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C72, C91, C92, D02, H41

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# PEER SANCTIONING IN ISOMORPHIC PROVISION AND APPROPRIATION SOCIAL DILEMMAS

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## 1. Introduction

This study was designed to integrate two strands of experimental literature; the framing of linear public good games, and peer sanctioning mechanisms. Beginning with the seminal article Andreoni (1995), numerous experimentalists have been interested in whether subjects behave differently in settings described as positive frames where subjects' decisions create gains in group welfare or negative frames where subject decisions create losses in group welfare. The specific form used for studying positive and negative frames differs somewhat across studies. The frames studied here are most closely tied to recent work described in J. Cox et al. (2013). In the *provision* game frame subjects' make allocations to a public good provision fund. In the *appropriation* game frame subjects' make withdrawals from a fund that would be used to provide a public good. The literature in experimental economics examining sanctioning mechanisms as institutions for facilitating cooperation is often linked to two studies, Fehr and Gächter (2000) for the case of public good provision and Ostrom et al. (1992) for the case of appropriation from common-pool resources. The version of the sanctioning mechanism we study is most closely linked to that of Gächter et al. (2008).

The motivation for this study was to examine whether subjects use a punishment mechanism differentially in a provision setting versus an appropriation setting and, if so, would that lead to differential effects on efficiency. The theory of reciprocal preferences developed by Cox et al (2008) suggests that this might be the case. The reason is that a public goods game with a punishment mechanism is a sequential game where punishment decisions are taken after contribution decisions are made public. So, if individual preferences are reciprocal, it might be well the case that they change as a result of the contribution decisions. In a setting with inequity-averse individuals (Fehr and Schmidt, 1999), we articulate this change as affecting the parameter representing disadvantageous inequality $\alpha$ (as punishment is typically directed

at low contributors that have larger earnings than high contributors do). As the same contribution behaviour is evaluated as more generous in the giving than in the appropriation frame, we assume that the parameter $\alpha$ takes larger values in the appropriation game than in the giving game. This model has a number of testable predictions that are tested in a lab. The key one is that enforcers will be more prepared to punish, which reinforces the effectiveness of the sanctioning mechanism to overcome the under provision of the public good. Our experimental results show that in the absence of the punishment institution, there is less cooperation in the negative frame of the appropriation game. We also find that peer sanctioning is able to overcome this decrease in cooperation, because low contributors are targeted more often –as suggested by the model- in the negative frame.

The paper is organized as follows. In section 2, we provide a brief overview of the literature that is most relevant to the focus of this study, and present the hypotheses we test. Section 3 provides a description of experimental design and procedures. Section 4 presents results and Section 5 concludes.

## 2. Literature Review and Hypotheses

The results from studies examining the effect of positive versus negative frames in linear public goods, in both one-shot and repeated games, are somewhat mixed, either finding significant decreases in cooperation in the negative frame or no significant differences between the two frames. Andreoni (1995) examined a pair of contribution games, one with a positive frame (tokens invested in the group exchange provide a positive return to each group member) and the other with a negative frame (tokens invested in the individual exchange reduce the earnings of other group members). The result of these experiments were that levels of cooperation were greater in the positive frame. More recently, Khadjavi and Lange (2015) report results from

games described as "give and take" that support Andreoni's finding. Further, when agents can both give and take, their cooperation levels are similar to when they can only give, and above levels observed when they can only take.

Dufwenberg et al. (2011) also examine give versus take games, with the primary conclusion that frames affect first and second order beliefs, and those beliefs of others' choices affect choices. Overall, they find evidence of greater cooperation in the give frame. The authors interpret these results as supportive of theories of guilt aversion and reciprocity. More recently, C. Cox and Stoddard (2015) examine provision and appropriation games under two matching mechanisms (Partners or Strangers) and two levels of information on others' decisions (Aggregate or Individual). They find that the combination of an appropriation frame with information on individual decisions leads to more extreme behaviour, both free-riding and full cooperation, especially in a partners matching protocol. See C. Cox and Stoddard (2015), Table 1, for a survey of other studies examining positive and negative framing. Based on this literature review, we state our first hypothesis.

**Hypothesis 1**: *Cooperation rates are higher in the contribution frame than in the appropriation frame*

The literature on the effect of introducing a peer sanctioning mechanism to a linear public goods setting uniformly supports the conclusion that such a mechanism can increase average overall cooperation. However, once the costs of punishment are taken into account, most studies find that average earnings are not significantly increased. See Gächter et al. (2008) for a review. In addition, Cason and Gangadharan (2015) contrast the effectiveness of the sanctioning mechanism in a linear VCM game with its effectiveness in a non-linear (piece-wise linear) public goods game and in a CPR game. They find that while sanctioning

opportunities increase cooperation in both settings, effectiveness is reduced in non-linear settings, which they attribute to the added complexity of the decision setting.

To our knowledge, no existing study compares the effectiveness of the peer sanctioning institution in environments that are strategically and payoff-equivalent, differing only in relation to whether the subjects' decisions can be interpreted as positive or negative frames games.[1] In this paper, we will use the terms "positive" and "provision" interchangeably when referring to frames; the same applies to "negative" and "appropriation". Relevant to the analysis is the notion of reciprocal preferences developed in Cox et al (2008) applied to two-person extensive games with complete information (as for example, Dictator or Trust games). The essential idea is that the second mover's preferences can depend on a first mover's action; in particular, their axiom R says that more generous choices by a first player (e.g. choices that increase the second mover's maximum possible payoff more than the first mover's possible payoff increase) induces more altruistic preferences by a second mover.

J. Cox et al. (2013) apply axiom R to sequential public good games with a positive (provision game) and negative (appropriation game) framing to prove that if preferences are reciprocal in the sense of Axiom R, then preferences – and therefore actions – by the second mover contributor will differ across framings. The reason is that in the positive frame the initial group fund is the least generous for the second mover, and it becomes gradually more generous by any token contributed by a first mover player; whereas in the negative frame, the initial group fund is the most generous for the second mover, and it becomes gradually less generous by any token appropriated by a first mover. Axiom R implies that the second mover will be more

[1] McCusker and Carnevale (1995) study punishment in repeated provision and appropriation social dilemmas that differ from the setting investigated here. Beyond differences in the structure of the games, subjects interacted with simulated decision makers (both contribution/appropriation and sanctions were pre-programmed). Subjects were told they were facing human decision makers and that *automatic* sanctions would be imposed on the least cooperative 'decision maker'.

altruistic (generous) in the positive frame than in the negative frame, meaning that for the same number of tokens in the group fund after the first mover has played, the second mover will retain more in the individual fund in the appropriation game than in the contribution game.

We can extend the analysis in J. Cox et al. (2013) to cover a public goods game with a sanctioning mechanism. It is a two-stage game with complete information where in the punishment stage, subjects are informed about the decisions by all members in their group. Hence, according to Axiom R, a choice by a group member in the first stage is expected to affect the preferences of the remaining members towards him. The difference in our game is that in the second stage, decisions are not about contributions – as in the original sequential public goods game – but punishment opportunities. In order to make operative the implications of Axiom R in the punishment stage, we will use the standard social preference modelling based on inequity aversion developed by Fehr and Schmidt (1999).

As J. Cox et al. (2013) make clear, reciprocal preferences are fundamentally different from fixed preferences in that other-regarding preferences depend on the prior actions by other players. Social preferences à la Fehr and Schmidt are parametrized by two parameters governing the dislike for disadvantageous inequality (parameter $\alpha$) and advantageous inequality (parameter $\beta$). Because the sources of payoff inequality are the decisions to contribute to the group fund, we formalize the workings of Axiom R through changes in the parameters, specifically through changes in the parameter representing disadvantageous inequality $\alpha$ (as punishment is typically directed at low contributors that have larger earnings than high contributors do). As the same contribution behaviour is evaluated as more generous in the giving than in the appropriation frame, we assume that the parameter $\alpha$ takes larger values in the appropriation game than in the giving game: the same behaviour, considered as

less generous in the negative frame, and hurts more in the negative than in the positive frame. The consequences of Axiom R for punishment behaviour are stated in Proposition 1.

**Proposition 1**. *An inequity averse player with reciprocal preferences (i) will be more prepared to punish in the negative frame than in the positive frame, (ii) although the magnitude of the punishment will not differ across frames. As a consequence, the sanctioning mechanism will successfully increase contributions in the negative frame.*

**Proof**. See Proposition 5 in Fehr and Schmidt (1999).[2]

Proposition 1 is a consequence of Proposition 5 in Fehr and Schmidt (1999). They identify the conditions necessary for the sanctioning mechanism to sustain any symmetric contribution profile to the group fund as a (subgame perfect) equilibrium. It is shown that the more an enforcer cares about disadvantageous inequality, the easier it is to fulfil the requirement for finding it individually rational to punish defectors (condition 13). Therefore, for the same constellation of social preferences in the population, the efficiency of the punishing mechanism will be as high in the appropriation frame as in the provision frame. Also, the optimal punishment comes from a utility maximization problem, that implies that punishment is administered to achieve monetary payoff equalization. Therefore, it is independent from the particular values of the parameters. Proposition 1 leads to the following three hypotheses regarding contribution and punishment behaviour across frames.

**Hypothesis 2**. The sanctioning mechanism will raise contributions in the negative frame.

[2] An alternative is to assume changes in the parameter $\beta$ governing advantageous inequality. In this case, the natural direction of movement would be to a reduction in size: in the appropriation frame, a player would be less sensitive to advantageous inequality, making it harder to fulfil the condition for the existence of enforcers ($a + \beta \geq 1$, where $a$ is the MPCR). If any, the overall effect would be towards the total inability of the punishment mechanism to increase contributions to the public goods in the appropriation game. As we will see later, this is not what it is observed in the data. We have therefore preferred to keep this discussion in this footnote.

