives, average **group** appropriation in symmetric treatments will equal that of asymmetric treatments. That is, conjecture 2 implies average group behavior

in  $Asy^{RD-L^{PB}}$  (average  $RD=2.4$ ,  $PB=1$ ) will equal that in symmetric  $M^{RD-L^{PB}}$  and average group behavior in  $Asy^{RD-Asy^{PB}}$  (average  $RD=2.4$ , average  $PB=2$ ) will equal that in symmetric  $M^{RD-M^{PB}}$ .

Conjecture 3: There is a positive correlation between individual appropriation levels and individual's forecasts of others' appropriation levels.

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, examining the extent to which appropriation decisions and forecasts of others appropriation are correlated.

### III. The Experimental Decision Setting

The experiment consisted of eight sessions conducted in the spring of 2012, with a total of 124 university students. Individual sessions included from 8 to 20 subjects. 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 decision situations with subject-specific parameters. The initial instructions informed the subjects of the structure of the decision situations. As explained, 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 7, 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 tokens with a conversion rate of US\$0.124 per token<sup>4</sup>. After receiving this information, subjects were asked to read and sign the consent form if they were willing to participate in the experiment.

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<sup>4</sup> Experimental earnings were in Colombian pesos. By the time of the experiment, one US dollar was valued at approximately 1765 Colombian pesos.

Next, the experimenters reviewed instructions for each decision situation. The first decision situation was described as follows. Each group began with a Group Fund of 400 tokens. Each group member began with Individual Fund containing 0 tokens. Each person's decision task was to decide privately and independently whether to move (appropriate) tokens from the Group Fund to his/her own Individual Fund. Each person could move up to a maximum of 25 tokens from the Group Fund to his/her own Individual Fund. Subjects received 1 token ( $PB_i$ ) in their Individual Fund for each token moved from the Group Fund. At the same time, each token appropriated imposed damage to the resource affecting the entire group, reducing the size of the Group Fund by 3.6 tokens ( $RD_i$ ). The size of the final Group Fund equaled the initial Group Fund after accounting for tokens removed by all group members and for the size of the resource damage parameter  $RD_i$ . Each person's decision was in whole tokens (0,1,2,3,4,5,...., 20, 21, 22, 23, 24 or 25). In each group of four, an individual's earnings were the sum of the value of that person's Individual Fund plus an equal share ( $1/4$ ) of the value of the final Group Fund for his/her group. Therefore, each individual incurred only  $1/4$  of the total value of the resource damage imposed to the group when appropriating from the Group Fund. As discussed above, the additional decision situations were identical to decision situation 1 except for the value of the resource damage ( $RD_i$ ) and the value of tokens moved to a group member's Individual Fund ( $PB_i$ ). The instructions for each of the decision situations included a "quiz" for subjects to check their understanding of the decision situations. The answers to the quiz were displayed with a projector, read aloud, and questions 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) and BLW, it was the subjects' choice to determine the order in which he/she made decisions in the seven decision situations. Importantly, the decision for any situation could be revised as long as the experimenter did not announce that the time to make decisions was finalized.

At the end of the experiment all appropriation decisions were finalized and one copy of the decision sheets was collected from each participant. At this point, 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. 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, she earned an additional US\$ 4.5. If the forecast was more than 1 token away from the average she earned US\$ 1.7 divided by the (absolute) distance between the forecast and the actual average group appropriation. For the asymmetric decision situations subjects reported the average per-person appropriation of high incentive subjects and of low incentive subjects separately.<sup>5</sup>

#### **IV. Results**

We begin with an overview of summary statistics for each decision situation and relevant pairwise hypothesis tests based on the specific conjectures presented in section II. This discussion is followed by regression analyses that include all decision situations, as well as investigating behavior related to forecasts and two demographic variables.

##### ***Pairwise Tests Related to Conjectures***

Table 2 presents summary statistics for each of the seven decision situations. Because decisions are one-shot, and there is no feedback between decision situations, the analysis focuses on average individual behavior instead of group behavior. Table 3 provides non-parametric Mann-Whitney tests and

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<sup>5</sup> Average earnings (in US\$) including earnings from the game, the forecast task and show-up fee (2.83) were 13.95 in  $H^{RD-L^{PB}}$ , 14.51 in  $M^{RD-L^{PB}}$ , 15.80 in  $L^{RD-L^{PB}}$ , 14.59 pooling the two asymmetric sub-groups for  $Asy^{RD-L^{PB}}$  (14.30 and 14.88), 15.03 in  $H^{RD-H^{PB}}$ , 15.40 in  $M^{RD-M^{PB}}$ , and 15.25 pooling the two asymmetric sub-groups for  $Asy^{RD-Asy^{PB}}$  (17.27 and 13.23).

t-tests for the average individual pairwise comparisons among all decision situations. The discussion below is organized around conjectures 1 and 2. In addition, Table 2 provides measures of the economic efficiency ( $E_j$ ) in each decision situation, calculated at the group level. For this purpose, efficiency is defined for decision situations  $j=1, \dots, 7$  as:

$$E_j = (P_j - \min P_j) / (\max P_j - \min P_j)$$

where  $P_j$  is the group payoff in decision situation  $j$ ,  $\min P_j$  is the minimum possible payoff in  $j$ , which corresponds to the payoffs at Nash Equilibrium that varies between the different decision situations, and  $\max P_j$  is the maximum possible payoff in  $j$ , the social optimum, that is constant across all decision situations.<sup>6</sup> Notice that for identical appropriation levels, efficiency would vary across decision situations through changes in the payoffs  $P_j$ , as well as the minimum possible payoff in a given decision situation,  $\min P_j$ . In summary, the efficiency measure captures the difference between actual payoffs and minimum payoffs in proportion to the difference between the maximum and the minimum payoffs in a decision situation. An alternative measurement of the effect of appropriation decisions on outcomes is to measure the level of total resource damage resulting from a given level of appropriation by a group ( $RD_i \cdot \sum_{i=1}^n z_i$ ). The average value of this measurement is also shown in Table 2 for each decision situation.

