ANALYSIS OF COOPERATION

IN THE PUBLIC GOODS SETTING

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Abstract

This is an experimental study aimed to analyze which incentive —punishment or reward—is better at promoting cooperation under the possibility to free-ride in the framework of the financing of public goods. The main tool that has been used to conduct this study is the Public Goods Game experiment with two of its variations. In the first variation, punishment opportunities were allowed and, in the second one, rewarding opportunities were present. This methodology has allowed the comparison of both incentives against each other and against the standard PGG, revealing their weaknesses and advantages. In line with former research, results have verified that individuals, on average, provide levels of contributions halfway the free-riding and the full provision scenario. Also, while both incentives have been able to prevent the decline of cooperation observed in the standard game, punishment has promoted the highest mean contributions and reward the highest mean payoffs. For such reason, it has been far from easy to determine which one is better overall. In conclusion, this study provides evidence that both punishment and reward can succeed at sustaining cooperation in the PGG setting, although reward can be the optimal force at delivering higher payoffs.

Keywords: Public Goods Game, free-rider problem, cooperation, incentives, punishment and reward.

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1. Introduction

Every single one of us, voluntarily or not, have had to participate on group projects. We pleasingly accept to take part in them because by doing so we will theoretically be able to achieve a common and desired goal that would be inconceivable to procure if working separately. However, even if all members of the group target the same objective, in this kind of enterprises most often participants are differently committed to that goal and they don't put the same effort to strive for it. At this point, moral values such as equality and reciprocity enter the scene, as we expect that all members of the group put more or less the same effort. Unfortunately, this is hardly ever the case and we often encounter individuals that will take advantage from the fruits of our work, while contributing themselves as little as possible. Thus, the question is: What could we do to incentivize cooperation or disincentive parasitism in this kind of scenarios?

To answer such question I am going to do an experimental study that, in particular, will be focused on a what could be described as a large scale "group project": the financing of public goods. A public good is both a non-rivalrous and a non-excludable good. On the one hand, this means that one individual's consumption of the good does not affect another's opportunity to consume that good. On the other, non-excludability implies that individuals cannot deny each other the opportunity to consume the good. One of the characteristics of this kind of goods, is that the optimal provision cannot be attained by the private-sector or, in other words, the market mechanism does not provide an efficient outcome. This implies that welfare of individuals could be improved if a larger quantity of the good is provided. If that's the case, we say that there is under provision of that good. To avoid that individuals underinvest —that is, free-ride— the public good can be supplied by the government in order to reach the social optimal equilibrium.

However, even if that is the case, individuals can free ride through mechanisms such as tax evasion or tax avoidance. Furthermore, the maintenance of this kind of goods often relies on voluntary and informal interactions, meaning that it still depends on the willingness of individuals to cooperate (Merrett, 2012). Also, even if public goods are supplied by the public sector, there is a growing evidence that in recent years welfare states will struggle even more to supply the efficient level. For instance, McMorrow & Roeger (1999) had already pointed out the hazard of population ageing as to its implications to public finances overall and, in particular, the pension and health care budgets. Today we are certain that population pyramids are shrinking over time, increasing the

ratio of retired population relative to the labor force and forcing governments to rise more money from fewer individuals to keep financing welfare states. Furthermore, the size of the shadow economy in Southern European countries such as Spain is above 20% of the official GDP (Schneider & Boockmann, 2018) and, for now, it seems that this situation will not be reversed.

All in all, it seems reasonable enough to accept that under provision is currently a threat for many economies. In particular, for many states that have had to deal with several economic crises almost in a row and are struggling to finance themselves. Fortunately, there are multiple steps that policymakers could take to overcome these issues, but many times the promotion of cooperation is not considered as a decisive point. For my part, I think that it is perhaps the most straight-forward step that could be taken to tackle under provision; while I acknowledge that free-riding is possibly not the main cause, I find that it is still relevant and deserves a deeper analysis. For such reason, I will study two mechanisms that can be implemented to curb free-riding and incentivize cooperation —punishment and reward. The first one, is the most widely used and the second one, a reward scheme, is more difficult to find as it is usually considered less efficient.

My thesis statement is as follows: *"Reward schemes can be as effective as punishment at sustaining long term cooperation. Furthermore, punishment schemes will harm social welfare at a larger extent than reward schemes, as they entail a cost for both the punishing individual and the recipient".* Consequently, in this study I will be examining how the provision of public goods can be sustained under the possibility to free-ride and hence how to promote cooperation and curb free-riding. In particular, I will try to understand how individuals behave when mechanisms to promote contributions are implemented. But before going any further, I will review the most relevant literature that concerns our topic. This review will hopefully be enlightening and will provide interesting remarks surrounding the questions I intend to analyze.

2. Literature review

In 1988, James Andreoni already analyzed the free riding hypothesis in public good experiments. Regarding the Public Goods Game —from now on PGG—, he observed that, while it is true that the extent of free riding differs across experiments, three observations were consistently replicated. First, there was no evidence of free riding in single shot games and, in addition, he pointed out that subjects generally provide the public goods at levels halfway between the Pareto efficient level and the free riding level. Second, Andreoni observed that when the game is repeated, provision decays toward the free riding level, regardless if individuals know the length of the game or not. Third, he suggested that exact free riding is seldom realized. All in all, he argued that repetition seems to be necessary for subjects to approach the free riding behavior.

As we have seen with Andreoni, PGG experiments have showed that individuals deviate from the theoretical PGG's equilibrium —i.e. they choose to cooperate— contributing on average half of their endowments. Also, while it is true that generally cooperation decays with repetition, it is still persistent. The reasons behind this have become a crucial issue to understand and, traditionally there have been two paramount hypotheses: one pointing out that cooperation is due to non-standard behavior —moral values, bounded rationality, social norms— and the other focusing on errors and confusion. Even if it is likely that both hypothesis play a role, it has been extremely difficult to determine whether cooperation comes out of kindness or out of confusion.

Still with Andreoni, he attemped in 1995 to separate the aforementioned hypothesis, showing that they are equally important in generating cooperative moves in public goods experiments. He observed that, in the iterated game, the reduction in confusion is first replaced by a growth in kindness, followed by a movement towards the Nash equilibrium —or zero cooperation scenario. However, he realized that the decrease in cooperation was not the result of learning the free-riding incentives but the consequence of frustrated attempts at kindness; suggesting that the focus on "learning" in experimental research should shift to include studies of preferences for cooperation. In other words, kindness can be fundamental for strategies —so the potential explanations for cooperation, together with learning hypothesis, should also include this factor.

Another mistaken assumption made in early investigations was that individuals consider self-interest only and interpreted the decline in cooperation as a preference for free-riding. Against this background, Fischbacher and Gächter (2010) argued that many people prefer to cooperate

provided that others also cooperate, which is inconsistent with the self-interest argument. So they decided to add into the equation the "other-regarding preferences" to explain the conditionally cooperative behavior that they previously in the iterated PGG. All in all, they pointed out the existence of conditional cooperators that reduce their contribution when observing others free-riding, a scenario that leads to the decline in cooperation in the repeated game —note that this remark is parallel to Andreoni's observation stating that the decline of cooperation is the result of frustrated attempts at kindness.

For such reason, Fischbacher and Gächter indicated that human behavior in the PGG can be better described through a combination of the self-regarding preference and the other-regarding preference. They showed that these imperfect conditional cooperators who match others' contributions only partly are the vast majority of individuals. Dong et al., (2016), noted that this behavior implies that the voluntary cooperation in PGG is inherently fragile. These authors broaden the argument, stating that even if there are no free riders in the group, imperfect conditional cooperators will decrease their contribution because of the self-regarding preference. In consequence, Fischbacher and Gächter already suggested that other mechanisms such as punishment and rewards must be implemented to sustain cooperation.

In this last respect (Dong et al., 2016), most empirical and theoretical research on PGG indicates that incentives — rewards and/or punishment— can curb free-riding. These incentives can be decentralized —peer incentives— or centralized —institutional incentives, and, for both types, theoretical research and experiments have determined that the effect of rewards is not the same as the effect of punishment. In particular, previous studies have found punishment to be more effective than reward for maintaining cooperation in public goods games. There is also a crucial difference between centralized and decentralized incentives; peer incentives encourage contribution in both punishment and rewards, but for institutional incentives only punishment successfully increases the contribution of the penalized ones. Accordingly, in the institutional rewards experiments levels of contribution are not significantly above the standard levels.

Rand et al. (2009), in an experimental setting with peer incentives and where player identities persisted from round to round, showed that reward is as effective as punishment for maintaining public cooperation in the repeated PGG and leads to higher total earnings. They argue that what is essential for maintaining cooperation in the repeated PGG is the possibility of targeted interactions

more generally, regardless if that is in the form of punishment or reward. However, while punishment is costly for both parties, reward creates benefit and thus results in higher total payoffs. Furthermore, when both punishment and reward are possible, they advocate that positive reciprocity supersedes negative reciprocity, and punishing results in lower group-level benefits.