**Hypothesis 3**. For the same contribution profile, the probability of being punished in the appropriation game is larger than in the contribution game.

**Hypothesis 4**. For the same contribution profile, punishment magnitude will not differ across frames.

Proposition 5 in Fehr and Schmidt (1999) does not allow us to formally compare the efficiency of the sanctioning mechanism in raising contributions to the public goods across frames, because for both frames, a full range of contributions (from zero to full) can be supported in equilibrium. They however select full contribution using the Pareto efficiency criterion. This criterion also selects full contribution in the negative frame.

**Hypothesis 5**. There will be no differences in contributions when the sanctioning mechanism is in place across frames.

## 3. Experimental Design and Procedures

In all treatments, the base game was a linear social dilemma. Each individual received earnings from two accounts – a private account and a group account. A 2 × 2 design was implemented, crossing the framing of the decision (provision or appropriation) and the availability (or not) of opportunities for sanctioning. Appendix A contains the experimental instructions.

### 3.1 Decision Frame

#### 3.1.1 Provision game

The stage game in the provision frame was the linear Voluntary Contributions Mechanism. Each player $i$ ($i = 1, 2, \ldots, n$) begins each round with $y$ tokens in a private account from which

he/she can allocate $g_i \in \{0, 1, 2, \ldots, y\}$ to a group account (the public good). The balance, $e_i = y - g_i$, remains in the private account and earns a return of 1. Each player in the group receives *aG* from the group account, where $G = \sum_{i=1}^{n} g_i$ is the total contribution to the public good and *a* (*0 < a < 1 < an*) is the MPCR. The payoffs to player *i* are given by

$$\pi_i(g) = (y - g_i) + aG.$$

The Nash equilibrium in the stage game is for each player to contribute zero to the public good ($g_i = 0 \ \forall \ i = 1, 2, \ldots, n$) while the social optimum is for each player to contribute his/her entire endowment to the public good ($g_i^* = y \ \forall \ i = 1, 2, \ldots, n$). The Nash equilibrium and the social optimum remain unchanged under finite repetitions of the stage game.

### 3.1.2 Appropriation game

In the appropriation game each group of *n* players begins with *ny* tokens in the group account and each player *i* (*i* = 1, 2, …, *n*) begins with 0 tokens in his/her private account. Each player can then move $e_i \in \{0, 1, 2, \ldots, y\}$, i.e., up to *y* tokens, from the group account to his/her private account. Thus, each player leaves $g_i = y - e_i$ in the group account. As in the VCM, each player earns a return of 1 from the private account and receives *aG* from the group account where *a* and *G* are as defined above. All other details, including payoff calculations, are the same in both games. In particular, payoffs for individual *i* are given by

$$\pi_i(e) = e_i + aG.$$

The Nash equilibrium and social optimum (respectively, $g_i = 0$ and $g_i^* = y \ \forall \ i = 1, 2, \ldots, n$) are the same as in the provision game.

### 3.2 Punishment

Treatments that allow punishment have two stages. Stage one is the provision (appropriation) game. In the second stage, a player can use his/her earnings from the first stage to reduce the earnings of other players in the group. An earnings reduction of one token imposed on another player costs the punishing player *c* tokens ($0 < c < 1$). In the two stage game with punishment, payoffs for individual *i* are[3]

$$\pi_i(g,p) = (y - g_i) + aG - c\sum_{\substack{j=1 \\ j\neq i}}^{n} p_{ij} - \sum_{\substack{j=1 \\ j\neq i}}^{n} p_{ji}$$

where $p_{kl}$ denotes the punishment player $k$ sends to player $l$, $k \neq l$. The addition of punishment does not change the Nash equilibrium or the social optimum predictions for contributions in either the provision or appropriation game. In addition, based on standard assumption of self-regarding behaviour, punishment is zero in both the Nash equilibrium and the social optimum.

### 3.3 Parameters and Treatments

In the treatments using the provision game, the per-round individual endowment was $y = 20$ tokens. In the treatments using the appropriation game, subjects were limited to appropriating no more than 20 tokens from the group fund. In all treatments $a = 0.5$. Subjects interacted in the same groups of four ($n = 4$) for 30 rounds. There were no subject specific identifiers that might allow for reputation effects to develop. The 30 decision rounds were split into two parts. Part 1, which consisted of 10 rounds, was incorporated to control for inherent differences in group-specific levels of cooperation. Part 2, which consisted of 20 rounds allowed for the inclusion of the sanctioning mechanism in two of the 4 treatment conditions. At the beginning

[3] We state payoffs using the VCM notation – for identical decisions, payoffs are identical in both games.

of a session, subjects were informed that the experiment would consist of two parts, but received details and instructions for Part 2 only upon completion of Part 1. Subjects were publicly informed of the number of decision rounds in each part. In all treatments, at the end of each decision round, players were shown the number of tokens contributed to (appropriated from) the group account by each individual in the group, in descending order. They were also shown their individual earnings from the private account and the group account in that round.

The treatments *Prov* and *Prov-Pun* utilized the provision game, while treatments *App* and *App-Pun* utilized the appropriation game. In the *Prov* and *App* treatments subjects played the game in Part 1 and Part 2 without punishment opportunities. After playing the game for 10 rounds in Part 1, they were told that the game played in Part 2 would be identical to that in Part 1, but for 20 rounds.

In the *Prov-Pun* and *App-Pun* treatments, subjects played the game without punishment opportunities for the 10 rounds of Part 1. In each of the 20 rounds in Part 2, the contribution (appropriation) stage was followed by the punishment stage. A player could assign a maximum of 5 deduction tokens to any other player, i.e., a player could use a maximum of 15 tokens or the earnings from the first stage, whichever was lower, to punish others in the second stage. Each token used to punish another player cost the punishing player 1 token and the recipient 3 tokens (i.e., $c = 1/3$). The costs of assigned and received punishment were then subtracted from the individual's first-stage earnings.[4] At the end of the punishment stage, players were shown the *total* amount of punishment they received and their individual earnings from both stages of the round. They were not informed of who they received punishment from.

[4] The form of the sanctioning used is based on Gächter et al. (2008). Note that players could earn negative amounts in a round but not in the experiment.

Table 1 summarises our four treatments and lists the number of subjects and independent groups in each.

**Table 1. Summary of treatments**

| Treatment | Decision Frame | Punishment Opportunity | | # subjects (groups) |
|---|---|---|---|---|
| | | **Part 1** | **Part 2** | |
| ***Prov*** | Provision | No | No | 44 (11) |
| ***Prov-Pun*** | Provision | No | Yes | 48 (12) |
| ***App*** | Appropriation | No | No | 48 (12) |
| ***App-Pun*** | Appropriation | No | Yes | 48 (12) |

### 3.4 Procedures

All sessions were conducted at the University of East Anglia (UEA) and 188 participants were recruited from the University's student body. In each session, subjects were randomly assigned to groups of four that remained fixed throughout the session (partner matching). To maximise understanding of the games, experimental instructions for the provision treatments were based on the *long* instructions described in Ramalingam et al. (2016). Instructions for the appropriation treatments were based on instructions used in Blanco et al. (2015).[5] At the beginning of each session, the instructions were read aloud by an experimenter and the important elements of the game (such as its repeated nature and fixed matching) were made common information to subjects. Subjects also had printed instructions that they could refer to at any time. Prior to Part 1, subjects had to correctly answer a quiz that tested their understanding of payoff calculations. In the treatments with punishment, subjects had to answer questions before beginning Part 2 as well. At the end of a session, subjects answered a short demographic questionnaire.

[5] Treatment conditions were mixed across time and varied across experimental sessions, but not within a session.

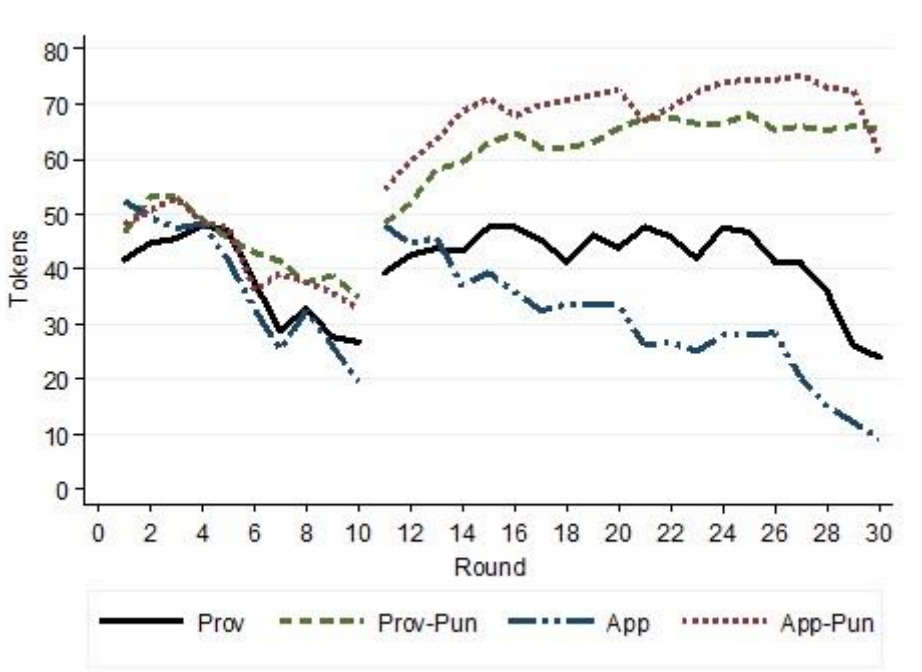
The experiment was programmed in z-Tree (Fischbacher, 2007). Subjects were paid their token earnings from all 30 rounds of the game (with no carry-over between rounds), which were converted to Pounds at the rate of 60 tokens to £1. Each session lasted approximately 60 minutes and subjects earned an average of £17.36 (max = £25.50 and min = £10.80) including a £2 show-up fee.