Conjecture 1 implies that, holding constant  $PB_i$ , increasing (lowering) the value of  $RD_i$  will result in lower (higher) average levels of appropriation from the Group Fund. The data provided in Tables 2 and 3 provide strong support for this conjecture. Average appropriation in decision situation  $H^{RD-L^{PB}}$  is 6.8, increasing to 9.62 in  $M^{RD-L^{PB}}$  and further increasing to 14.52 in  $L^{RD-L^{PB}}$ . All pairwise comparisons of average appropriation are statistically significant at the 1% level. Next, consider the implications of Conjecture 1 for asymmetric decision situation  $Asy^{RD-L^{PB}}$ . Average appropriation by high- $RD_i$  subjects is lower than that of the low- $RD_i$  subjects (7.90 and 12.11 respectively), the difference being statistically significant at the 1% level.

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<sup>6</sup> All efficiency calculations derive from average appropriations reported in Table 2.

Conjecture 2 focuses on comparisons between decisions situations where the ratio of  $RD_i$  to  $PB_i$  is held constant. The data provide clear evidence in support of this conjecture. In symmetric decision situations  $L^{RD}-L^{PB}$ ,  $M^{RD}-M^{PB}$ ,  $H^{RD}-H^{PB}$  the ratio of  $RD_i$  to  $PB_i$  is held constant at 1.2. As shown in Table 3, none of the paired comparisons of average appropriation among these decision situations is statistically significant. Non-significant differences are also found for appropriate pairwise comparisons between symmetric and asymmetric decisions situations where the ratio of  $RD_i$  to  $PB_i$  remains constant. The behavior of each of the sub-groups in the asymmetric setting of  $Asy^{RD}-L^{PB}$  is statistically equal to that observed in the corresponding symmetric decision situations with the same value of  $RD_i$ . That is, the average individual behavior in  $H^{RD}-L^{PB}$  is not statistically different from that of high- $RD_i$  subjects in  $Asy^{RD}-L^{PB}$ . The same is true for  $L^{RD}-L^{PB}$  and low- $RD_i$  subjects in  $Asy^{RD}-L^{PB}$ . Similarly, average group behavior in  $Asy^{RD}-L^{PB}$  (average  $RD=2.4$ ,  $PB=1$ ) is not statistically different from that in symmetric  $M^{RD}-L^{PB}$ .<sup>7</sup> Similarly, in decision situation  $Asy^{RD}-Asy^{PB}$ , average individual appropriation by subjects parameterized with high private benefits and high resource damage are not significantly different from subjects parameterized with low private benefits and low resource damage. Moreover, for decision situation  $Asy^{RD}-Asy^{PB}$  average appropriation by subjects with the same parameter values in symmetric and asymmetric groups are not significantly different ( $Asy^{RD}(1.2)-Asy^{PB}(1)$  vs.  $L^{RD}-L^{PB}$  vs  $Asy^{PR}(1.2)-L^{PB}$ ;  $Asy^{PR}(3.6)-Asy^{PB}(3)$  vs.  $H^{RD}-H^{PB}$ ). Similarly, average group behavior for  $Asy^{RD}-Asy^{PB}$  (average  $RD=2.4$ , average  $PB=2$ ) is not significantly different than that in  $M^{RD}-M^{PB}$ .

Additionally, as one can see from the efficiency measures presented in Table 2, there is strong correlation between efficiencies and the ratio of  $RD_i$  to  $PB_i$ . In particular, decision situations with equal ratios of  $RD_i$  to  $PB_i$  have very similar efficiencies, and efficiencies increase from 42% to 62% to 73% as the ratio of  $RD_i$  to  $PB_i$  increases (from  $RD_i$  low to medium to high while maintaining a low  $PB_i$ ). Thus, as the magnitude of marginal resource damage increases, the level of reduction in appropriation is sufficiently large to lead to increases in overall efficiency. This does not imply, however, that total

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<sup>7</sup> Analyses that compare averages across types in the asymmetric decision situations to their symmetric counterparts are available from the authors upon request.



resource damage is decreased as  $RD_i$  increases. Referring to Table 2, with  $RD_i$  values of 1.2, 2.4, 3.6 and a low  $PB_i$ , total resource damage is increasing from 69.70 to 92.35, and to 98.06 respectively. For decision situations where the ratio of  $RD_i$  to  $PB_i$  remains constant (see Table 1) the extent of total resource damage varies substantially, from a minimum of 69.70 for  $L^{RD}-L^{PB}$  to a maximum of 191.23 for  $H^{RD}-H^{PB}$  (see Table 2) despite efficiencies being fairly similar. These two decision situations represent the opposite extremes of resource appropriation contexts in our experimental design. They highlight the fact that alternative measurements of the impact of appropriation can lead to quite different conclusions.

### ***Regression Analyses***

To complement the paired analysis presented in the preceding section, a more comprehensive analysis was conducted by pooling data from all seven decision settings in an OLS analysis and clustering on individuals. More specifically, the following model was examined:

$$z_{ij} = \alpha_1 + \sum_{j=2}^7 \beta_j D_j + e_{ij} \quad \text{Model 1}$$

As defined above,  $z_{ij}$  is appropriation by subject  $i$  in decision situation  $j$ , and  $D_j$  is a vector of dummy variables for each decision setting, with the decision situation  $H^{RD}-L^{PB}$  serving as the omitted condition. The results of examining Model 1 are presented in Table 4, with Table 5 containing a complementary set of Wald tests of paired comparisons.<sup>8</sup> As shown, the OLS results support the conclusions drawn above for paired treatment analyses. Regarding Conjecture 1, decreasing the value of  $RD_i$ , while holding constant the value of  $PB_i$ , leads to statistically significant increases in appropriation (all relevant comparisons significant at the 1%). Additionally, as related to Conjecture 2, in situations where the ratio of  $RD_i$  to  $PB_i$  is held constant, appropriation levels are not statistically different

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<sup>8</sup> Notice that treatment comparisons relevant for testing the behavioral conjectures include comparisons with the  $H^{RD}-L^{PB}$  condition, but also other pairwise comparisons. For this reason, both Tables 4 and 5 are necessary for examining the full set of relevant comparisons. Tobit analyses were also conducted for Models 1 and 2, see Appendix B. All results reported below are robust to the two approaches.