Consequently, they question the proposal that costly punishment is the optimal force for prompting cooperation (Fehr & Gächter, 2000); and they point out that it can be inappropriate for several reasons. First, costly punishment generates a social loss by reducing both players' payoffs. In addition, punishment could be used by free riders against cooperators, either randomly or as acts of revenge. And last, the extent to which punishment is perceived as justified greatly affects the response of those who have been punished. In conclusion, they find that reward outperforms punishment in repeated public goods games and that human cooperation in such repeated settings is best supported by positive interactions with others —i.e. positive reciprocity should play a more important role than negative reciprocity in maintaining public cooperation in repeated situations.

Regarding the costs of punishment, Boyd et al. (2010) conducted a model of coordinated punishment to capture the fact that the total cost of punishing a free-rider declines as the number of punishers increases —because the costs are shared. Beforehand we knew that as punishment increases it reduces more and more the gain to free-riding, so groups with more punishment can sustain more cooperation. Nevertheless, it should be also taken into account that punishment can reduce the average payoffs of groups members because the costs of it may exceed the gains from cooperation. In this scenario, punishers, in order to survive, must engage in enough punishment of defectors so that the induced cooperation more than offsets the cost of punishing. Thus, rare punishers do not have the benefit of outnumbering their targets, because the cost of punishing a free-rider is substantial and they usually bear the cost alone rather than sharing it.

As an extension of Rand et al. (2009), who concluded that rewarding can be as effective as punishment for maintaining public cooperation, Szolnoki and Perc (2010) investigated the impact of reward on the evolution of cooperation in the spatial PGG by means of the introduction of a third strategy in addition to the traditional cooperator and defector —therefore, it is a theoretical study, not experimental. This third strategy is called "rewarding cooperators", cooperators willing to reward other cooperators even if this implies bearing an additional cost. Furthermore, they find that costly rewards facilitate cooperation more effectively if the synergetic effects of cooperation

are low —i.e. a low multiplication factor— and, surprisingly enough, their results indicate that high rewards may be less effective in promoting cooperation than moderate rewards.

These authors also point out that, at high multiplication factors, the network of reciprocity is enough to decimate defectors, and then the impact of reward just consists on establishing the victor between traditional cooperators and rewarding cooperators —i.e. the profit margin is too low. However, they find that the promotion of cooperation by means of costly rewards still seems altogether less efficient compared to costly punishment. In this respect, they argue that for reward to work equally well as punishment, the ratio between the benefit and the cost of rewarding must be significantly higher than in the case of punishment. This reasoning follows from the fact that, in the absence of defectors, the punishing cooperators become equivalent to the cooperators while rewarding cooperators still keep paying the cost of reward and therefore remain inferior to the strategy of traditional cooperators —or as they call them, the second-order free-riders.

Lastly, let me add that in order to analyze the data I have collected throughout the course of my own PGG experiments, I will try to consider the remarks of the authors I have just reviewed. Also, as I have already mentioned in the hypothesis, I will try to argue which incentive is better to sustain cooperation according to the data I have collected. Therefore, with the experiment I describe further below, I have intended to test the effects of punishment and reward on cooperation.

3. The Public Goods Game

To understand how individuals behave in the public goods setting, the tools provided by experimental economics are quite useful. In a nutshell, this branch of economic science consists on the application of experimental methods to study economic questions. The data provided in this kind of experiments helps us to test the validity of economic theories and illuminate market mechanisms. For such reason, I am confident that the application of the experimental method I describe below will help us understand the economic question that concerns us.

I will analyze a game called "Public Goods Game" —from now on PGG— to understand how individuals behave in a framework where subjects try to achieve a common goal —the funding of the public goods. In our setting participants secretly choose how many of their private tokens —also called "points" or "monetary units"— to contribute to a group project —the public pot. In the shared pot contributions are multiplied by a factor greater than one and less than the total number of players and the resulting number is evenly divided among players. Those who contribute below average or nothing will be called "free riders" or "defectors", as opposed to the above-average contributors who are called "cooperators" (Systems Innovation, 2017).

In this experiment, the group total payoff is maximized when all players contribute all of their tokens to the group project, but each is incentivized to do otherwise as keeping their money will render them the potential greatest payoff regardless of what everyone else does —those are "the free-rider incentives". However, experimental research has shown that most of the time individuals still decide to cooperate —Marwell & Ames (1981) found that subjects generally provide the public goods at levels halfway between the Pareto efficient level and the free riding level— and, as a result, the outcome goes most of the time against the notion of what the equilibrium should be according to economic theory. Thus, the Nash Equilibrium —zero contributions scenario— is rarely seen, and it is completely opposed to the social optimum equilibrium —where the total payoff is maximized.

Public Goods Games can also be analyzed as a social dilemma where each person benefits by consuming the tokens that others contribute, while contributing himself as little as possible. However, if everyone behaves this way there would be no additional tokens to enjoy. For such reason, public good games are usually employed to model the behavior of groups of individuals trying to achieve a common goal —a public good from which all may benefit regardless of whether

they contribute to its financing. Most public goods are collectively shared and once they are being provisioned it is difficult to exclude people from them and, as a result, there is a temptation to enjoy the good without making a contribution. Surprisingly enough is rational to free ride, but if all do so the public good is not provided and everybody is worse off. Thus, again, the question is: How could we promote contributions to boost "social welfare"?

To address the proposed questions, and test the validity of my hypothesis I have designed my own PGG experiment. The free web-based platform *Lioness.com* —run by the Universität Passau— has provided all the necessary tools to make a proper design for the experiment, as well as "example experiments" upon which I have based my own —in particular the published PGG experiment by Arechar, Gaechter & Molleman (2018). I will detail the experimental design on the next chapter, but for now I will advance that, in order to suit my research interests, I had to set up a public goods game experiment with punishment opportunities and another one with rewarding opportunities. In this way, I have been able to compare the results of both experiments and reach some conclusions regarding the questions I pretended to analyze.

Once the experiment was already designed, I had to deal with the difficult task of finding enough participants to legitimate the results of the experiment. I lacked access to a laboratory to test massively my hypothesis, but finally I managed to find a considerable number of participants. Due to material limitations and Covid-19 restrictions, the experiment was performed over a whole week, segmented into separate sessions of 4 subjects. Participants were able to interact online in order to fulfill the requirements of the experiment. All the results were collected in Excel tables to allow a proper analysis of the results. Hereafter, I explain all the details of the experimental design.

4. The experimental design

The overall design of the experiment consists of a control experiment with two treatments conditions. All of them share the basic characteristics of PGG experiments, where there are several groups of N players (N=4) that interact anonymously for a number of rounds (T=10 rounds). In each round, each player receives a given number of monetary units (y=20 m.u.) and must decide freely and anonymously which amount to contribute. Each member can either contribute all their tokens, just part of them or decide to fully free-ride and not contribute at all. Players keep the tokens they do not contribute and they are told so. Once all players have taken a decision, contributions are multiplied by the synergy factor (r=1.6) and evenly divided among the members of the group. I have set a low synergy factor, following Rand et al. (2009), who found that costly rewards facilitate cooperation more effectively if the synergetic effects of cooperation are low.

At the beginning of each experiment I provide the instructions of the game to each player. They contain an explanation about how the experiment works and also a few examples to illustrate it. In the instructions, parameter values of *N*, *T*, *y* and *r* are clearly stated —i.e. they are made common knowledge. Moreover, prior to start the experiment, players are asked to answer a few "Control Questions" about the basics of the experiment. This will show to what degree participants understood their task, and it will serve me as to observe whether this has a connection with their performance in the game. Once they have written the answers, the system will take them to the lobby, where they will have to wait until a group of four can be created. Then, each experiment will start following its particular functioning.

As I have said, the overall design of the experiment consists of three different settings. On the one hand, the Control Experiment ("Case Study 1"), which is the standard iterated PGG. On the other, the two treatment conditions, that differ from the Control Experiment in that each round is followed by a second stage that allows targeted interactions at each other group member. In the first treatment ("Case study 2"), I have allowed for peer punishment opportunities at the end of each round —i.e. each member of the group, if deemed necessary, can assign "Punishment Points" to other members. And, in the second treatment ("Case Study 3"), there are peer rewarding opportunities after each round —i.e. each member of the group, if deemed necessary, can assign "Rewarding Points" to other members. Below, I describe more accurately each of the designs:

- **Case study 1 (control experiment): "STANDARD ITERATED PGG"**

The control experiment is the standard iterated PGG where players interact anonymously without any kind of incentive for a number t of rounds (T=10). In each round, players receive an endowment of y monetary units (y=20) and simultaneously decide how much to contribute ($0 \leq c_i \leq y$) in the public pot. Then, contributions are multiplied by the synergy factor (r=1.6) and evenly divided among the members of the group (N=4). This process is repeated ten times, but subjects are not told the number of rounds Note that, for a given group, the payoff of each subject *i* in period t is given by:

$$\pi_i^t = y - c_i + (r\,\bar{c}_t) \tag{1}$$

where $\bar{c}_t$ (average contribution at period t) = $\left(\sum_{j=1}^{n} c_i\right)\frac{1}{n}$

The instructions provided to participants are the following:

- Your task. At the beginning of each round, each participant receives 20 Points. You have to decide how many of the 20 Points you want to contribute to a group project. The other three members of your group make this decision at the same time.
- The Points you do not contribute, you keep for yourself. These Points are added to your total.
- After all group members have made their decision, all Points contributed to the group project are added up, and this number of Points is multiplied by 1.6.
- The resulting number of Points is then divided equally among the group members (irrespective of how much they individually contributed to the group project).
- In summary, your income in a round = the points you keep for yourself *plus* the points you receive from the group project.