## 4. Results

We use the terms *contributions* to refer to the amount *allocated to* the group fund in the provision frame and the amount *left in* the group fund in the appropriation frame. We first compare contributions across treatments and then turn to an examination of punishment behaviour in *Prov-Pun* and in *App-Pun*. Finally we turn to comparisons of earnings across treatment conditions. The presentation of results is organized around descriptive statistics, followed by formal hypothesis tests based on regressions with standard errors clustered on independent groups.

We start by discussing behaviour in Part 1, which consisted of 10 rounds, and was incorporated to control for inherent differences in group-specific levels of cooperation. Figure 1 presents mean group contribution over decision rounds.

**Figure 1. Average group contributions to the public good**




As shown, average contributions in the first part start at approximately 50-60% of endowment (40-50 tokens) in both frames and decline over time. The differences are not found to be statistically significant across treatments (Wilcoxon $p > 0.10$ for all pairwise treatment comparisons). A visual analysis of behaviour in individual groups in Part 1 reveals substantial heterogeneity across groups (see Appendix B). As it is plausible that groups that were more successful in Part 1 are more likely to be successful in Part 2, we control for a group's baseline cooperativeness in Part 1 in regressions examining behaviour in Part 2.

### 4.1 Contribution behaviour

Turning to Part 2, as shown in Figure 1, there is a restart effect in all treatments; average contributions begin at 50-60% of endowment (40-50 tokens) in the *Prov* and *App* treatments and at 60-70% (50-55 tokens) in *Prov-Pun* and *App-Pun*. Although average contributions in *Prov* and *App* begin at somewhat similar levels, their paths diverge across decision rounds. Average contributions in *App* are below those in *Prov* in all rounds except the initial few rounds of Part 2. In *Prov*, average group contributions fluctuate between 50-60% of endowment for

rounds 11-25, then steadily decline to about 25% of endowment (20 tokens). In *App*, average group contributions steadily decline from the start to about 12.5% of endowment (10 tokens) by round 30. Table 2 provides overall mean contributions and standard deviations in Part 2.

**Table 2. Mean group contributions to the public good in tokens: Part 2**

| | ***Prov*** | ***Prov-Pun*** | ***App*** | ***App-Pun*** |
|---|---|---|---|---|
| Obs | 11 | 12 | 12 | 12 |
| Mean | 41.93 | 63.13 | 30.09 | 69.16 |
| St. Dev. | 19.52 | 19.34 | 21.93 | 13.99 |

The opportunity to punish one another is associated with an increase in average group contributions. Contributions rise and then stay relatively steady at higher levels in both game settings. In *Prov-Pun*, average contributions increase to about 80% of endowment, while in *App-Pun* they increase to about 90% of endowment. As shown in Figure 1 and Table 2, contributions in both punishment treatments are higher than in the treatments without punishment, with the difference increasing in later decision rounds.

Table 3 reports estimates from group-level panel random effects regressions that test for differences across treatments. The dependent variable is group contribution in a round. The first regression focuses on differences across treatments in the level of contributions, including only treatment dummies as independent variables, with *Prov* as the excluded treatment. The second regression controls for the time dynamics evident in Figure 1, i.e., it examines differences in contributions across treatments *after* accounting for within-group path dependencies in the form of one-period lagged group contributions. In addition, as a control for a group's baseline cooperativeness in Part 1, the regression includes (for each group) the average group contribution across all rounds of Part 1. As shown in Table 3, the lagged contribution variable is significant, while the control for baseline cooperativeness is both small and not significant.

**Table 3. Group-level regressions: Treatment differences in contributions**

| Group contributions | No controls | With controls for past behaviour |
|---|---|---|
| *Prov-Pun* | 21.198*** | 3.804*** |
| | (7.846) | (1.372) |
| *App* | -11.536 | -2.420*** |
| | (8.362) | (0.932) |
| *App-Pun* | 27.235*** | 3.898*** |
| | (6.900) | (1.161) |
| Lagged group contribution | - | 0.899*** |
| | | (0.024) |
| Mean group contribution in Part 1 | - | -0.006 |
| | | (0.016) |
| Constant | 41.927*** | 3.742*** |
| | (5.681) | (0.941) |
| Obs | 940 | 893 |

Dep. variable: Group contribution in a round. Std. errors clustered on independent groups in parentheses. * Sig. at 10%, ** Sig. at 5%, *** Sig. at 1%.

Both regressions provide evidence of lower contributions in *App* than in *Prov*, as Hypothesis 1 states. This difference, however, is only significant after controlling for lagged contribution behaviour.[6]

**Result 1**: *In Part 2, after controlling for lagged group contributions, group contributions are significantly higher in Prov than in App.*

Both regressions (and Wald-tests) provide evidence that contributions in the treatments with punishment are significantly higher than in *Prov* and *App*, as stated in Hypothesis 2. Both regressions also provide evidence that contributions in *App-Pun* are higher than in *Prov-Pun*, although in neither case are the differences statistically significant, as stated in Hypothesis 5.

[6] A one-sided Wilcoxon test that does not control for lagged behaviour and treats average group contribution over all 20 rounds of Part 2 as independent observations finds some evidence ($p = 0.0698$) of a treatment effect.

**Result 2**: *In Part 2, group contributions are higher in treatments with punishment opportunities. Further, contributions are higher in App-Pun than in Prov-Pun, but the difference is not statistically significant.*

We next explore if, and how, *individuals'* contributions react differently to past behaviour – their own and that of others – in the two frames. Table 4 reports individual level panel random effects regressions where the dependent variable is an individual's contribution in a decision round. We report separate regressions for cases where an individual contributed less than the average of the others in the *previous* round (Negative Deviations) and where an individual contributed more than the average, or the same, in the *previous* round (Positive Deviations).

The independent variables include a dummy for the provision frame and round dummies (not reported for brevity). To control for past behaviour, we include the individual's contribution in the previous round relative to other group members. As in Table 3, we include the average group contribution in Part 1. For the treatments with punishment opportunities, the independent variables also include the amount of punishment received by the individual in the previous round and an interaction of this variable with the frame dummy.

**Table 4. Determinants of individual contributions to the public good: Part 2**

| Individual contributions | No Punishment treatments | | Punishment treatments | |
|---|---|---|---|---|
| | Negative deviations | Positive deviations | Negative deviations | Positive deviations |
| Provision frame dummy | 0.512 | 1.587** | -0.632 | 0.138 |
| | (0.424) | (0.679) | (0.998) | (0.182) |
| Lagged contribution | 0.740*** | 0.839*** | 0.793*** | 0.875*** |
| | (0.085) | (0.043) | (0.034) | (0.067) |
| Lagged absolute deviation from average contribution of others | 0.204*** | -0.680*** | 0.422*** | -0.336*** |
| | (0.079) | (0.066) | (0.102) | (0.065) |
| Mean group contribution in Part 1 | 0.046*** | -0.002 | -0.019 | 0.004 |
| | (0.012) | (0.011) | (0.024) | (0.004) |
| Lagged amount of punishment received | - | - | 0.521*** | -0.363*** |
| | | | (0.156) | (0.139) |
| Provision dummy × Lagged punishment received | - | - | -0.118 | 0.287** |
| | | | (0.283) | (0.138) |
| Constant | 0.093 | 0.131 | 3.241* | 0.296 |
| | (1.695) | (0.997) | (1.783) | (1.676) |
| Observations | 714 | 1034 | 399 | 1425 |

Dep. variable: Individual contribution in a round. Std. errors clustered on independent groups in parentheses. Includes round dummies (not reported). * Sig. at 10%, ** Sig. at 5%, *** Sig. at 1%. Deviations were equal to zero in 391 of 1034 observations in the No-Punishment treatments and in 996 of 1425 observations in the Punishment treatments.

Focusing first on the no-punishment treatments, the regressions show the usual pattern of reactions to past behaviour. In particular, current contributions are positively correlated with own past contributions. Further, those who contributed less (more) than the average in the previous round increase (decrease) their contributions in the current round. As before, the control for cooperativeness in Part 1 has little explanatory power. The provision frame dummy is positive and significant for those with positive deviations in the prior decision round, indicating that the source of higher contributions in *Prov* relative to *App* reported in Result 2 is primarily through the behaviour of those subjects who contribute above the group mean.

Turning to the treatments with punishment opportunities, as before, lagged contributions and lagged deviations from the average contributions of the others are significant predictors of contributions in the current round. In particular, lagged contributions are positively correlated with current contributions and lagged deviations are negatively correlated with current contributions. Unlike in the treatments without punishment, the provision frame dummy is not statistically significant in either regression – as stated in Hypothesis 5, indicating that there is no significant difference in contribution *levels* between the two frames after accounting for path dependencies and sanctioning across decision rounds.