### *Post Experiment Questionnaire*

The evidence reported above shows that subjects respond systematically to changes in monetary incentives. It is an open question, however, whether appropriation decisions are motivated directly by the changes in monetary incentives or, at least for a subset of subjects, by changes in expectations of others' behavior. Evidence from previous social dilemma experiments, in particular those examining public goods settings, suggests that some subjects decisions are conditional on expectation of others' behavior. These expectations may serve as reference points for socially acceptable appropriation when norms of conditional reciprocity are used by subjects for making appropriation decisions. Eliciting subject's forecasts of other's appropriation levels allows us to examine this question for this decision setting.

As shown in Table 2, mean forecasts of other's individual appropriation levels (potentially ranging between 0-25) are similar, but in most cases somewhat higher than actual appropriation levels. In order to examine to what extent variations in forecasts explain variations in appropriation levels across treatment conditions, we constructed the aggregate variable  $F_{ij}$ , the forecast for individual  $i$  of aggregate appropriation of *other group members* in treatment  $j$ . For the decision situation  $Asy^{RD-L^{PB}}$ ,  $F_{ij}$  was constructed for subjects with a low value of  $RD_i$  by aggregating individual forecasts of two high and one low valued subject. For subjects with a high value of  $RD_i$ ,  $F_{ij}$  was constructed by aggregating individual forecasts of two low and one high valued subject. A similar procedure was followed for  $Asy^{RD-Asy^{PB}}$ . Note that the resulting variable can take any value between 0-75. As in BLW and similar to Fischbacher et al (2012), who use the strategy method, the effect of beliefs of others behavior is incorporated by creating dummy variables that interact forecasts in each decision situation with the corresponding treatment dummies. Based on Conjecture 3, subjects' own appropriation decision in each decision situation is expected to be positively correlated with their beliefs of others' appropriation levels.

In addition, the analysis includes a dummy variable "G" for gender, taking the value 1 for females, and the variable "T" which is a trust variable with values of 1 to 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, the following model is examined:

$$z_{ij} = \alpha_1 + \sum_{j=2}^7 \beta_j D_j + \beta_8 G_i + \beta_9 T_i + \sum_{j=10}^{16} \beta_j F_{ij} D_j + e_{ij} \quad \text{Model 2}$$

Table 4 presents the results from an OLS analysis, clustering on individuals, with the  $H^{RD-L^{PB}}$  decision situation as the omitted condition. All interaction coefficients with the variable forecast are positive and significant at the 1% level, supporting conjecture 3 of a positive correlation between individual appropriation levels and individual's forecasts of others' appropriation levels for all decision situations. Note that because average forecasts range between 25 and 45 tokens, the absolute impact on appropriation decisions provides strong support for an argument that subjects' behavior is contingent on expected behavior of others. That is, in this setting, a coefficient of 0.33 implies an increase in appropriation of 1 token for an identical increase in the forecast of other group members' appropriation; i.e. 3 tokens in total for others in the group. Thus, consistent with findings in BLW and Fischbacher et al (2012), these results suggest a strong indirect effect from changes in the marginal values of appropriation from  $RD_i$  and  $PB_i$ , that arises through changes in subjects' expectations of appropriation by other group members. Further, notice that after controlling for the indirect effect linked to forecasts, the coefficients for the direct effect of pecuniary changes are smaller and significance levels are lower in comparison to Model 1, suggesting that an important component of the response of subjects to changes in the monetary incentives related to appropriation are tied to their expectations of other's appropriation.

Lastly, as in BLW, the results show some support for the conjecture that those who are more trusting of others will display more cooperative behavior. That is, subjects showing higher levels of trust appropriate less on average, although the magnitude of this effect is quite small. Also as in BLW, gender is not statistically significant in explaining variations in appropriation levels.

## V. Summary and Conclusions

This study reports behavior from a linear appropriation game, where subjects make decisions in the context of a menu of seven decision situations. The marginal damage from appropriation and the marginal private benefit of appropriation are varied in both symmetric and asymmetric treatments. After all decisions were completed, and before receiving any feedback, subjects provided forecasts of other's decisions in each of the decision situations, allowing for the estimation of both a direct effect (monetary) 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 across decision situations. In this sense, the study examined the effect of changes in incentives, in a setting that did not allow for opportunities for reputation building or signaling across decision rounds.

In summary, on average, subjects respond systematically to changes in the resource damage from appropriation. Individual appropriation levels decrease as the size of the resource damage derived from appropriation increases in *ceteris paribus* conditions. Subjects also consider in their decision-making the tension between the private benefits received from units appropriated and the negative externality imposed on others from appropriation. When changes in resource damage are accompanied by variations in private incentives to appropriate that hold constant the ratio of resource damage to private benefits, no significant differences are observed in average appropriation levels across decision situations. This finding is independent of whether decision situations are symmetric or asymmetric. That is, in asymmetric situation, subjects appear to react primarily to their own marginal incentives and not significantly to the marginal incentives of other group members. In addition, consistent with models of conditional reciprocity (Croson, 2007) there is a strong correlation between subjects' forecasts of other group members' and appropriation decisions. These results are consistent with findings reported in BLW for a linear appropriation game and by Fischbacher et al (2012) for VCMs.

The changes in appropriation levels have quite different "economic" implications, depending on how one chooses to evaluate outcomes. As discussed, subjects facing higher levels of resource damage from appropriation reduce appropriation sufficiently as to increase the economic efficiency of their CPR use. Yet, these decreases in appropriation are not sufficient to negate the effects on total resource damage;

total resource damage increases as marginal resource damage increases. Further, as discussed, for decision situations where the ratio of marginal resource damage to marginal private benefits remains constant, efficiencies are very similar, but total resource damage increases substantially when contrasting the high- damage-high-benefit decision situation with the low-damage-low-benefit decision situation. These two situations highlight the fact that alternative measurements of the impact of appropriation can lead to quite different conclusions.