Also, in order to illustrate how the experiment works, I also provide the following examples:

Group Project - Example 1:

- All 4 players contribute 20 Points to the group project.
- Sum of contributions is 80 Points.
- This amount is multiplied by 1.6, resulting in 128 Points.
- Each participant receives (128/4 =) 32 Points from the group project.

- Therefore, the income of each player is 32 Points.

Group Project - Example 2:

- Participants A, B and C contribute each 20 Points to the group project.
- Participant D contributes 0 Points.
- Sum of contributions is 60 Points.
- This amount is multiplied by 1.6, resulting in 96 Points.
- Each participant receives (96/4 =) 24 Points from the group project.
- Therefore, the income of Participants A, B and C is 24 Points from the group project.
- The, income of Participant D is 44 Points (20 kept for himself *plus* 24 from the group project).

Finally, in order to check whether participants understood or not the instructions of the game, participants are asked to answer a few questions regarding the functioning of the experiment. It is not required to answer them correctly nor to answer all of them in order to continue and start the experiment; participants are told that this is just to be able to draw conclusions and, accordingly, will not affect their final score.

First question: At the start of a round, each group member receives 20 Points. Suppose nobody (including you) contributes any Points to the project.

a. How many points would you earn? (*Correct answer:* 20 Points).
b. How many Points would each of the other members earn? (*Correct answer:* 20 Points).

Second question: Suppose the other three members of your group each contribute 20 Points to the project.

a. How many points would you earn if you contribute 20 Points? (*Correct answer:* 32 Points).
b. How many Points would you earn if you contribute 0 Points? (*Correct answer:* 44 Points).

**This is the link that shows the review version of the control experiment:* https://lioness.uni-passau.de/bin/function/getGameDetails.php?c=YToyOntzOjQ6ImNvZGUiO3M6NjoieHgyM3NyIjtzOjY6ImlkR2FtZSI7czo1OiIyNDQ0NiI7fQ==¡

- **Case study 2 (first treatment condition): "PGG WITH PEER PUNISHMENT"**

Treatment experiment A is a variation of the iterated PGG where players have the opportunity to punish its group mates bearing a cost. It differs from the Control Experiment in that each game is followed by a second stage that allows targeted interactions (in this treatment, peer punishment opportunities) at each other group member. The other characteristics coincide with the standard game; therefore players also interact anonymously for a number of 10 rounds, they receive 20 monetary units and should decide how much to contribute. Then, contributions are multiplied by the synergy factor (r=1.6) and evenly divided among the members of the group (n=4). But here, there is another stage where players have the opportunity to punish at a cost for themselves —i.e. to assign "Deduction Points". For each "Deduction Point" "d" players assign, 3 points will be deducted from the total of the recipient, and 1 point will be deducted from the punisher. This whole process will be also repeated ten times and, once again, subjects are not told the number of rounds. Finally, for a given group, the payoff of each subject *i* in period t is given by:

$$\pi_i^t = y - c_i + (r\,\bar{c}_t) - d - P_P$$

(2) where $\bar{c}_t$ (average contribution at period t) $= \left(\sum_{j=1}^{n} c_i\right)\frac{1}{n}$

and

$$P_P \text{ (probability of being punished)} \approx \frac{c_{t+1}}{4(\bar{c}_t+1)}$$

**The estimate of the probability of being punished was taken from Fehr & Gächter (2000).*

The instructions provided to participants are the following:

In STAGE 1:

- YOUR TASK; at the beginning of each round, each participant receives 20 Points. You have to decide how many of the 20 Points you want to contribute to a group project. The other three members of your group make this decision at the same time.
- The Points you do not contribute, you keep for yourself. These Points are added to your total.
- After all group members have made their decision, all Points contributed to the group project are added up, and this number of Points is multiplied by 1.6.

- The resulting number of Points is then divided equally among the group members (irrespective of how much they individually contributed to the group project).
- In summary, your income in a round = the Points you keep for yourself *plus* the Points you receive from the group project

* At the end of Stage I, you will be informed of the average contributions to the group project, and your earnings in the round so far. Then, Stage II begins.

In STAGE 2:

- At the beginning of Stage II, you are informed of the contributions to the group project of each of the other group members. You will have the opportunity to assign Deduction Points to each of them.
- For each Deduction Point you assign, 3 Points will be deducted from the total of the recipient, and 1 Point will be deducted from your total.
- In each round, you can assign between 0 and 10 Deduction Points to each of the other members of your group.

Also, in order to illustrate how the experiment works, I provide the following examples after the instructions of each stage (examples for the first stage are the same as the ones provided for the "Control experiment", here I only provide the examples for the second stage):

Deduction Points - Example:

- You are informed of the contributions of each of the other members of your group.
- You assign the following Deduction Points to Participants A, B and C: 2, 0 and 3.
- This reduces your earnings in this round by (2+0+3=) 5 Points.
- The other participants assign a total of 4 Deduction Points to you.
- This reduces your earnings in this round by (4*x*3=) 12 Points.
- In Stage II of this round, your total *earnings reduction* due to Deduction Points is (5+12=) 17 Points.

Finally, in order to check whether participants understood or not the instructions of the game, participants are asked to answer a few questions regarding the functioning of the experiment. It is not required to answer them correctly nor to answer all of them in order to continue and start the

experiment; participants are told that this is just to be able to draw conclusions and, accordingly, will not affect their final score. Down below I provide the aforementioned questions:

First question: At the start of a round, each group member receives 20 Points. Suppose nobody (including you) contributes any Points to the project.

a. How many points do you earn in Stage 1? (*Correct answer:* 20 Points).
b. How many Points do the other members of your group earn? (*Correct answer:* 20 —or 60— Points).

Second question: At the start of a round, each group member receives 20 Points. Suppose the other three group members contribute a total of 40 Points in total to the group project. Now suppose you contribute 0 Points to the group project.

a. How many Points will each player receive from the group project? *(Correct answer:* 16 Points).
b. How many Points will you earn in Stage I of this round? (*Correct answer:* 36 Points).

Third question: At the start of a round, each group member receives 20 Points. Suppose that again, the other three group members contribute a total of 40 Points to the group project. Now suppose you contribute 10 Points to the group project.

a. How many Points will each player receive from the group project? *(Correct answer:* 20 Points).
b. How many Points will you earn in Stage I of this round? (*Correct answer:* 30 Points).

Fourth question: Suppose that in Stage II you assign the following Reward Points to the other members of your group: 2, 0 and 5.

a. How many Points will be deducted from your total by assigning these Points? *(Correct answer:* 7 Points).

Fifth question: Suppose that in Stage II the other members of your group assign a total of 5 Reward Points to you.

a. How many Points will be added to your total by having these Points assigned to you? *(Correct answer:* 15 Points).

**This is the link that shows the review version of the first treatment condition:* https://lioness.uni-passau.de/bin/function/getGameDetails.php?c=YToyOntzOjQ6ImNvZGUiO3M6NjoieHgyM3NyIjtzOjY6ImlkR2FtZSI7czo1OiIyNDM3MCI7fQ==

- **Case study 3 (second treatment condition): "PGG WITH PEER REWARDING"**

Treatment experiment B is an iterated PGG where players have the opportunity to reward its group mates bearing a cost for themselves. It differs from the Control Experiment in that each game is followed by a second stage that allows targeted interactions (in this treatment, peer rewarding opportunities) at each other group member. The other characteristics coincide with the standard game; therefore, players also interact anonymously for a number of 10 rounds, they receive 20 monetary units and should decide how much to contribute. Then, contributions are multiplied by the synergy factor (r=1.6) and evenly divided among the members of the group (n=4). But here, there is another stage where players have the opportunity to reward at a cost for themselves (for each assigned "Reward Point" "s", 3 points will be added to the total of the recipient, and 1 point will be deducted from the rewarder. This whole process will be also repeated ten times and, once again, subjects are not told the number of rounds. Finally, for a given group, the payoff of each subject *i* in period t is given by:

$$\pi_i^t = y - c_i + (r\,\bar{c}_t) - s + P_R$$

(3) where $\bar{c}_t$ (average contribution at period t) $= \left(\sum_{j=1}^{n} c_i\right)\frac{1}{n}$

and

P_R (probability of being rewarded)

The instructions provided to participants are the following:

In STAGE 1:

- YOUR TASK; at the beginning of each round, each participant receives 20 Points. You have to decide how many of the 20 Points you want to contribute to a group project. The other three members of your group make this decision at the same time.
- The Points you do not contribute, you keep for yourself, and will be added to your total.
- After all group members have made their decision, all Points contributed to the group project are added up, and this number of Points is multiplied by 1.6.