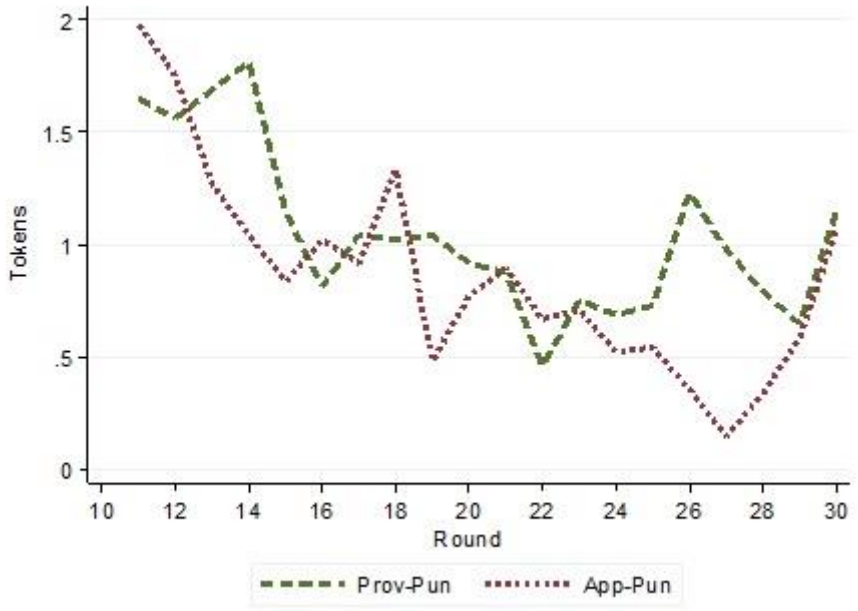
In both punishment treatments, individuals with negative (positive) deviations increase (decrease) contributions after being punished. Note, however, in the case of positive deviations, the interaction between the provision frame dummy and the amount of punishment received is positive and significant, indicating that individuals in *Prov-Pun* reduce their contributions by a smaller amount in response to 'anti-social' punishment.

**Result 3**: *Low (high) contributors increase (reduce) their contributions in response to receiving anti-social punishment in both games. However, high contributors reduce their contributions by a smaller amount in Prov-Pun relative to App-Pun.*

### 4.2 Punishment behaviour

Use of punishment can be characterized by the amount of, and targeting of, punishment. Figure 2 presents the average amount of punishment used by groups over time in the two frames. The aggregate amount and pattern of punishment used is very similar between the two frames. The average per-round punishment used was 1.05 tokens (s.d. = 1.41) in *Prov-Pun* and 0.56 tokens (s.d. = 0.69) in *App-Pun*.

**Figure 2. Average group punishment**




To explore the differences between the uses of punishment in the two frames, Table 5 provides results from individual-level regressions designed to examine the probability of being punished (Probit) and the magnitude of punishment received (Panel random effects) across the two frames. Both sets of regressions include separate estimates for observations that are negative (positive) deviations from the average contribution of the others in the *current* round, the round in which punishment occurs. The independent variables are the same in the Probit and the RE regressions. They include a dummy for the provision frame, an individual's (absolute) deviation from the average contribution of the others in the group in the current round, an interaction between the above two variables, a control for average group cooperativeness in Part 1 (as discussed earlier) and round dummies (not reported).

**Table 5. Determinants of punishment received**

| | Probability of receiving punishment (Probit) | | Amount of punishment received (Panel RE) | |
|---|---|---|---|---|
| Individual punishment received | Negative deviations | Positive deviations | Negative deviations | Positive deviations |
| Provision frame dummy | -0.186 | 0.502 | -0.231 | 0.358 |
| | (0.553) | (0.335) | (0.730) | (0.394) |
| Absolute deviation from average contribution of others | 0.252*** | 0.123*** | 0.328*** | 0.004 |
| | (0.048) | (0.044) | (0.072) | (0.032) |
| Provision dummy × absolute deviation | -0.173*** | -0.051 | -0.010 | -0.041 |
| | (0.054) | (0.059) | (0.093) | (0.037) |
| Mean group contribution in Part 1 | 0.005 | 0.002 | -0.001 | 0.001 |
| | (0.019) | (0.009) | (0.019) | (0.007) |
| Constant | -0.134 | -1.427** | 0.966 | 0.711 |
| | (0.883) | (0.602) | (0.886) | (0.543) |
| Observations | 412 | 1508 | 412 | 1508 |

Dep variable for probit = 1 if received positive punishment in a round and = 0 otherwise. Dep variable for RE = amount of punishment received in a round. Std. errors clustered on independent groups in parentheses. Includes round dummies (not reported). * Sig. at 10%, ** Sig. at 5%, *** Sig. at 1%.

As expected, the likelihood of receiving punishment and the amount of punishment received increase with the negative deviation of an individual's contribution.[7] In regard to the effects of framing, based on the provision frame dummy, there is no significant difference between the two frames in both probability and level of punishment. This is so for both negative and positive deviations from the average contributions of the others in the group. However, for negative deviations, the interaction between the frame dummy and absolute deviations is negative and significant, as predicted by Hypothesis 3, suggesting that the decision to punish low contributors is less sensitive to the size of the negative deviation in the provision frame than in

[7] The likelihood is also increasing in the size of the non-negative deviation. Such 'anti-social' punishment is likely associated with "blind" revenge (see Ostrom et al., 1992 and Hermann et al., 2008). However, the amount of punishment received is not significantly influenced by the size of the non-negative deviation.

the appropriation frame. However, this interaction term is not statistically significant in the panel regressions for level of punishment received, as predicted by Hypothesis 4.

**Result 4**: *In both frames, low contributors are more likely to be punished and receive a higher level of punishment the lower their contributions are relative to the average contribution of others. The likelihood of receiving punishment, however, is less sensitive to the magnitude of the negative deviation in Prov-Pun than in App-Pun.*

### 4.3 Earnings comparisons

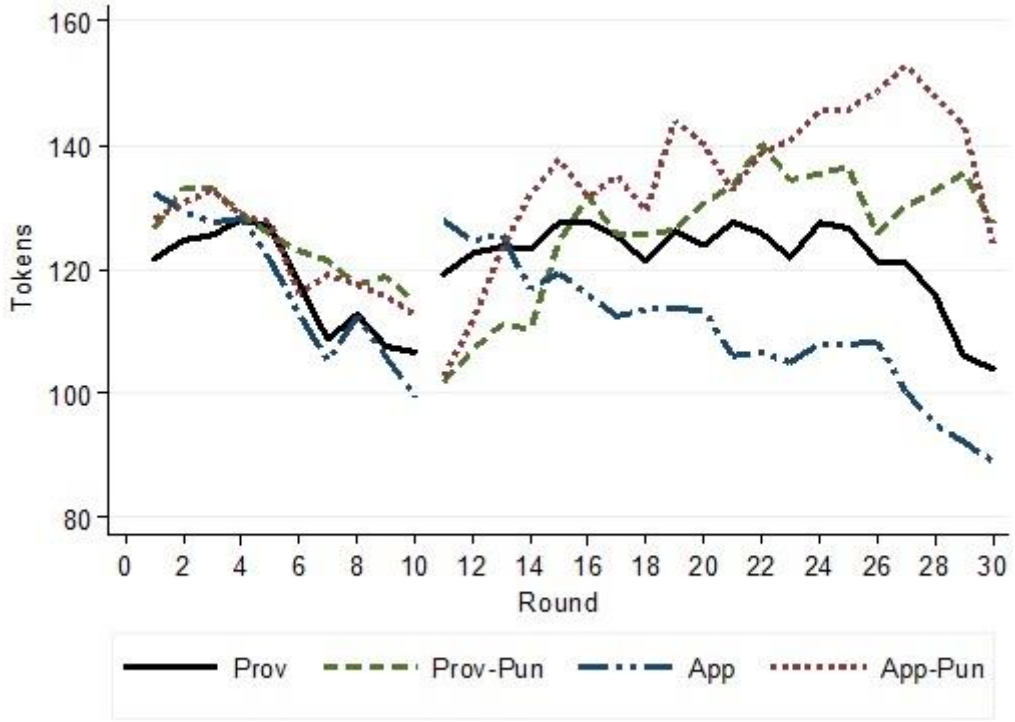
Figure 3 presents the path of average group earnings over time in all treatments in Part 2.[8] Summary statistics of group earnings are presented in Table 6.

**Table 6. Mean group earnings: Part 2**

| | ***Prov*** | ***Prov-Pun*** | ***App*** | ***App-Pun*** |
|---|---|---|---|---|
| Obs | 11 | 12 | 12 | 12 |
| Mean | 121.93 | 126.34 | 110.09 | 135.39 |
| St. Dev. | 19.52 | 30.29 | 21.93 | 23.37 |

[8] Earnings in *Prov* and *App* are simply a linear transformation of contributions and thus follow the same time pattern as contributions.

**Figure 3. Average group earnings**




Since group contributions are greater in *Prov* than *App*, so are average earnings. As shown, earnings in the punishment treatments, which incorporate the costs of punishment, begin lower than in the corresponding treatments without punishment. After round 5, however, earnings in *Prov-Pun* are above those in *Prov* and earnings in *App-Pun* are above those in *App*. Further, average earnings are higher in *App-Pun* than in *Prov-Pun.*

A group-level regression that controls for past behaviour (as in Table 3) was also conducted. As expected, earnings are significantly lower in *App* than in *Prov* ($p = 0.036$).[9] The regression and Wald tests also show that earnings in *Prov-Pun* are not significantly different than in *Prov* ($p = 0.235$), but earnings in *App-Pun* are significantly higher than in *App* ($p = 0.0005$).[10]

[9] For brevity, the group-level regressions are not reported. They are available upon request.
[10] Earnings in *Prov-Pun* are higher than in *App* ($p = 0.0145$) and earnings in *App-Pun* are higher than in *Prov* ($p = 0.021$).