Furthermore, the results reported in this study are relevant for understanding the implications of marginal monetary incentives from appropriation in symmetric and asymmetric user groups of shared resources. Referring back to the example provided in the introduction, our results related to asymmetric settings may suggest that small scale fishermen in coastal fisheries select their fishing strategy based primarily on their own incentives, disregarding the actions of large trawlers. Further, the results contrasting measures of economic efficiency and total resource damage suggest the need for conservation policies that carefully consider alternative interpretations of outcomes. From one perspective, our results suggest large fishing trawlers that create greater resource damage, but higher marginal monetary benefits, may result in higher levels of economic efficiency in comparison to artisanal fishers. Yet, the implications for long term sustainability of the resource are radically different, as those would be the ones with largest resource degradation.

Of course, our findings are limited to a context in which there is common information and a stark institutional setting that does not allow for collective action that might facilitate cooperative. Gaining an understanding of individual responses to manipulations of the damage caused from appropriation and the relative value of the resource (i.e. the opportunity cost of conservation) is fundamental in designing programs whose intention is to ameliorate inefficiencies in use and or destruction of common-pool resources.

The findings provide strong evidence that, on average, subjects make appropriation decisions that take into consideration the private benefits from appropriation, the size of the external damage they inflict on a shared resource, and forecasts of other users response to changes in such incentives. These

results parallel findings in the public goods literature for decisions where cooperation entails provision decisions instead of appropriation decisions. In this sense, these results add importantly to the broader literature on social dilemmas. Such evidence is necessary for understanding responses to changes in the intensity of tensions between individual benefits and group damages; and the influence of first-order beliefs in mediating such responses.

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Table 1: Decision Setting Names and Parameters

Decision Setting	Damage Value: $RD_i$	Private Benefit Value: $PB_i$	Ratio $RD/PB$	Decision Situation	Related Conjecture
$H^{RD}-L^{PB}$	3.6	1	3.6	1	Conjecture 1
$M^{RD}-L^{PB}$	2.4	1	2.4	2	Conjecture 1
$L^{RD}-L^{PB}$	1.2	1	1.2	3	Conjectures 1&2
$Asy^{RD}-L^{PB}$	3.6 and 1.2	1	2.4 (average)	4	Conjectures 1 & 2
$H^{RD}-H^{PB}$	3.6	3	1.2	5	Conjecture 2
$M^{RD}-M^{PB}$	2.4	2	1.2	6	Conjecture 2
$Asy^{RD}-Asy^{PB}$	3.6 and 1.2	3 and 1	1.2	7	Conjecture 2

$RD_i$  (marginal external damage from appropriation),  $PB_i$  (marginal private benefit from appropriation)

In the setting  $Asy^{RD}-L^{PB}$ , the average ratio of  $RD/PB$  is 3.6 for two subjects and 1.2 for two subjects, yielding an average group  $RD/PD$  of 2.4. Otherwise, in all designs the stated  $RD/PD$  is common for both individuals and groups.

Decision setting number was the order of presentation of the decision situations in the experimental instructions.

Table 2. Individual-Group Level Appropriation and Forecasts

	Ratio <i>RD/PB</i>	Average Individual Appropriation (0-25 tokens)	Average Final Value Group Fund (0-400 tokens)	Efficiency (0-100%)	Average total Resource Damage (initial resource size 400)	Forecast of Individual Appropriation (0-25 tokens)
<b>H<sup>RD</sup>-L<sup>PB</sup></b>	0.9	6.81 (7.99)	301.88 (65.72)	72.76	98.06	8.31 (6.54)
<b>M<sup>RD</sup>-L<sup>PB</sup></b>	0.6	9.62 (8.63)	308.41 (48.16)	61.52	92.35	10.99 (6.70)
<b>L<sup>RD</sup>-L<sup>PB</sup></b>	0.3	14.52 (9.37)	330.32 (25.42)	41.92	69.70	15.14 (7.06)
<b>Asy<sup>RD</sup>-L<sup>PB</sup></b>	0.6	10.01 (9.08) <i>RD</i> = 3.6 7.90 (7.67)  <i>RD</i> = 1.2 12.11 (9.93)	314.03 (43.94)	67.21	85.94	<i>RD</i> =3.6 9.06 (5.91)  <i>RD</i> =1.2 15.03 (6.98)
<b>H<sup>RD</sup>-H<sup>PB</sup></b>	0.3	13.28 (9.18)	208.74 (65.30)	46.88	191.23	14.48 (7.30)
<b>M<sup>RD</sup>-M<sup>PB</sup></b>	0.3	13.73 (9.11)	268.15 (46.97)	45.08	131.81	13.95 (6.95)
<b>Asy<sup>RD</sup>-Asy<sup>PB</sup></b>	0.3	13.49 (9.94) <i>RD<sub>i</sub></i> =3.6, <i>PB<sub>i</sub></i> =3 14.52 (9.38)  <i>RD<sub>i</sub></i> =1.2, <i>PB<sub>i</sub></i> =1 12.47 (10.45)	265.56 (50.56)	43.97	134.47	<i>RD<sub>i</sub></i> =3.6, <i>PB<sub>i</sub></i> =3 13.76 (7.28)  <i>RD<sub>i</sub></i> =1.2, <i>PB<sub>i</sub></i> =1 14.38 (7.23)

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 decision situations.