- The resulting number of Points is then divided equally among the group members (irrespective of how much they individually contributed to the group project).
- In summary, your income in a round = the Points you keep for yourself *plus* the Points you receive from the group project

* At the end of Stage I, you will be informed of the average contributions to the group project, and your earnings in the round so far. Then, Stage II begins.

In STAGE 2:

- At the beginning of Stage II, you are informed of the contributions to the group project of each of the other group members. You will have the opportunity to assign Reward Points to each of them.
- For each Reward Point you assign, 3 Points will be added to the total of the recipient, and 1 Point will be deducted from your total.
- In each round, you can assign between 0 and 10 Reward Points to each of the other members of your group.

Also, in order to illustrate how the experiment works, I provide the following examples after the instructions of each stage (examples for the first stage are the same as the ones provided for the Control experiment; here I just provide the examples for the second stage):

Reward Points - Example:

- You are informed of the contributions of each of the other members of your group.
- You assign the following Reward Points to Participants A, B and C: 2, 0 and 3.
- This reduces your earnings in this round by (2+0+3=) 5 Points.
- The other participants assign a total of 4 Reward Points to you.
- This increases your earnings in this round by (4*x*3=) 12 Points.
- In Stage II of this round, your total *earnings increase* due to Deduction Points is (12-5=) 7 Points.

Finally, in order to check whether participants understood or not the instructions of the game, participants are asked to answer a few questions regarding the functioning of the experiment. It is not required to answer them correctly nor to answer all of them in order to continue and start the experiment; participants are told that this is just to be able to draw conclusions and, accordingly, will not affect their final score.

First question: At the start of a round, each group member receives 20 Points. Suppose nobody (including you) contributes any Points to the project.

a. How many points do you earn in Stage 1? (*Correct answer:* 20 Points).

b. How many Points do the other members of your group earn? (*Correct answer:* 20 —or 60— Points).

Second question: At the start of a round, each group member receives 20 Points. Suppose the other three group members contribute a total of 40 Points in total to the group project. Now suppose you contribute 0 Points to the group project.

a. How many Points will each player receive from the group project? *(Correct answer:* 16 Points).

b. How many Points will you earn in Stage I of this round? (*Correct answer:* 36 Points).

Third question: At the start of a round, each group member receives 20 Points. Suppose that again, the other three group members contribute a total of 40 Points to the group project. Now suppose you contribute 10 Points to the group project.

a. How many Points will each player receive from the group project? *(Correct answer:* 20 Points).

b. How many Points will you earn in Stage I of this round? (*Correct answer:* 30 Points).

Fourth question: Suppose that in Stage II you assign the following Reward Points to the other members of your group: 2, 0 and 5.

a. How many Points will be deducted from your total by assigning these Points? *(Correct answer:* 7 Points).

Fifth question: Suppose that in Stage II the other members of your group assign a total of 5 Reward Points to you.

a. How many Points will be added to your total by having these Points assigned to you? *(Correct answer:* 15 Points).

**This is the link showing the review version of the second treatment condition:*https://lioness.uni-passau.de/bin/function/getGameDetails.php?c=YToyOntzOjQ6ImNvZGUiO3M6NjoieHgyM3NyIjtzOjY6ImlkR2FtZSI7czo1OiIyNDU2OSI7fQ==

5. Results of the experiment

A total of 68 individuals participated in this study at the Universitat Autònoma de Barcelona. Due to material limitations and Covid-19 restrictions, the experiment was performed over a whole week, segmented into separate sessions of 4 or 8 subjects. In order to control the entrance to the experiment and secure reliable results individuals were subject to IP address recognitions. As indicated in the experimental design, participants interacted anonymously for a number of 10 rounds in permanent groups of four. As shown in **Table 1**, a total number of 17 groups of 4 individuals participated in the experiment. A number of 7 groups and 28 subjects participated in the Control experiment (i.e. the Standard PGG) and, the first and the second treatment, had a participation of 5 groups of 4 individuals each.

Table 1 – Group Composition

	Case Study 1 *Control experiment (Standard Iterated PGG)*	***Case Study 2*** *First treatment (Peer punishment opportunities)*	***Case Study 3*** *Second treatment (Peer rewarding opportunities)*
Participants	7 groups of size *4*	5 groups of size *4*	5 groups of size *4*

- **Case study 1 (Control experiment): "STANDARD ITERATED PGG"**

First of all, the data regarding the degree of understanding before starting the game is shown in **Table 2** —calculations are based upon the percentage of correct answers in the "Control Questions", that check whether participants understood or not the provided instructions. Overall, subjects seem to have understood the first question (see them in page 12) asking for the payoff received if no one contributed any point to the group project. Therefore, most of the participants are able to predict their payoff in the absence of cooperation. However, this understanding significantly decreases in the second question —specifically in part b. As a result, prior to the game, approximately half of participants seem to do not understand the dynamics of the game in the presence of contributions —in particular, the impact on payoff of cooperating or not cooperating at all. More than 60% of the participants do not realize the incentives of free riding —

reflected in question 2.b.— and hence this could partially explain the relatively higher levels of cooperation at the beginning of the game. Thereby, the reason of the unsteadily decrease being the progressive acknowledgment of the free-riding incentives as the game progresses. All in all, the degree of understanding prior to the game indicate that subjects cannot be totally consistent with their beliefs due to an overall poor understanding of the instructions, so even if they only care about their individual payoffs, this is cannot be initially reflected in their behavior.

Table 2 – Initial understanding of the Standard PGG

Percentage of correct answers in Control Questions	
Question 1.a.	*71,43 %*
Question 1.b.	*64,29 %*
Question 2.a.	*60,71 %*
Question 2.b	*39,29 %*

Regarding the results of the experiment, in **Figure 1** we see the mean contribution per round in the standard iterated PGG. In the first period, on average, subjects have contributed 14 m.u. or, equivalently, 70% of their endowments. Then, we observe a sustained drop on cooperation until we reach an apparent stabilization at 9 m.u. in the final rounds (periods 7, 8, 9 and 10). Therefore, in just a few rounds, the level of cooperation has been cut down by nearly a half. In addition, we observe that, on average, individuals contribute half of their endowments (mean contribution of the game: $\bar{c}$ = 11.07). The bottom line of this trend is that, for some reason that we will discuss later on, cooperation declines as the game progresses to its final rounds —note that, however, for

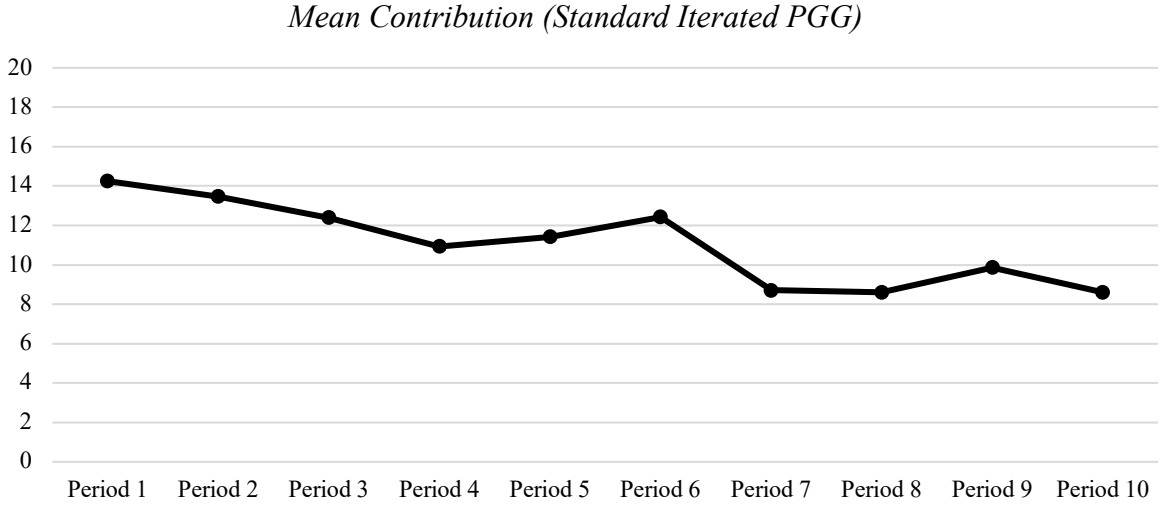

Figure 1 – Mean Contribution (nominated in m.u.) in the Standard Iterated Public Goods Game.

some reason, cooperation do not vanish and it is still persistent. Knowing that the payoff function significantly depends on the level of cooperation —as seen in equation (1)—, it comes with no surprise the decline also on payoffs depicted in **Figure 2**. Therefore, we observe that, as cooperation declines, individual payoff decreases accordingly.