**Result 5**: *Relative to the no-punishment conditions, punishment significantly raises average group earnings in the appropriation frame but not in the provision frame.*

Based on Result 5, we compare the *gains* in contributions and earnings that result from the introduction of punishment relative to their corresponding control treatments. Recall, contributions (earnings) in *App-pun* are greater than in *Prov-Pun*, but the differences are not statistically significant. However, based on the fact that contributions decayed at a faster rate in *App* than in *Prov* during Part 2, relative to these no punishment conditions, there is greater opportunity for improvement in the appropriation frame. Table 7 provides summary statistics of the average gain in group contributions and earnings in the two punishment treatments relative to their no-punishment counterparts.[11]

**Table 7. Mean (st dev) increase in group outcomes relative to the no-punishment treatment**

| | Obs | Contributions | Earnings |
|---|---|---|---|
| ***Prov-Pun relative to Prov*** | 12 | 21.20 (19.34) | 4.41 (30.29) |
| ***App-Pun relative to App*** | 12 | 39.07 (14.00) | 25.30 (23.37) |

As shown, the gain in contributions and earnings are higher in the appropriation frame than in the provision frame. The difference is significant for both contributions (Wilcoxon p = 0.0047) and for earnings (Wilcoxon p = 0.0496).[12]

[11] The observations for Table 7 were constructed in the following manner. For each group in a punishment treatment, the average group contribution, as well as earnings, in the group in each round were averaged, resulting in one observation per group for each of contributions and earnings. From each of these observations, we subtracted the "grand mean" of group contributions (earnings) in the corresponding no punishment treatment. This yields the average change in contribution (earnings) for each group in a punishment treatment relative to the overall mean observed in the no-punishment treatment.

[12] In additional analysis, we compare the gains in the two frames using group-level panel random effects regressions (not reported for brevity). The dependent variable is the group average contribution (earnings) in a round *minus* the average (across all groups) group contribution (earnings) in the corresponding no-punishment treatment in that round. The independent variables are a dummy for the provision frame and round dummies. The

**Result 6**: *Relative to the no-punishment benchmark, the presence of punishment opportunities leads to a greater increase in contributions and earnings in the appropriation frame in comparison to the provision frame.*

## 5. Conclusions

This study integrates two strands of experimental literature; the framing of linear public good games and peer sanctioning mechanisms designed to facilitate cooperation. Prior research suggests that negative frames can lead to lower levels of cooperation, even in cases where the games being played are isomorphic in strategy and payoff space. The primary motivation for this study was to examine the relative effectiveness and use of a peer punishment mechanism across the two frames. There are reasons to suspect that the use of the sanctioning mechanism will differ across framings. Specifically, if players are endowed with reciprocal preferences á la J. Cox et al (2008), it is plausible that other-regarding preferences can be dependent on the actions of other group members in the contribution stage.

As argued in the theory section, the main impact of reciprocal preferences on punishing behaviour is through a change in the parameter governing disadvantageous inequality. In the appropriation frame, because actions in the contribution stage are deemed less generous, players become more sensitive to disadvantageous inequality compared to the provision frame. Two main implications of this modelling is that for the same constellation of social preferences in the population, the efficiency of the punishing mechanism will be as good in the appropriation frame as in the contribution frame, with players more prepared to punish free riders in the negative frame.

provision dummy is negative and significant in both the contributions and earnings regressions. These results are available upon request.

Our experimental results neatly confirm the theoretical predictions. In summary we find evidence that the negative frame does lead to less cooperation. Further, in both frames, low contributors are more likely to be punished and receive a higher level of punishment the lower their contributions are relative to the average contribution of others. The likelihood of receiving punishment, however, is less sensitive to the magnitude of the negative deviation in the provision frame than in the appropriation frame. Finally, relative to the no-punishment benchmark, we find that the presence of punishment opportunities leads to a greater increase in contributions and earnings in the appropriation frame.

The importance of this study lies primarily in its contribution to the literature that focuses on mechanisms for promoting self-governance in settings where groups of individuals face a tension between group level and individual level incentives to cooperate. Given the evidence that decision makers appear to be less cooperative in decision settings where their choices degrade the provision of a public good relative to those in which they provide for the provision of a public good, the effectiveness of a sanctioning mechanism in the former condition is not obvious a priori. The results presented here suggest that in situations where subjects face the same level of complexity in the game environment, those facing the negative frame are able to overcome the behavioural bias toward non-cooperative behaviour inherent in the negative frame.

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**References**


Andreoni, James (1995) "Warm-Glow Versus Cold-Prickle: The Effects of Positive and Negative Framing on Cooperation in Experiments", *Quarterly Journal of Economics,* 110(1), 1-21.

Blanco, Esther, Maria Claudia Lopez and James M. Walker (2015) "The Opportunity Costs of Conservation with Deterministic and Probabilistic Degradation Externalities", *Environmental and Resource Economics*, forthcoming.

Cason, Timothy N. and Lata Gangadharan (2015) "Promoting cooperation in nonlinear social dilemmas through peer punishment", *Experimental Economics*, 18(1) 66-88.

Cox, Caleb A. and Brock Stoddard (2015) "Framing and Feedback in Social Dilemmas with Partners and Strangers", *Games,* 6(4), 394-412.

Cox, James C., Daniel Friedman, and Vjollca Sadiraj. 2008. "Revealed Altruism". Econometrica 76 (1), 31–69.

Cox, James C., Elinor Ostrom, Vjollca Sadiraj and James M. Walker (2013) "Provision versus Appropriation in Symmetric and Asymmetric Social Dilemmas", *Southern Economic Journal,*79(3), 496-512.

Dufwenberg, Martin, Simon Gächter and Heike Henning-Schmidt (2011) "The framing of games and the psychology of play", *Games and Economic Behaviour,* 73(2), 459-478.

Fehr, Ernst and Klaus Schmidt (1999) "A theory of fairness, competition, and cooperation", *The Quarterly Journal of Economics*, *114*(3), 817-868.

Fehr, Ernst and Simon Gächter (2000) "Cooperation and Punishment in Public Goods Experiments", *American Economic Review*, 90(4), 980-994.

Fischbacher, Urs (2007) “z-Tree: Zurich toolbox for ready-made economic experiments”, *Experimental Economics*, 10(2), 171-178.

Gächter, Simon, Elke Renner and Martin Sefton (2008) “The Long-Run Benefits of Punishment”, *Science*, 322(5907), 1510.

Herrmann, Benedikt, Christian Thöni and Simon Gächter (2008) “Antisocial punishment across societies”, *Science*, 319(5868), 1362-1367.

Khadjavi, Menusch and Andreas Lange (2015) “Doing good or doing harm: experimental evidence on giving and taking in public good games”, *Experimental Economics*, 18(3), 432-441.

McCusker, Christopher and Peter J. Carnevale (1995) “Framing in Resource Dilemmas: Loss Aversion and the Moderating Effects of Sanctions”, *Organizational Behaviour and Human Decision Processes*, 61(2), 190-201.

Ostrom, Elinor, James Walker and Roy Gardner (1992) “Covenants with and without a Sword: Self-Governance is Possible”, *American Political Science Review*, 86(2), 404-417.

Ramalingam, Abhijit, Antonio J. Morales and James M. Walker (2016) “Variation in experimental instructions: punishment in public goods games”, *CBESS Working Paper*.

## Appendix A. Experimental Instructions

### A1. Provision Instructions – Part 1

Thank you for coming! This is an experiment about decision-making. You will receive £2 for your participation. If you follow the instructions carefully, you can earn more money depending both on your own decisions and on the decisions of others.

These instructions and your decisions in this experiment are solely your private information. During the experiment you are not allowed to communicate with any of the other participants or with anyone outside the laboratory. Please switch off your mobile phone now. If you have any questions at any time during the course of this experiment, please raise your hand. An experimenter will assist you privately.

Your decisions will be recorded privately at your computer terminal. Your identity will never be disclosed to other participants. You will be paid individually and privately in cash at the end of the experiment.

During the experiment all decisions are made in tokens (more details below). Your total earnings will also be calculated in tokens and, at the end of the experiment will be converted to Pounds at the following rate:

**60 tokens = £1**

The experiment consists of two parts. Part 1 consists of 10 rounds and Part 2 consists of 20 rounds. Your total earnings will be the sum of your earnings from all 30 rounds.

Instructions for Part 1 are below. You will receive instructions for Part 2 after Part 1 is completed.

# Part 1

**Part 1 of the experiment consists of ten (10) consecutive decision rounds.**

**At the beginning of Part 1, participants will be randomly divided into groups of four (4) individuals.** The composition of the groups will remain the same in each round. This means that you will interact with the same people in your group throughout the experiment.

You are a member of a group of four participants. At the beginning of each round, each member receives an endowment of **20 tokens.** The task of each group member **is to decide how many of their 20 tokens they would like to allocate to a Group Project (GP) and how many to keep for themselves in their**

**Individual Project (IP).** Each token not allocated to the Group Project will automatically be allocated to your Individual Project (IP). Your total earnings from the round include earnings from both your Individual Project and the Group Project.

**All participants in your group will simultaneously face the same decision situation.**

## Your earnings from the Individual Project in each round

**You will earn one (1) token for each token allocated to your Individual Project.** No other member in your group will earn from your Individual Project.

## Your earnings from the Group Project in each round

**For each token you allocate to the Group Project, you will earn 0.5 tokens. Each of the other three people in your group will also earn 0.5 tokens. Thus, the allocation of 1 token to the Group Project yields a total of 2 tokens for all of you together.** Your earnings from the Group Project are based on the total number of tokens allocated by all members in your group. Each member will profit equally from the amount allocated to the Group Project. For each token allocated to the Group Project, each group member will earn 0.5 tokens regardless of who made the allocation. This means that you will earn from your own allocation to the Group Project, as well as from the allocations of others to the Group Project.