Table 3: Paired Tests of Equality on Mean Individual Decisions: Non-parametric Z and t-tests

Individual Decisions	$H^{RD} - L^{PB}$	$M^{RD} - L^{PB}$	$L^{RD} - L^{PB}$	$Asy^{RD}(3.6) - L^{PB}$	$Asy^{RD}(1.2) - L^{PB}$	$H^{RD} - H^{PB}$	$M^{RD} - M^{PB}$	$Asy^{RD}(3.6) - Asy^{PB}(3)$
$H^{RD} - L^{PB}$	-----							
$M^{RD} - L^{PB}$	t=-2.66 (0.008) z=-2.74 (0.006)	-----						
$L^{RD} - L^{PB}$	t=-6.97 (0.000) z=-6.24 (0.000)	t=-4.28 (0.00) z=-4.19 (0.000)	-----					
$Asy^{RD}(3.6) - L^{PB}$	t=-0.89 (0.376) z=-1.32 (0.187)	t= 1.33 (0.186) z=1.18 (0.238)	t= 4.81 (0.000) z=4.44 (0.000)	-----				
$Asy^{RD}(1.2) - L^{PB}$	t= -3.92 (0.000) z=-3.46 (0.001)	t= -1.76 (0.079) z=-1.67 (0.095)	t= -1.62 (0.108) z=1.50 (0.133)	t= -2.64 (0.009) z=-2.20 (0.028)	-----			
$H^{RD} - H^{PB}$	t= -5.92 (0.000) z=-5.69 (0.000)	t= -3.24 (0.001) z=-3.33 (0.001)	t= 1.05 (0.296) z=0.93 (0.353)	t= -3.97 (0.000) z=-3.75 (0.000)	t= -0.80 (0.427) z=-0.93 (0.353)	-----		
$M^{RD} - M^{PB}$	t= -6.36 (0.000) z=-6.06 (0.000)	t= -3.65 (0.000) z=-3.69 (0.000)	t= 0.67 (0.506) z=0.70 (0.487)	t= -4.33 (0.000) z=-4.15 (0.000)	t= 1.11 (0.27) z=-1.09 (0.278)	t= -0.39 (0.698) z=-0.28 (0.778)	-----	
$Asy^{RD}(3.6) - Asy^{PB}(3)$	t= -5.84 (0.000) z=-5.32 (0.000)	t= -3.54 (0.001) z=-3.54 (0.000)	t= 0.00 (1.00) z=-0.10 (0.917)	t= -4.30 (0.000) z=-3.97 (0.000)	t= 1.39 (0.168) z=-1.42 (0.156)	t= -0.86 (0.392) z=-0.81 (0.418)	t= -0.55 (0.585) z=-0.65 (0.516)	-----
$Asy^{RD}(1.2) - Asy^{PB}(1)$	t= -4.09 (0.000) z=-3.45 (0.001)	t= -1.97 (0.050) z=-1.82 (0.069)	t= 1.35 (0.178) z=1.20 (0.229)	t= -2.77 (0.006) z=-2.30 (0.021)	t= 0.19 (0.847) z=-0.07 (0.945)	t= 0.54 (0.587) z=0.76 (0.448)	t= 0.85 (0.396) z=0.88 (0.382)	t= 1.15 (0.253) z=1.27 (0.205)

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures.

Table 4. OLS: Dependent Variable - Individual Appropriation

	Model 1	Model 2
<b>Intercept</b>	6.81*** (0.72)	0.58 (0.982)
<b>M<sup>RD</sup>-L<sup>PB</sup></b>	<b>2.81*** (0.45)</b>	<b>0.47 (0.84)</b>
<b>L<sup>RD</sup>-L<sup>PB</sup></b>	<b>7.70*** (0.76)</b>	<b>3.20** (1.541)</b>
<b>Asy<sup>RD</sup>(3.6)-L<sup>PB</sup></b>	<b>1.09 (0.84)</b>	<b>-0.20 (2.789)</b>
<b>Asy<sup>RD</sup>(1.2)-L<sup>PB</sup></b>	5.30*** (1.10)	0.97 (1.555)
<b>H<sup>RD</sup>-H<sup>PB</sup></b>	6.47*** (0.88)	2.88** (1.347)
<b>M<sup>RD</sup>-M<sup>PB</sup></b>	6.92*** (0.79)	3.14** (1.393)
<b>Asy<sup>RD</sup>(3.6)-Asy<sup>PB</sup>(3)</b>	7.70*** (1.28)	0.39 (2.328)
<b>Asy<sup>RD</sup>(1.2)-Asy<sup>PB</sup>(1)</b>	5.65*** (1.14)	0.50 (2.080)
<b>Gender</b>		-0.55 (1.061)
<b>Trust</b>		0.04*** (0.011)
<b>F* H<sup>RD</sup>-L<sup>PB</sup></b>		0.26*** (0.290)
<b>F* M<sup>RD</sup>-L<sup>PB</sup></b>		0.28*** (0.031)
<b>F* L<sup>RD</sup>-L<sup>PB</sup></b>		0.24*** (0.34)
<b>F* Asy<sup>RD</sup>(3.6)-L<sup>PB</sup></b>		0.20*** (0.072)
<b>F* Asy<sup>RD</sup>(1.2)-L<sup>PB</sup></b>		0.32*** (0.043)
<b>F* H<sup>RD</sup>-H<sup>PB</sup></b>		0.23*** (0.33)
<b>F* M<sup>RD</sup>-M<sup>PB</sup></b>		0.24*** (0.032)
<b>F* Asy<sup>RD</sup>(3.6)-Asy<sup>PB</sup>(3)</b>		0.31*** (0.042)
<b>F* Asy<sup>RD</sup>(1.2)-Asy<sup>PB</sup>(1)</b>		0.29*** (0.049)
Observations	868	868
Clusters	124	124
Prob. >F	0.000	0.00
R <sup>2</sup>	0.088	0.394

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

Med-RD is the omitted decision situation.