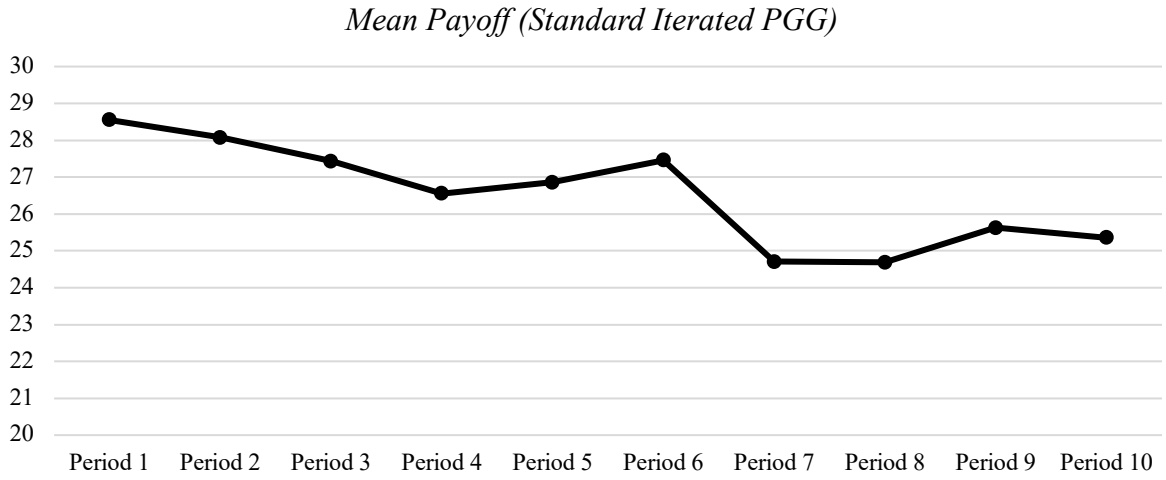

Figure 2 – Mean Payoff (nominated in m.u.) in the Standard Iterated Public Goods Game.

Figure 3 shows the percentage of the maximum possible payoff achieved in each round. Remember that maximum payoff in a round is achieved if and only if all subjects of the group contribute their entire endowment to the "group project" —i.e. full cooperation. However, this is not the case for any of the rounds in the Control experiment, hence in all rounds total payoff is just a fraction of the maximum possible payoff. Once again, as payoff declines with cooperation, the function is nearly full downward-sloping, meaning that the achieved payoff over the maximum possible one have had a decreasing trend.

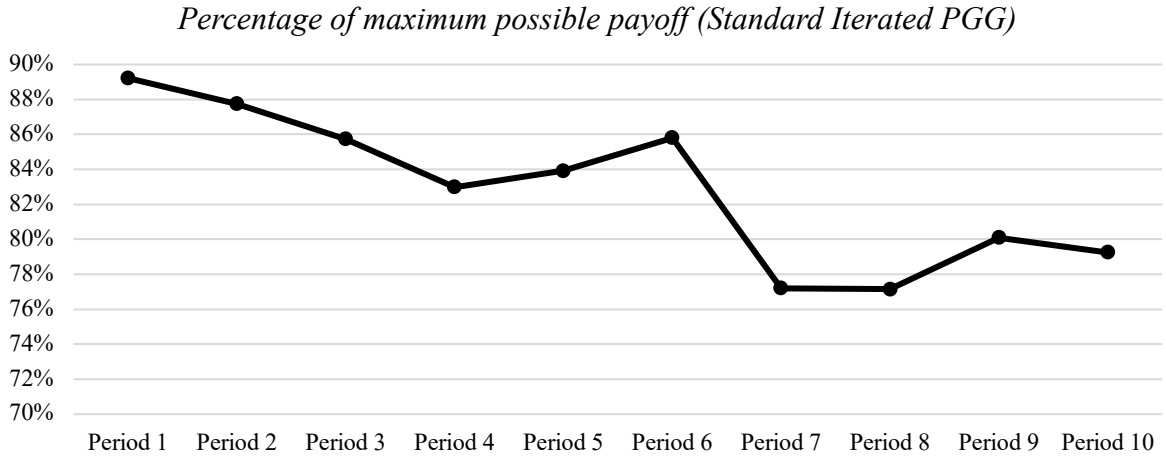

Figure 3 – Percentage of maximum possible payoff in the Standard Iterated Public Goods Game.

- **Case study 2 (first treatment condition): "PGG WITH PEER PUNISHMENT"**

To begin with, the data regarding the degree of understanding before starting the game is shown in **Table 3.** It seems that 3 out of 4 participants understood part "a" and "b" of the first question (see them in page 15). Consequently, most subjects are able to predict their payoff in the absence of cooperation and understood rightly that they keep for themselves the points they do not contribute. Just as in the previous case, understanding significantly decreases in the second question. The percentage of correct answers is almost the same for the second and the third question, meaning that, before starting the game, more than half of the participants were unable to predict their payoffs if either they, their group members or both decided to cooperate. Therefore, once again, a significant part of the subjects that participated in the experiment do not understand the dynamics of the game in the presence of contributions. While participants initially do not realize the incentives of free-riding, we observe that at least 40% them understood that increasing cooperation yields a higher group payoff —reflected in part "a" of questions 2 and 3. Understanding improves a bit in questions 4 and 5, asking for the cost of assigning "Deduction Points" —first for the punisher and, then, for the recipient. Thus, approximately half of participants understand how punishing works even before starting the game.

Table 3 – Initial understanding of the PGG with punishment

Percentage of correct answers in Control Questions	
Question 1.a.	*75 %*
Question 1.b.	*75 %*
Question 2.a.	*40 %*
Question 2.b.	*35 %*
Question 3.a.	*45 %*
Question 3.b.	*35 %*
Question 4.	*50 %*
Question 5.	*60 %*

Regarding the data I have collected from the first treatment condition —i.e. punishment opportunities after each round—, in **Figure 4** we observe how in this case the mean contribution has been extraordinarily stable throughout the whole experiment. This is so much the case that the highest mean contribution took place in the last round —exactly the opposite from what we observed in the Standard Iterated PGG. In all but the first round, contributions remained stable

between the gap [15,16] and the average contribution has been 16 m.u —or, equivalently, 80% of the initial endowment. Therefore, it seems that the treatment condition succeeded to prevent the fall of cooperation in the final rounds that we observed in the Standard PGG —in the discussion we will further elaborate on these effects.

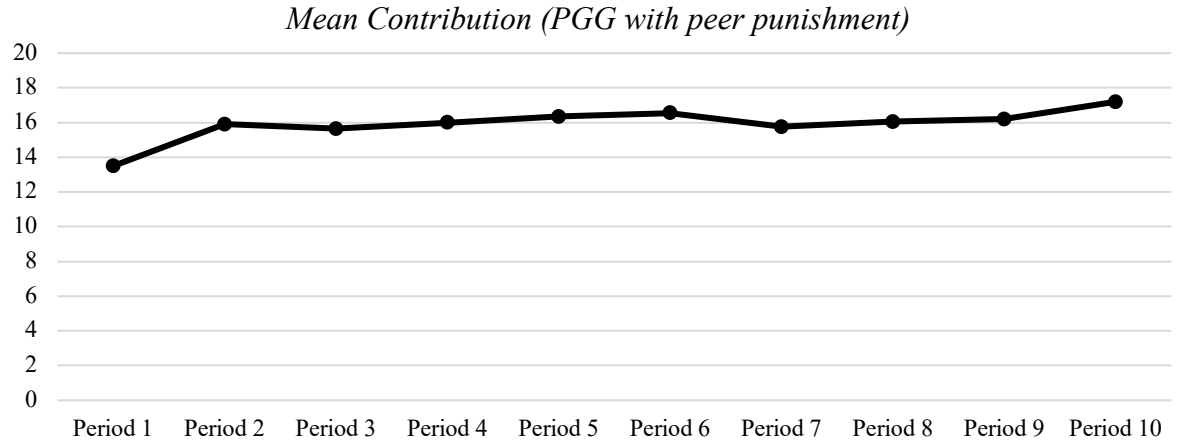

Figure 4 – Mean Contribution (nominated in m.u.) in the PGG with peer punishment.

In this case, the payoff function does not only depend on the level of cooperation, instead it is a function of contributions and deductions. As a result, the correlation between the mean contribution and the mean payoff is much more ambiguous than before. In **Figure 5**, we observe that, even if contributions remained stable, the payoff declines with repetition, but why? Indeed, this results could be counter-intuitive if we ignore the usage of punishment throughout the rounds, but if we do take a look also on **Figure 7** —the usage of punishment— we will see that this reduction of payoffs coincides with an increase of punishment —that harms the payoff of both the punisher and the recipient.