## Your total earnings in each round

Your total earnings consist of earnings from your Individual Project *and* the earnings from the Group Project.

**Your earnings from the round = Earnings from your Individual Project + Earnings from the Group Project**

**The following examples are for illustrative purposes only.**

**Example 1.** Assume that you have allocated 0 tokens to the Group Project. Suppose that each of the other group members has also allocated 0 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 0. Your earnings from this round will be 20 tokens (20 tokens from your Individual Project and 0 tokens from the Group Project). The earnings of the other group members in f this round will be 20 tokens each.

**Example 2.** Assume that you have allocated 10 tokens to the Group Project. Suppose that each of the other group members has allocated 0 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 10. Your earnings from this round will be 15 tokens (= 10 tokens from your Individual Project and 10*0.5 = 5 tokens from the Group Project). The earnings of the other group members from this round will be 25 tokens each (= 20 tokens from the Individual Project + 10*0.5 = 5 tokens from the Group Project).

**Example 3.** Assume that you have allocated 20 tokens to the Group Project. Suppose that each of the other group members has also allocated 20 tokens to the Group Project. Thus the total number of tokens in the Group Project in your group is 80. Your earnings from this round will be 40 tokens (= 0 tokens from your Individual Project and 80*0.5 = 40 tokens from the Group Project). The earnings of the other group members in this round will similarly be 40 tokens each.

After all individuals have made their decisions in the round, you will be informed of the total allocation to the Group Project and your earnings from the round. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

The same process will be repeated for a total of 10 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment of 20 tokens in each round.

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**Questions to help you better understand the decision tasks**

When everyone has finished reading the instructions, and before the experiment begins, we will ask you a few questions regarding the decisions you will make in the experiment. The questions will help you understand the calculation of your earnings and ensure that you have understood the instructions.

Please answer these questions on your computer terminal. Please type your answer in the box next to the corresponding question. Once everyone has answered all questions correctly we will begin the experiment.

## A2. Provision Instructions – Part 2 – No Punishment

**Part 2 of the experiment consists of twenty (20) consecutive decision rounds.** Your total earnings will be the sum of your earnings from all these rounds.

**You will remain in the same group of four individuals as in Part 1.** Again, the composition of the groups will remain the same in each round.

Each round is identical to a round in Part 1. In particular, at the beginning of each round, each member receives an endowment of 20 tokens.

**Your task is to decide how many tokens you would like to allocate to a Group Project (GP) and how many to keep for yourself in an Individual Project (IP).** Each token not allocated to the Group Project will automatically be allocated to your Individual Project (IP). Your total earnings from the round include earnings from both your Individual Project and the Group Project.

**All participants in your group will simultaneously face the same decision situation.**

**Earnings from the Individual Project:** You will earn one (1) token for each token allocated to your Individual Project.

**Earnings from the Group Project:** Your earnings from the Group Project are based on the total number of tokens allocated by all members in your group. Each member will profit equally from the amount allocated to the Group Project. For each token allocated to the Group Project, each group member will earn 0.5 tokens regardless of who made the allocation.

**Your earnings in the round = Earnings from your Individual Project + Earnings from the Group Project**

After all individuals have made their decisions in the round, you will be informed of the total allocation to the Group Project and your earnings from the round. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment of 20 tokens in each round.

**At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.**

### A3. Provision Instructions – Part 2 – Punishment

**Part 2 of the experiment consists of twenty (20) consecutive decision rounds.** Your total earnings will be the sum of your earnings from all these rounds.

**You will remain in the same group of four individuals as in Part 1.** Again, the composition of the groups will remain the same in each round.

In each round in Part 2, there will be **two decision stages**.

## First Stage of each round

The first stage of each round is identical to a round in Part 1. In particular, at the beginning of each round, each member receives an endowment of 20 tokens.

**Your task is to decide how many tokens you would like to allocate to a Group Project (GP) and how many to keep for yourself in an Individual Project (IP).** Each token not allocated to the Group Project will automatically be allocated to your Individual Project (IP). Your total earnings from the round include earnings from both your Individual Project and the Group Project.

**All participants in your group will simultaneously face the same decision situation.**

**Earnings from the Individual Project:** You will earn one (1) token for each token allocated to your Individual Project.

**Earnings from the Group Project:** Your earnings from the Group Project are based on the total number of tokens allocated by all members in your group. Each member will profit equally from the amount allocated to the Group Project. For each token allocated to the Group Project, each group member will earn 0.5 tokens regardless of who made the allocation.

**Your earnings from the first stage in the round = Earnings from your Individual Project + Earnings from the Group Project**

After all individuals have made their decisions in the first stage of the round, you will be informed of the total allocation to the Group Project and your earnings from the first stage. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

## Second Stage of each round

In this stage, you can use your earnings from Stage 1 to decrease the earnings of any other member in your group by assigning deduction tokens to them. **Each deduction token assigned by you to a group member will cost you 1 token and will decrease the earnings of that group member by 3 tokens.** If you do not want to change the earnings of a member of your group, enter zero in the corresponding box.

You can assign a maximum of 5 deduction tokens to any group member. The maximum number of deduction tokens you can assign to all members of the group in total is 15 tokens ***OR*** your Stage 1 earnings, whichever is lower.

### Your total earnings in each round

**Your earnings in the round = Earnings from Stage 1**

**- Total number of deduction tokens you assigned to other group members**

**- 3 × Total number of deductions tokens assigned to you by other group members**

After all participants have made their decisions in the second decision stage, you will be informed of the total number of deduction tokens received by you and of your earnings in the round. You will not be informed of who assigned deduction tokens to you.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment of 20 tokens in each round.

Notice that your total calculated earnings in tokens at the end of a decision round can be negative if the costs from assigned and received deduction tokens exceed your earnings from the first stage. If your cumulative earnings from all 30 rounds at the end of the experiment are negative, the computer will automatically record zero earnings for you from the experiment. Thus, while your earnings from any particular round can be negative, your earnings from the experiment CANNOT be negative.

**At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.**

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Before the experiment begins, we will ask you a few questions regarding the decisions you will make in the experiment. The questions will help you understand the calculation of your earnings and ensure that you have understood the instructions. Please answer these questions on your computer terminal.

## A4. Appropriation Instructions – Part 1

Thank you for coming! This is an experiment about decision-making. You will receive £2 for your participation. If you follow the instructions carefully, you can earn more money depending both on your own decisions and on the decisions of others.

These instructions and your decisions in this experiment are solely your private information. During the experiment you are not allowed to communicate with any of the other participants or with anyone outside the laboratory. Please switch off your mobile phone now. If you have any questions at any time during the course of this experiment, please raise your hand. An experimenter will assist you privately.

Your decisions will be recorded privately at your computer terminal. Your identity will never be disclosed to other participants. You will be paid individually and privately in cash at the end of the experiment.

During the experiment all decisions are made in tokens (more details below). Your total earnings will also be calculated in tokens and, at the end of the experiment will be converted to Pounds at the following rate:

**60 tokens = £1**

The experiment consists of two parts. Part 1 consists of 10 rounds and Part 2 consists of 20 rounds. Your total earnings will be the sum of your earnings from all 30 rounds.

Instructions for Part 1 are below. You will receive instructions for Part 2 after Part 1 is completed.

# Part 1

**Part 1 of the experiment consists of ten (10) consecutive decision rounds.**

**At the beginning of Part 1, participants will be randomly divided into groups of four (4) individuals.** The composition of the groups will remain the same in each round. This means that you will interact with the same people in your group throughout the experiment.

You are a member of a group of four participants. Each of you will have an Individual Project (IP) and your group of four will have a Group Project (GP). At the beginning of each round, each group of four begins with 80 tokens placed in their initial GP. Each token in the Group Project is worth 2 tokens. Thus, each group begins with an initial GP worth 160 tokens. Each person begins with 0 tokens placed in his/her initial IP.

**The task of each group member is to decide how many tokens, if any, they would like to move from the initial Group Project to their Individual Project. Each group member may move a maximum of 20 tokens from the GP to their IP.** Each token not moved to their IP will automatically remain in the GP. Your total earnings from the round include earnings from both your Individual Project and the Group Project.

**All participants in your group will simultaneously face the same decision situation.**

**Your earnings from the Individual Project in each round**

Each token you move to your IP increases the value of your IP by 1 token. **Thus, you will earn one (1) token for each token allocated to your Individual Project.** No other member in your group will earn from your Individual Project.

**Your earnings from the Group Project in each round**

Each token moved from the initial GP reduces the value of the final GP by 2 tokens for the group. That is, the value of the final GP is the result of subtracting from the initial GP, the sum of tokens removed by each participant in your group. **For each token that remains in the Group Project, you will earn 0.5 tokens. Each of the other three people in your group will also earn 0.5 tokens. Thus, 1 token left in the Group Project yields a total of 2 tokens for all of you together.** Your earnings from the Group Project are based on the total number of tokens left in the GP by all members in your group. Each member will profit equally from the amount left in the Group Project. For each token left in the Group Project, each group member will earn 0.5 tokens regardless of who left it there. This means that you will earn from the tokens that you have left in the GP as well as from the tokens left in the GP by the others.

**Your total earnings in each round**

Your total earnings consist of earnings from your Individual Project *and* the earnings from the Group Project.