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

Individual Decisions	$M^{RD}-L^{PB}$	$L^{RD}-L^{PB}$	$Asy^{RD(3.6)}-L^{PB}$	$Asy^{RD(1.2)}-L^{PB}$	$H^{RD}-H^{PB}$	$M^{RD}-M^{PB}$	$Asy^{RD(3.6)}-Asy^{PB(3)}$
$M^{RD}-L^{PB}$	-----						
$L^{RD}-L^{PB}$	<b>61.52</b> <b>(0.000)</b>	-----					
$Asy^{RD(3.6)}-L^{PB}$	3.79 (0.054)	38.78 (0.000)	-----				
$Asy^{RD(1.2)}-L^{PB}$	5.77 (0.018)	<b>5.48</b> <b>(0.021)</b>	<b>6.97</b> <b>(0.009)</b>	-----			
$H^{RD}-H^{PB}$	19.30 (0.000)	<b>1.96</b> <b>(0.016)</b>	26.10 (0.000)	0.84 (0.362)	-----		
$M^{RD}-M^{PB}$	34.87 (0.000)	<b>1.12</b> <b>(0.293)</b>	33.94 (0.000)	1.99 (0.161)	<b>0.61</b> <b>(0.438)</b>	-----	
$Asy^{RD(3.6)}-Asy^{PB(3)}$	<b>16.61</b> <b>(0.001)</b>	<b>0.00</b> <b>(1.000)</b>	27.74 (0.000)	1.92 (0.169)	<b>1.24</b> <b>(0.268)</b>	<b>0.47</b> <b>(0.495)</b>	-----
$Asy^{RD(1.2)}-Asy^{PB(1)}$	6.89 (0.010)	<b>3.11</b> <b>(0.080)</b>	7.68 (0.007)	0.14 (0.713)	<b>0.35</b> <b>(0.556)</b>	<b>1.04</b> <b>(0.310)</b>	<b>1.32</b> <b>(0.253)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures.

Table 6. Wald t-tests for Paired-treatments – Model 2

Individual Decisions	$M^{RD}-L^{PB}$	$L^{RD}-L^{PB}$	$Asy^{RD(3.6)}-L^{PB}$	$Asy^{RD(1.2)}-L^{PB}$	$H^{RD}-H^{PB}$	$M^{RD}-M^{PB}$	$Asy^{RD(3.6)}-Asy^{PB(3)}$
$M^{RD}-L^{PB}$	-----						
$L^{RD}-L^{PB}$	<b>5.05</b> <b>(0.027)</b>	-----					
$Asy^{RD(3.6)}-L^{PB}$	0.01 (0.929)	1.69 (0.197)	-----				
$Asy^{RD(1.2)}-L^{PB}$	0.39 (0.535)	<b>1.29</b> <b>(0.258)</b>	<b>0.12</b> <b>(0.727)</b>	-----			
$H^{RD}-H^{PB}$	4.74 (0.031)	<b>0.03</b> <b>(0.860)</b>	1.35 (0.247)	1.05 (0.308)	-----		
$M^{RD}-M^{PB}$	6.87 (0.001)	<b>0.00</b> <b>(0.971)</b>	1.57 (0.212)	1.54 (0.217)	<b>0.05</b> <b>(0.827)</b>	-----	
$Asy^{RD(3.6)}-Asy^{PB(3)}$	<b>0.00</b> <b>(0.997)</b>	<b>1.42</b> <b>(0.237)</b>	0.00 (0.948)	0.12 (0.739)	<b>1.22</b> <b>(0.271)</b>	<b>1.63</b> <b>(0.204)</b>	-----
$Asy^{RD(1.2)}-Asy^{PB(1)}$	0.05 (0.819)	<b>1.37</b> <b>(0.244)</b>	0.04 (0.841)	0.06 (0.801)	<b>1.22</b> <b>(0.271)</b>	<b>1.64</b> <b>(0.203)</b>	<b>0.02</b> <b>(0.883)</b>

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures.

## Appendix A

### WELCOME

The instructions which follow describe 7 decision making situations (1 to 7). 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 7 independent decision situations. After the experiment is over, we will **randomly pick one of the 7 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.
- After reading the whole set of instructions and after you answer all the quizzes, we will handle the decision sheets to make your decisions.
- 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 7 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 7. 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.
- At the end of the experiment, you will be paid 220 pesos for every token 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 one hour and a half.
- Your earnings will be rounded to the closer 500 pesos. For example, if you earn 11.200 pesos, we will give you 11.000 pesos, if you earn 11.500 pesos we will give you 11.500 pesos and if you earn 11.800 we will give you 12.000 pesos.

*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 BALANCE:** Each **group of four** begins with 400 tokens placed in their initial *Group Fund*. 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 token**. However, each token moved to his/her *Individual Fund* reduces the value of the final *Group Fund* by **3.6 tokens 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 you and the other three participants 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 an equal share ( $\frac{1}{4}$ ) of the value of the final *Group Fund* for his/her group; meaning each subject gets a return of 0.25 tokens from each token in the final *Group Fund*.

See back of page for examples and quiz.

### 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 tokens and reduces the resulting value of the final *Group Fund* by 0 tokens for his/her group (0 tokens moved x 3.6).
- If a person moves 10 tokens from the initial *Group Fund*, that increases the value of his/her own *Individual Fund* by 10 tokens and reduces the resulting value of the final *Group Fund* by 36 tokens for his/her group (10 tokens moved x 3.6).
- If a person moves 25 tokens from the initial *Group Fund*, that increases the value of his/her own *Individual Fund* by 25 tokens and reduces the resulting value of the final *Group Fund* by 90 tokens for his/her group (25 tokens moved x 3.6).

### Three additional examples to illustrate group earnings:

- If a group moves 0 tokens from the initial *Group Fund*, that yields a final *Group Fund* equal to **400 tokens** (400 minus 0 resulting from 0 tokens moved x 3.6).
- If a group moves 50 tokens from the initial *Group Fund*, that yields a final *Group Fund* equal to **220 tokens** (400 minus 180 resulting from 50 tokens moved x 3.6).
- If a group moves 100 tokens from the initial *Group Fund*, that yields a final *Group Fund* equal to **40 tokens** (400 minus 360 resulting from 100 tokens moved x 3.6).

**Quiz 1:**

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

**DECISION SITUATION 2**

Decision Situation 2 is the same as Decision Situation 1, except for the following change: Each token that a person moves to his/her *Individual Fund* reduces the value of the final *Group Fund* by **2.4 tokens**. Recall, each group begins with 400 tokens in their initial *Group Fund*.