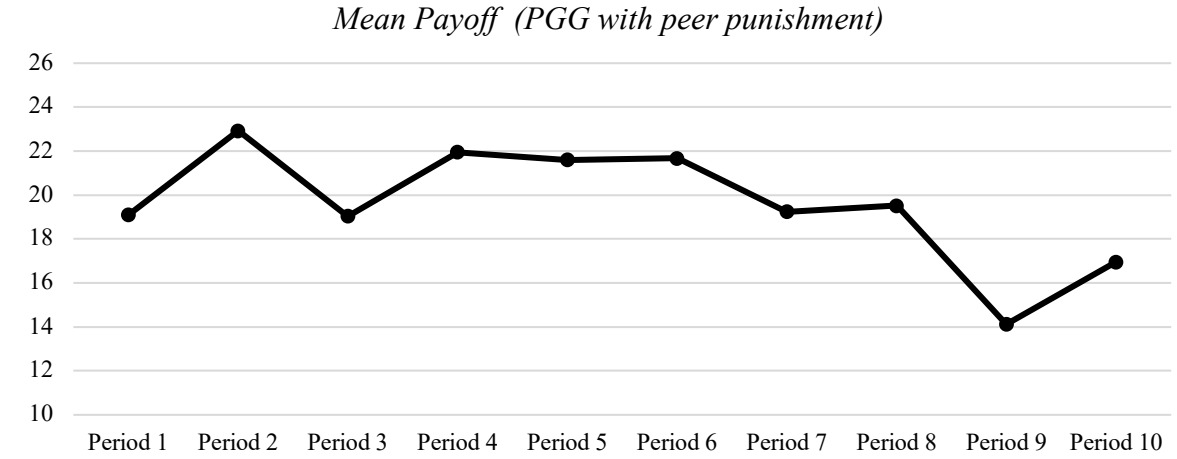

Figure 5 – Mean Payoff (nominated in m.u.) in the PGG with peer punishment.

Nevertheless, before going any further, we see in **Figure 6** the percentage of maximum possible payoff that has been achieved in each round. Note that, in the case of punishment, the maximum payoff is still achieved when every member of the group contributes their entire endowment to the "group project" and besides does not assign any "Deduction Point". As we have already seen, this is not the case for any of the rounds and, accordingly, total payoff is just a fraction of the maximum possible payoff. This figure follows the same trend as the latter and hence we observe how the percentage of maximum payoff declines with repetition.

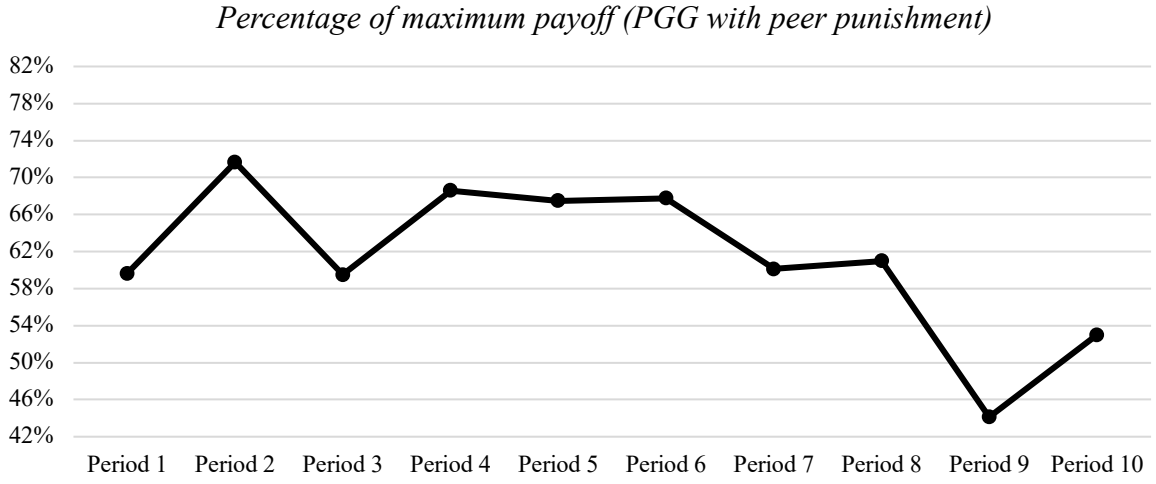

Figure 6 – Percentage of maximum possible payoff in the PGG with peer punishment.

Finally, in **Figure 7** is shown the usage of punishment throughout the game. Note, that it has an increasing tendency, as opposed to the decreasing fashion of payoff functions. Also, in the second-last round —round 9— the use of punishment surges to be cut down in the last round, most likely due to the finite horizon of the game —as the cost of punishing in the last round cannot be offset by an increase of cooperation in the following rounds.

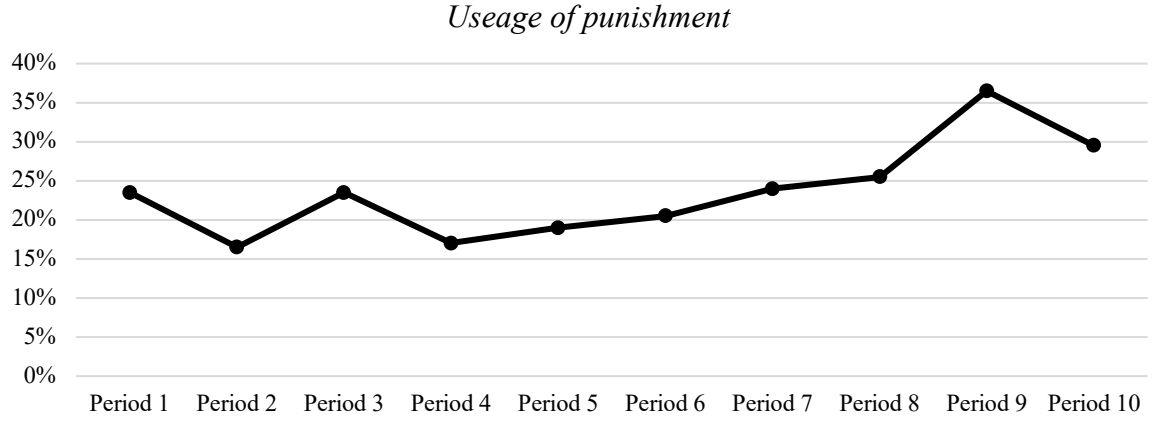

Figure 7 – Use of punishment throughout the PGG with peer punishment.

- **Case study 3 (second treatment experiment): "PGG WITH PEER REWARDING"**

Once again, let us first comment the data regarding the degree of understanding before starting the game —see **Table 4.** More than half of the participants answered correctly the first question (see them in page 18). However, the rate of correct answers decreases a little bit when participants are asked for their payoff in the presence of cooperation (second question). It seems that, once more, participants do not realize the incentives of free riding —i.e. they fail to predict the higher payoff that would result from a non-cooperating scenario. The situation is therefore quite similar to the previous cases, as participants understand better the situations where the sum of contributions is zero, but fail to predict their payoffs in the presence of cooperation. The understanding worsens even more in the third question asking for the group and individual payoffs if both group members and yourself contribute part of your initial endowment. More than half of the participants failed "part a" and just a third answered correctly "part b". This results provide more evidence, that approximately half of the participants do not understand the dynamics of the experiment before starting the game. However, most participants rightly understood how "Reward Points" work, both the cost of assigning them —fourth question —and the benefit of receiving them —fifth question.

Table 4 – Initial understanding of the PGG w/ Reward

Percentage of correct answers in Control Questions	
Question 1.a.	*65 %*
Question 1.b.	*60 %*
Question 2.a.	*65 %*
Question 2.b.	*50 %*
Question 3.a.	*45 %*
Question 3.b.	*35 %*
Question 4.	*90 %*
Question 5.	*90 %*

Regarding the results of the experiment, in **Figure 8** we see the mean contribution in each round in the PGG with peer rewarding. On average, in the first round participants have contributed 13 m.u. or, equivalently, 65% of their endowments to the group project. We then observe a sudden drop that is quickly stabilized in period 4, this also reflected on a higher usage of "Reward Points" in this same round —see **Figure 11,** showing how this sudden increase of contributions coincides with a higher usage of rewarding. In the following rounds, mean contributions are at least at 12 m.u. with a peak at 14 m.u. in period 9. Therefore, we see how in the PGG experiment with

rewarding opportunities contributions do not fall with repetition —instead, they are stable and they even rise in some rounds. In addition, we observe that, on average, individuals contribute approximately 60% of their endowments. The bottom line of this trend is that, for a reason that we will discuss below, cooperation do not fall with repetition in the presence of peer rewarding.