**Your earnings in the round = Earnings from your Individual Project + Earnings from the Group Project**

**The following examples are for illustrative purposes only.**

**Example 1.** Assume that you have moved 20 tokens from the Group Project to your Individual Project. Suppose that each of the other group members has also moved 20 tokens to their Individual Projects. Thus the total number of tokens remaining in the Group Project in your group is 0. Your earnings from

this round will be 20 tokens (20 tokens from your Individual Project and 0 tokens from the Group Project). The earnings of the other group members in this round will be 20 tokens each.

**Example 2.** Assume that you have moved 10 tokens from the Group Project to your Individual Project. Suppose that each of the other group members has moved 20 tokens to their Individual Projects. Thus the total number of tokens remaining in the Group Project in your group is 10. Your earnings from this round will be 15 tokens (= 10 tokens from your Individual Project and 10*0.5 = 5 tokens from the Group Project). The earnings of the other group members from this round will be 25 tokens each (= 20 tokens from the Individual Project + 10*0.5 = 5 tokens from the Group Project).

**Example 3.** Assume that you have moved 0 tokens from the Group Project to your Individual Project. Suppose that each of the other group members has also moved 0 tokens to their Individual Projects. Thus the total number of tokens remaining in the Group Project in your group is 80. Your earnings from this round will be 40 tokens (= 0 tokens from your Individual Project and 80*0.5 = 40 tokens from the Group Project). The earnings of the other group members in this round will similarly be 40 tokens each.

After all individuals have made their decisions in the round, you will be informed of the total number of tokens remaining in the Group Project and your earnings from the round. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

The same process will be repeated for a total of 10 rounds. Your earnings from earlier rounds cannot be used in the following rounds. Your group will begin each round with 80 tokens placed in your initial GP.

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**Questions to help you better understand the decision tasks**

When everyone has finished reading the instructions, and before the experiment begins, we will ask you a few questions regarding the decisions you will make in the experiment. The questions will help you understand the calculation of your earnings and ensure that you have understood the instructions.

Please answer these questions on your computer terminal. Please type your answer in the box next to the corresponding question. Once everyone has answered all questions correctly we will begin the experiment.

## A5. Appropriation Instructions – Part 2 – No Punishment

**Part 2 of the experiment consists of twenty (20) consecutive decision rounds.**

**You will remain in the same group of four individuals as in Part 1.** Again, the composition of the groups will remain the same in each round.

Each round is identical to a round in Part 1. In particular, at the beginning of each round, each group of four begins with 80 tokens placed in their initial GP. Each token in the Group Project is worth 2 tokens. Thus, each group begins with an initial GP worth 160 tokens. Each person begins with 0 tokens placed in his/her initial IP.

**Your task is to decide how many tokens, if any, you would like to move from the initial Group Project to your Individual Project. You may move a maximum of 20 tokens from the GP to your IP.** Each token not moved to your IP will automatically remain in the GP. Your total earnings from the round include earnings from both your Individual Project and the Group Project.

**All participants in your group will simultaneously face the same decision situation.**

**Earnings from the Individual Project:** You will earn one (1) token for each token allocated to your Individual Project.

**Earnings from the Group Project:** Your earnings from the Group Project are based on the total number of tokens left in the GP by all members in your group. Each member will profit equally from the amount left in the Group Project. For each token left in the Group Project, each group member will earn 0.5 tokens regardless of who left it there.

**Your earnings in the round = Earnings from your Individual Project + Earnings from the Group Project**

After all individuals have made their decisions in the round, you will be informed of the total number of tokens remaining in the Group Project and your earnings from the round. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. Your group will begin each round with 80 tokens placed in your initial GP.

**At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.**

### A6. Appropriation Instructions – Part 2 – Punishment

**Part 2 of the experiment consists of twenty (20) consecutive decision rounds.**

**You will remain in the same group of four individuals as in Part 1.** Again, the composition of the groups will remain the same in each round.

In each round in Part 2, there will be **two decision stages**.

## First Stage of each round

The first stage of each round is identical to a round in Part 1. In particular, at the beginning of each round, each group of four begins with 80 tokens placed in their initial GP. Each token in the Group Project is worth 2 tokens. Thus, each group begins with an initial GP worth 160 tokens. Each person begins with 0 tokens placed in his/her initial IP.

**Your task is to decide how many tokens, if any, you would like to move from the initial Group Project to your Individual Project. You may move a maximum of 20 tokens from the GP to your IP.** Each token not moved to your IP will automatically remain in the GP. Your total earnings from the round include earnings from both your Individual Project and the Group Project.

**All participants in your group will simultaneously face the same decision situation.**

**Earnings from the Individual Project:** You will earn one (1) token for each token allocated to your Individual Project.

**Earnings from the Group Project:** Your earnings from the Group Project are based on the total number of tokens left in the GP by all members in your group. Each member will profit equally from the amount left in the Group Project. For each token left in the Group Project, each group member will earn 0.5 tokens regardless of who left it there.

**Your earnings from the first stage in the round = Earnings from your Individual Project + Earnings from the Group Project**

After all individuals have made their decisions in the first stage of the round, you will be informed of the total number of tokens remaining in the Group Project and your earnings from the first stage. You will also be informed of the individual allocation decisions of each group member, ranked from top to bottom. Individuals in your group will NOT be identified in anyway. Thus, information about individual allocations will be completely anonymous.

## Second Stage of each round

In this stage, you can use your earnings from Stage 1 to decrease the earnings of any other member in your group by assigning deduction tokens to them. **Each deduction token assigned by you to a group member will cost you 1 token and will decrease the earnings of that group member by 3 tokens.** If you do not want to change the earnings of a member of your group, enter zero in the corresponding box.

You can assign a maximum of 5 deduction tokens to any group member. The maximum number of deduction tokens you can assign to all members of the group in total is 15 tokens ***OR*** your Stage 1 earnings, whichever is lower.

**Your total earnings in each round**

**Your earnings in the round = Earnings from Stage 1**

**- Total number of deduction tokens you assigned to other group members**

**- 3 × Total number of deductions tokens assigned to you by other group members**

After all participants have made their decisions in the second decision stage, you will be informed of the total number of deduction tokens received by you and of your earnings in the round. You will not be informed of who assigned deduction tokens to you.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. Your group will begin each round with 80 tokens placed in their initial GP.

Notice that your total calculated earnings in tokens at the end of a decision round can be negative if the costs from assigned and received deduction tokens exceed your earnings from the first stage. If your cumulative earnings from all 30 rounds at the end of the experiment are negative, the computer will automatically record zero earnings for you from the experiment. Thus, while your earnings from any particular round can be negative, your earnings from the experiment CANNOT be negative.