As in Decision Situation 1, each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **1 token**.

**Quiz 2:**

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

**DECISION SITUATION 3**

Decision Situation 3 is the same as Decision Situation 1, except for the following change: Each token that a person moves to his/her *Individual Fund* reduces the value of the final *Group Fund* by **1.2 tokens**. Recall, each group begins with 400 tokens in their initial *Group Fund*.

As in Decision Situations 1 and 2, each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **1 token**.

**Quiz 3:**

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



#### DECISION SITUATION 4

Decision Situation 4 is the same as Decision Situation 1, except for the following change: For two members of each group, tokens moved to their *Individual Fund* reduce the value of the final *Group Fund* by **3.6 tokens**. For the other two members of each group, tokens moved to their *Individual Fund* reduce the value of the final *Group Fund* by **1.2 tokens**. Recall, each group begins with 400 tokens in their initial *Group Fund*.

**The tokens you move will decrease the value of the *Group Fund* by \_\_\_\_ tokens.**

As in Decision Situations 1, 2 and 3, each token that a person moves from the initial *Group Fund* increases the value of his/her own *Individual Fund* by **1 token**.

#### Quiz 4:

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

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

4.3. In Decision Situation 4, tokens removed from the *Group Fund* by group members have different impacts on the *Group Fund*.

For you and one other group member, each token moved from the *Group Fund* reduces the value of the final *Group Fund* by \_\_\_\_ tokens.

For the other two group members, each token moved from the *Group Fund* reduces the value of the final *Group Fund* by \_\_\_\_ tokens.

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

#### DECISION SITUATION 5

Decision Situation 5 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 **3 tokens**.

Otherwise, all other aspects are the same as in decision situation 1.

Recall, each group begins with 400 tokens in their initial *Group Fund*.

As in Decision Situation 1, each token that a person moves to his/her *Individual Fund* reduces the value of the final *Group Fund* by **3.6 tokens**.

#### Quiz 5:

2.1. In Decision Situation 5, the starting value of your *Individual Fund* is \_\_\_\_ tokens.

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

2.3. In Decision Situation 5, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ tokens and reduces the value of the final *Group Fund* by \_\_\_\_ tokens.

## DECISION SITUATION 6

Decision Situation 6 is the same as Decision Situation 2, 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 **2 tokens**.

Otherwise, all other aspects are the same as in decision situation 2.

Recall, each group begins with 400 tokens in their initial *Group Fund*.

As in Decision Situation 2, each token that a person moves to his/her *Individual Fund* reduces the value of the final *Group Fund* by **2.4 tokens**.

### Quiz 6:

- 2.1. In Decision Situation 6, the starting value of your *Individual Fund* is \_\_\_\_ tokens.
- 2.2. In Decision Situation 6, the starting value of the initial *Group Fund* is \_\_\_\_ tokens.
- 2.3. In Decision Situation 6, each token you move from the initial *Group Fund* increases the value of your *Individual Fund* by \_\_\_\_ tokens and reduces the value of the final *Group Fund* by \_\_\_\_ tokens.

## DECISION SITUATION 7

Decision Situation 7 is the same as Decision Situation 4 in that tokens removed from the *Group Fund* by group members have different impacts on the *Group Fund*.

Additionally, we introduce the following change: For two members of each group, tokens moved to their *Individual Fund* reduce the value of the final *Group Fund* by **3.6 tokens** and tokens moved to their *Individual Fund* have a value of **3 tokens**.

For the other two members of each group, tokens moved to their *Individual Fund* reduce the value of the final *Group Fund* by **1.2 tokens** and tokens moved to their *Individual Fund* have a value of **1 token**.

Recall, each group begins with 400 tokens in their initial *Group Fund*.

**The tokens you move from the initial *Group Fund* decrease the value of the *Group Fund* by \_\_\_\_ tokens.**

**The tokens you move from the *Group Fund*, increase the value of your *Individual Fund* by \_\_\_\_ tokens.**

### Quiz 7:

- 7.1. In Decision Situation 7, the starting value of your *Individual Fund* is \_\_\_\_ tokens.
- 7.2. In Decision Situation 7, the starting value of the initial *Group Fund* is \_\_\_\_ tokens.
- 7.3. In Decision Situation 7, tokens removed by group members have different impact on the values of the *Group Fund*. For you and one other group member the value is \_\_\_\_ tokens. For the other two group members the value is \_\_\_\_ tokens.
- 7.4. In Decision Situation 7, tokens removed from the *Group Fund* by group members have different impacts on the *Group Fund* and *Individual Funds*.

For you and one other group member, each token you move from the *Group Fund* reduces the value of the final *Group Fund* by \_\_\_\_ tokens and adds \_\_\_\_ tokens to your respective *Individual Fund*.

For the other two group members, each token moved from the *Group Fund* reduces the value of the final *Group Fund* by \_\_\_\_ tokens and adds \_\_\_\_ tokens to each of their respective *Individual Funds*.