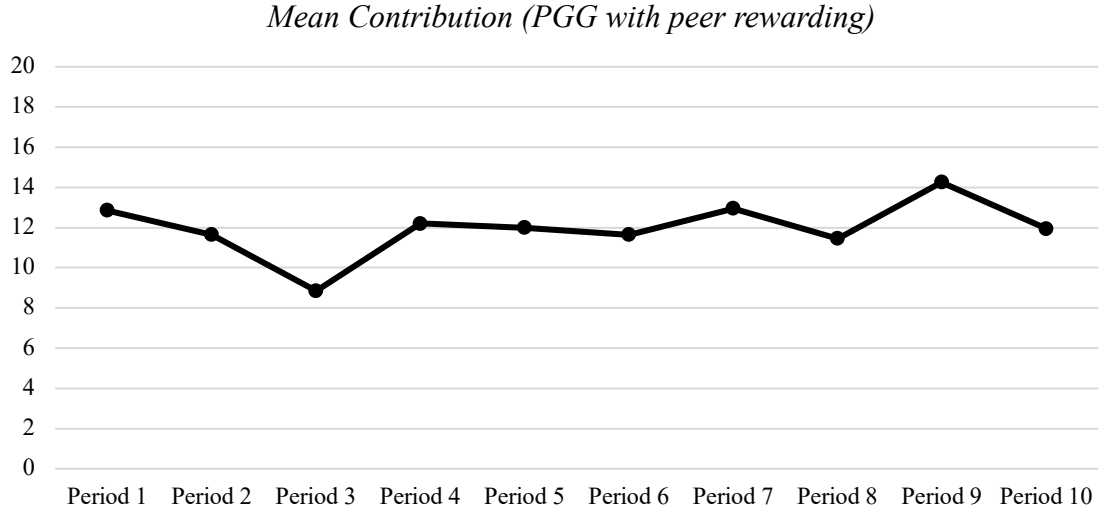

Figure 8 – Mean Contribution (nominated in m.u.) in the PGG with peer rewarding.

In **Figure 9**, we observe that the mean individual payoff depends on the level of cooperation even in the presence of peer incentives —recall that, in the first treatment, this relation was much more ambiguous. Every time that cooperation falls, individual payoffs fall accordingly —and *vice versa*. Also note that individual payoffs are much higher than in the previous cases. Finally, it is remarkable enough that the highest mean payoff of the game has come in the second-last round.

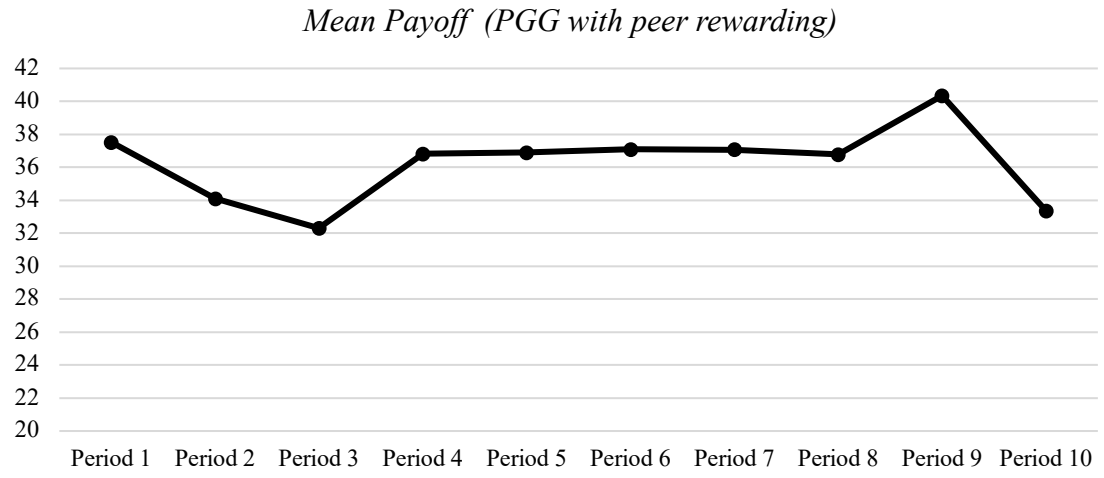

Figure 9 – Mean Payoff (nominated in m.u.) in the PGG with peer rewarding.

Figure 10 shows the percentage of maximum possible payoff that has been achieved in each round in the PGG experiment with peer rewarding. However, in this case, the maximum payoff that can be achieved is a combination of a full cooperation scenario and the assignment of the highest possible number of "Rewarding Points" —each individual can assign a maximum of 10 per round. As a result, this yields a much higher maximum possible payoff, but still percentages are slightly higher than the ones of the punishment treatment.

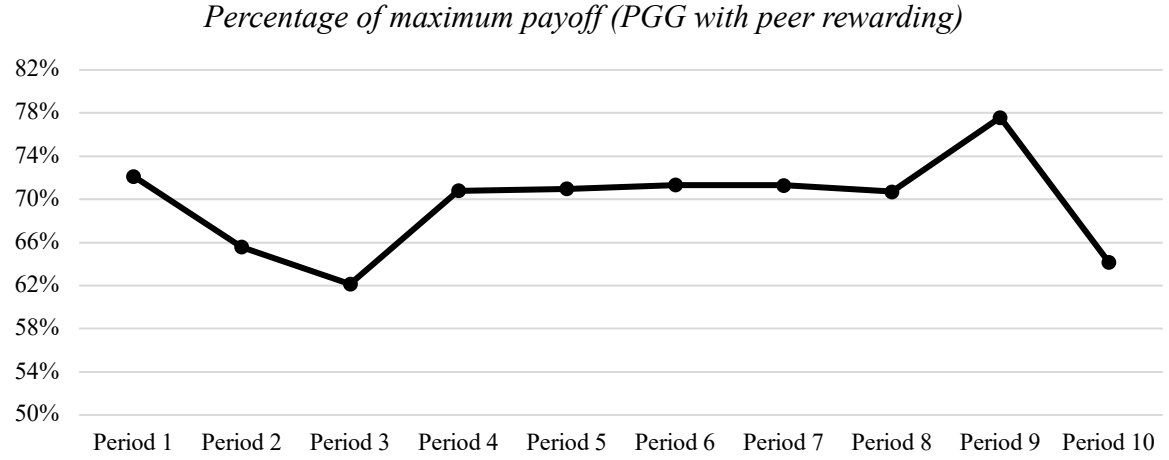

Figure 10 – Percentage of maximum possible payoff in the PGG with peer rewarding.

Finally, in **Figure 11** we see the average usage of "Rewarding Points" in each round. As we have already commented, the use of reward initially decreases but, in period 4, there is a sudden increase of them that coincides with a surge of cooperation in this same round and, consequently, an increase of the mean payoff. Finally, let me highlight that the usage of rewarding does not only coincide with the function of the mean contribution, it coincides as well with the payoff function.

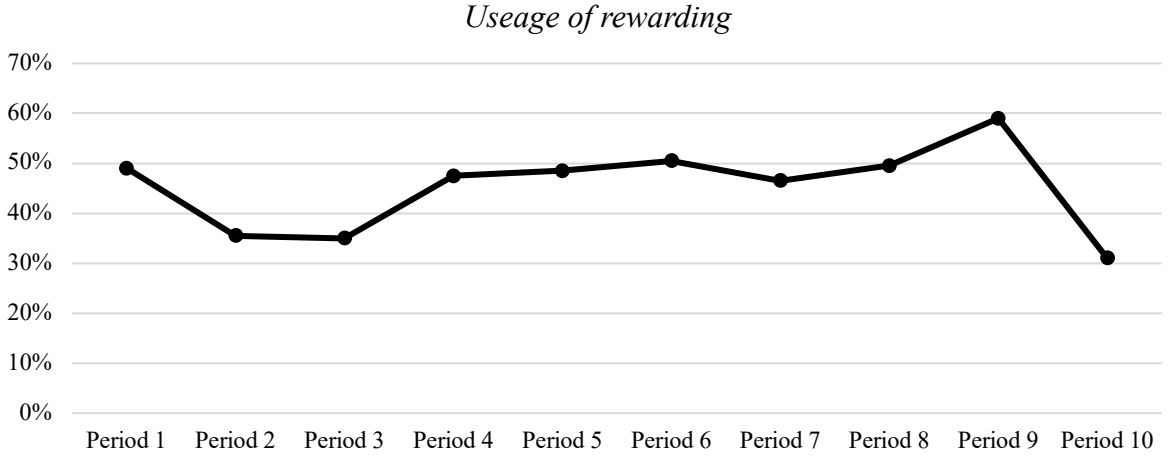

Figure 11 – Use of punishment throughout the PGG with peer rewarding.

6. Discussion of the results

First of all, these results verify that a significant part of the participants did not fully understand the instructions. In all cases, at least half of them, cannot predict their payoff in the presence of contributions and do not realize the free riding incentives. This lack of understanding could play an important role in the sustained drop in cooperation that we observe in the control experiment —i.e. the Standard Iterated PGG— due to the potential learning outcomes that participants can get as the game progresses. Therefore, understanding will inevitably increase over the course of the experiment and thus participants will realize the free-riding incentives as well as other aspects of the game that they did not comprehend before. As a result, subjects whose aim is to maximize individual payoff, will realize that free-riding can be the best strategy to achieve it and will cut down their contributions. Also, as the game progresses participants are able to develop more complex strategies that will better suit their objectives.