**At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.**

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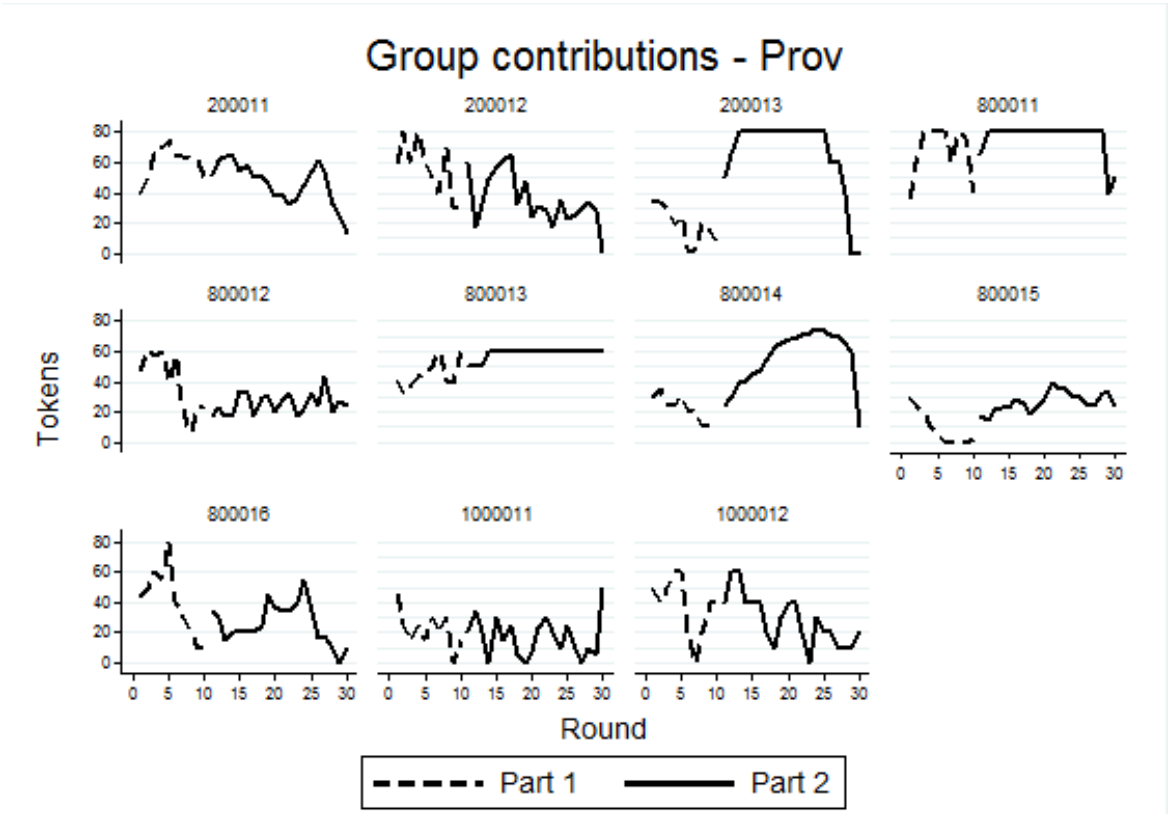
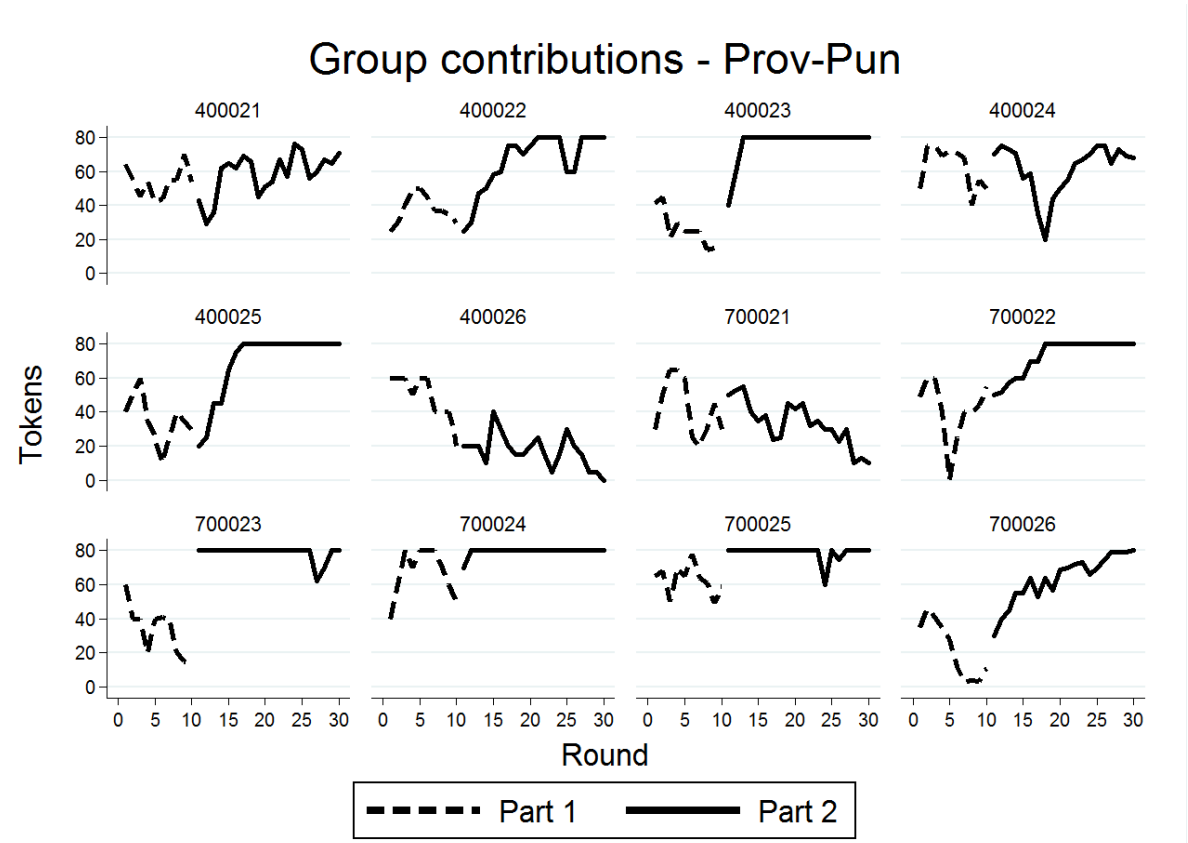
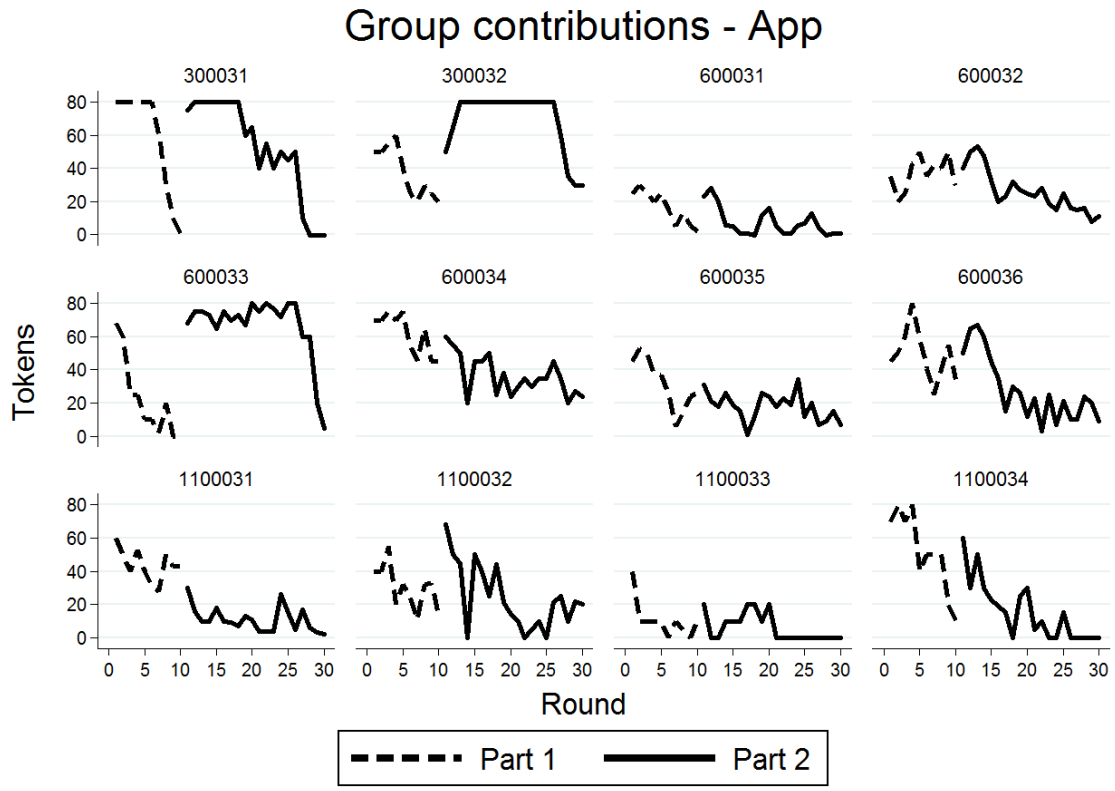
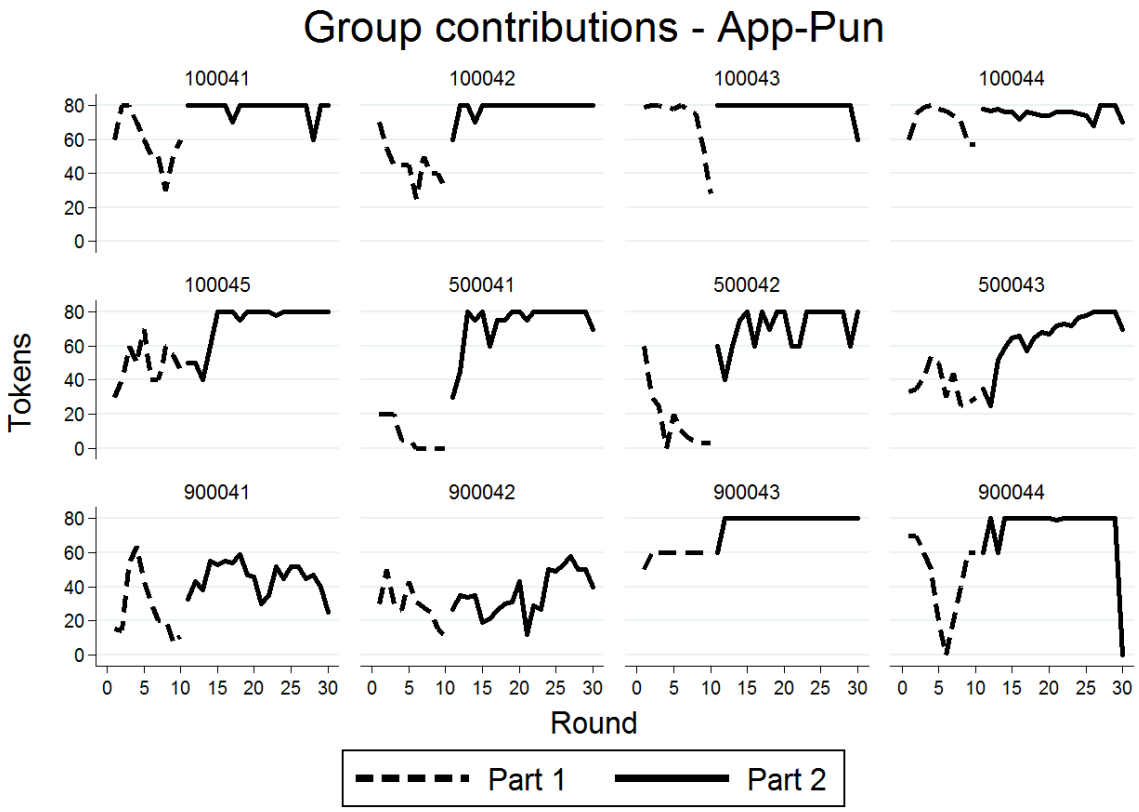
Before the experiment begins, we will ask you a few questions regarding the decisions you will make in the experiment. The questions will help you understand the calculation of your earnings and ensure that you have understood the instructions. Please answer these questions on your computer terminal.

**Appendix B: Heterogeneity in public goods contributions across groups**




Group contributions - App
300031
300032
600031
600032
600033
600034
600035
600036
1100031
1100032
1100033
1100034
Tokens
Round
Part 1
Part 2


Group contributions - App-Pun
100041
100042
100043
100044
100045
500041
500042
500043
900041
900042
900043
900044
Tokens
Round
Part 1
Part 2