## Appendix B

Table B1. Tobit: Dependent Variable - Individual Appropriation

	Model T1	Model T2
<b>Intercept</b>	2.81 (1.91)	-8.48** (3.55)
$M^{RD} - L^{PB}$	<b>4.68** (5.39)</b>	<b>1.55 (0.76)</b>
$L^{RD} - L^{PB}$	<b>12.92** (9.14)</b>	<b>7.68** (2.62)</b>
$Asy^{RD}(3.6) - L^{PB}$	<b>2.42 (1.66)</b>	<b>4.17 (0.86)</b>
$Asy^{RD}(1.2) - L^{PB}$	9.40** (4.90)	3.00 (0.88)
$H^{RD} - H^{PB}$	11.80** (6.80)	8.63** (3.26)
$M^{RD} - M^{PB}$	12.07** (7.62)	9.11** (3.71)
$Asy^{RD}(3.6) - Asy^{PB}(3)$	13.77** (5.61)	2.37 (0.57)
$Asy^{RD}(1.2) - Asy^{PB}(1)$	9.51** (4.91)	1.81 (0.45)
<b>Gender</b>		-0.78 (0.44)
<b>Trust</b>		0.08** (4.08)
$F^* H^{RD} - L^{PB}$		0.46** (8.14)
$F^* M^{RD} - L^{PB}$		0.44** (8.02)
$F^* L^{RD} - L^{PB}$		0.37** (6.29)
$F^* Asy^{RD}(3.6) - L^{PB}$		0.26* (2.26)
$F^* Asy^{RD}(1.2) - L^{PB}$		0.54** (5.72)
$F^* H^{RD} - H^{PB}$		0.34** (6.03)
$F^* M^{RD} - M^{PB}$		0.34** (6.66)
$F^* Asy^{RD}(3.6) - Asy^{PB}(3)$		0.51** (5.53)
$F^* Asy^{RD}(1.2) - Asy^{PB}(1)$		0.48** (4.98)
Observations	868	868
Clusters	124	124
Prob. >F	0.000	0.000
Pseudo R <sup>2</sup>	0.0174	0.0844

Table B2. Wald t-tests for Paired-treatments – Tobit Model 1

Individual Decisions	$M^{RD} - L^{PB}$	$L^{RD} - L^{PB}$	$Asy^{RD(3.6)} - L^{PB}$	$Asy^{RD(1.2)} - L^{PB}$	$H^{RD} - H^{PB}$	$M^{RD} - M^{PB}$	$Asy^{RD(3.6)} - Asy^{PB(3)}$
$M^{RD} - L^{PB}$	-----						
$L^{RD} - L^{PB}$	<b>56.25</b> (0.000)	-----					
$Asy^{RD(3.6)} - L^{PB}$	2.17 (0.141)	33.12 (0.000)	-----				
$Asy^{RD(1.2)} - L^{PB}$	6.93 (0.008)	<b>4.11</b> (0.043)	<b>6.45</b> (0.011)	-----			
$H^{RD} - H^{PB}$	22.10 (0.000)	<b>0.55</b> (0.458)	23.02 (0.000)	1.18 (0.277)	-----		
$M^{RD} - M^{PB}$	32.44 (0.000)	<b>0.44</b> (0.507)	27.68 (0.000)	1.73 (0.189)	<b>0.08</b> (0.778)	-----	
$Asy^{RD(3.6)} - Asy^{PB(3)}$	<b>17.08</b> (0.000)	<b>0.16</b> (0.687)	22.27 (0.000)	2.15 (0.143)	<b>1.11</b> (0.292)	<b>0.76</b> (0.384)	-----
$Asy^{RD(1.2)} - Asy^{PB(1)}$	6.97 (0.009)	<b>2.97</b> (0.085)	6.30 (0.012)	0.00 (0.944)	<b>0.94</b> (0.333)	<b>1.39</b> (0.239)	<b>1.93</b> (0.165)

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures.

Table B3. Wald t-tests for Paired-treatments – Model 2

Individual Decisions	$M^{RD} - L^{PB}$	$L^{RD} - L^{PB}$	$Asy^{RD(3.6)} - L^{PB}$	$Asy^{RD(1.2)} - L^{PB}$	$H^{RD} - H^{PB}$	$M^{RD} - M^{PB}$	$Asy^{RD(3.6)} - Asy^{PB(3)}$
$M^{RD} - L^{PB}$	-----						
$L^{RD} - L^{PB}$	<b>5.38</b> (0.021)	-----					
$Asy^{RD(3.6)} - L^{PB}$	0.29 (0.592)	0.61 (0.435)	-----				
$Asy^{RD(1.2)} - L^{PB}$	0.21 (0.651)	<b>1.61</b> (0.205)	<b>0.04</b> (0.846)	-----			
$H^{RD} - H^{PB}$	8.00 (0.005)	<b>0.10</b> (0.757)	0.95 (0.331)	2.36 (0.125)	-----		
$M^{RD} - M^{PB}$	13.05 (0.000)	<b>0.30</b> (0.582)	1.17 (0.279)	3.30 (0.07)	<b>0.07</b> (0.800)	-----	
$Asy^{RD(3.6)} - Asy^{PB(3)}$	<b>0.04</b> (0.843)	<b>1.27</b> (0.261)	0.08 (0.778)	0.02 (0.900)	<b>1.99</b> (0.589)	<b>2.54</b> (0.111)	-----
$Asy^{RD(1.2)} - Asy^{PB(1)}$	0.01 (0.944)	<b>1.93</b> (0.165)	0.13 (0.719)	0.11 (0.744)	<b>2.69</b> (0.101)	<b>3.56</b> (0.06)	<b>0.01</b> (0.920)

p-values in parentheses

Cells in bold highlight comparisons relevant to conjectures.

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Working Papers in Economics and Statistics

2013-02

Esther Blanco, Maria Claudia Lopez, James M. Walker

Tensions between the resource damage and the private benefits of appropriation in the commons

**Abstract**

This study examines appropriation decisions in a linear appropriation game setting with variations in the resource damage from appropriation and simultaneous variations in the resource damage and the opportunity cost of conservation, where the ratio of these two variables is held constant. In symmetric and asymmetric group contexts, subjects make decisions without feedback from a menu of seven decision situations. In summary, individual appropriation levels are found to be inversely correlated with the ratio of marginal resource damage from appropriation to the marginal private benefit of appropriation and no significant differences are observed in individual appropriation levels across treatments where this ratio is equal. Moreover, among subjects facing the same marginal incentives, no significant differences are found between decisions of subjects in symmetric and asymmetric groups. Finally, using forecasts of others' appropriation decisions; we find evidence of both a direct effect from changes in marginal monetary incentives and an indirect effect associated with changes in subjects' first order beliefs of the appropriation decisions of others. These findings are consistent with previous evidence for public goods games supporting the relevance of the marginal per-capita return and conditional reciprocity in explaining variations in cooperation levels.

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