An alternative explanation to the decline of cooperation in the Standard PGG is that subjects have a natural bias to initially cooperate, that is suppressed as a result of frustrated attempts at kindness (Andreoni, 1995). Throughout the game they realize that most of the time increasing their contribution harms their payoff and, on top of that, their group members decrease their contributions when observing a top contributor in their group. Finally, seeing that the strategy of defectors —below average contributors— yields higher payoffs, they decide to cut down their contributions as well. Also, we must consider that the cause of the decline in cooperation could be a combination of both the aforementioned factors—i.e. the progressive learning over the course of the game and the frustrated attempts at kindness. Regardless of the reason, we should still take into account that the behavior of participants in the starting rounds can mismatch their own beliefs and is undeniable that in the first rounds participants showed a bias towards cooperation.

Still on this topic, in the treatment conditions, most participants have understood correctly the functioning of “Reward Points”. The understanding of “Deduction Points” has been significantly lower but still percentages are above 50%. The poorer understanding of deduction, could have something to do with the fact that punishing is costly, harming both the payoff of the punisher and the punished. This can be counter-intuitive because participants could think that they do not deserve to incur additional costs just to punish free-riders. Rewarding is costly too, but just for the rewarder, causing that the overall result of rewarding is still a surplus, as for each “Reward Point”

you assign you lose just one point and the recipient receives three. Finally, let me remark once again that the understanding of the incentives has been considerably higher than on the previous questions; perhaps because in our society we are already familiar with this kind of incentives schemes.

Regarding the overall results of the experiment, we will take advantage from the following combined graphs to complement the discussion. In **Figure 12,** it is clear that both treatments —punishment and reward— have succeeded to prevent the decline of contributions —in this respect they seem equally efficient. However, there are also substantial differences between the two; while the average contribution of the PGG with peer rewarding ($\bar{c}$ = 11,98) has been just slightly above the one of the Standard PGG ($\bar{c}$ = 11,07), the average contribution of the PGG with peer punishment has been much higher ($\bar{c}$ = 15,92). In this respect, the punishment treatment has been significantly more efficient than reward in promoting cooperation; but at what cost?

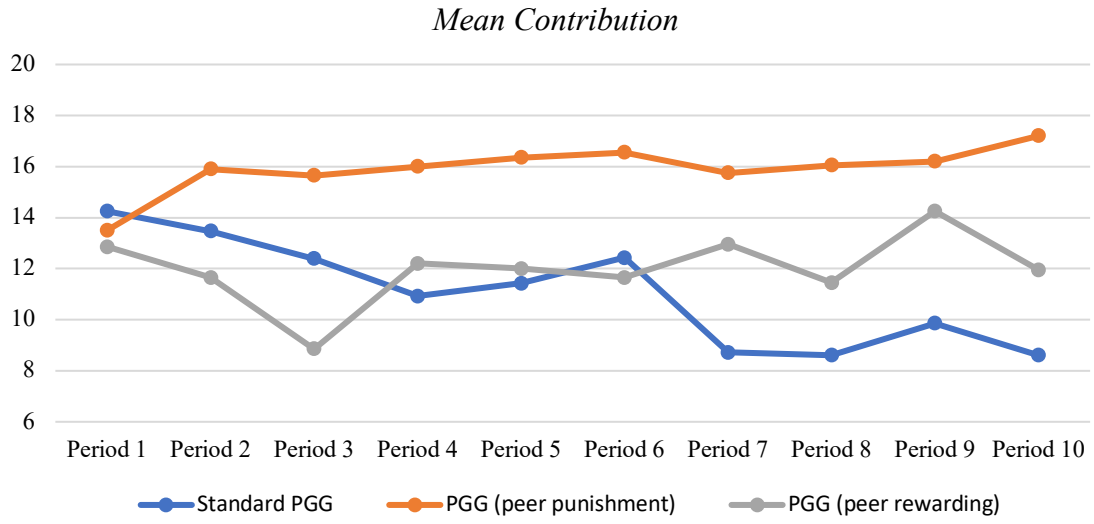

Figure 12 – Mean contribution in each variation of the PGG.

To answer this last question, we must compare the payoffs that have been achieved in each of the studied cases. **Figure 13** shows the mean payoff in both the control and the treatment experiments. In the graph we can observe how peer rewarding has been the most successful variation in this respect and peer punishment the worse. Even if punishment prompted higher contributions, this has not implied higher payoffs due to the costs of punishing. In the PGG, punishing produces a social welfare loss as it costly for both parties —the punisher and the recipient— while rewarding

produces social welfare improvements. These results indicate that the most efficient incentive scheme in increasing payoffs has been peer rewarding and, in the line of Rand et al. (2009), it suggests that what really matters is the possibility of targeted interactions, regardless if that is in the form of punishment or reward. Therefore, this results also question the proposal by Fehr & Gächter, (2000) that costly punishment is the optimal force for prompting cooperation.

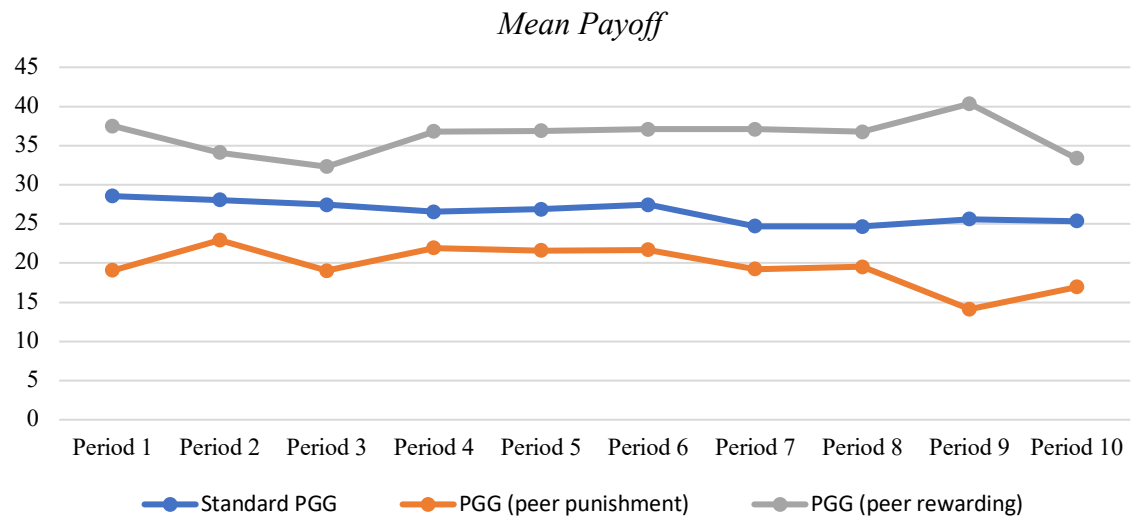

Figure 13 – Mean payoff in each variation of the PGG.

However, it is difficult to point out which incentive is overall more efficient, because while punishment has been more effective at incentivizing cooperation, reward has been clearly more effective at prompting higher payoffs. On the one hand, in the case of punishment, it is objectionable that the points subtracted from the punished just vanish while they could be added to the group payoff. On the other, it is unrealistic that the cost of reward is lower than the benefit that the recipient will experience —the cost is 1 and the benefit is 3. However, Szolnoki & Perk (2010) ascertain that this is reasonable enough because, for instance: "To praise someone hardly costs anything, yet it may do wonders for the recipient". It stands to reason, that this justification does not suffice in the case of the financing of public goods, but still their reasoning is correct.

Furthermore, one of the main problems of peer punishment is that individuals can punish as an act of revenge (Rand et al., 2009). Closely observing the data group by group, I have seen some situations where free riders punish cooperators, either randomly or because they have previously been punished by them. This harms heavily the payoff of both individuals and, even more concerning, it undermines the whole functioning of the peer punishment itself as cooperators,

fearing revenge, will either stop punishing or start punishing unjustly the individuals who took revenge against them. In this respect, as (Rand et al., 2009) already pointed out, reward outperforms punishment and human cooperation in repeated settings —such as the iterated PGG— seems to be best supported by positive interactions.

Regarding the cost of punishment, an interesting question to explore is why should we implement punishment schemes if they end up harming social welfare and they give rise to lower payoffs than the ones in the Standard Case scenario without incentives. It stands to reason that, from the point of view of maximizing welfare we should clearly reject such an investment scheme. However, moral values such as fairness and equality force us to implement some kind of mechanism to punish the ones who are benefiting from the fruits of the others —i.e. free-riding. But, in this respect, we should not carelessly set aside rewarding schemes.

Regarding the use of punishment and reward, we see in **Figure 14** that the latter has been more widely used. In many rounds the use of "Reward Points" has doubled the usage of "Deduction Points" and in all rounds reward's use is well above the punishment use, except for the last round, where the usage of both incentives decreases and is nearly the same. Most likely, due to the finite horizon of the game, that makes interaction pointless in the last round because there cannot be effects on future cooperation. In the case of punishment, you could assign "Deduction Points" to a free rider, but participants beforehand know that this will not have any effect on the recipient behavior. This should draw back most of the participants, but by far this is not what have occurred in the experiment, as punishment has been used at higher percentages than nearly all rounds except for the nineth.

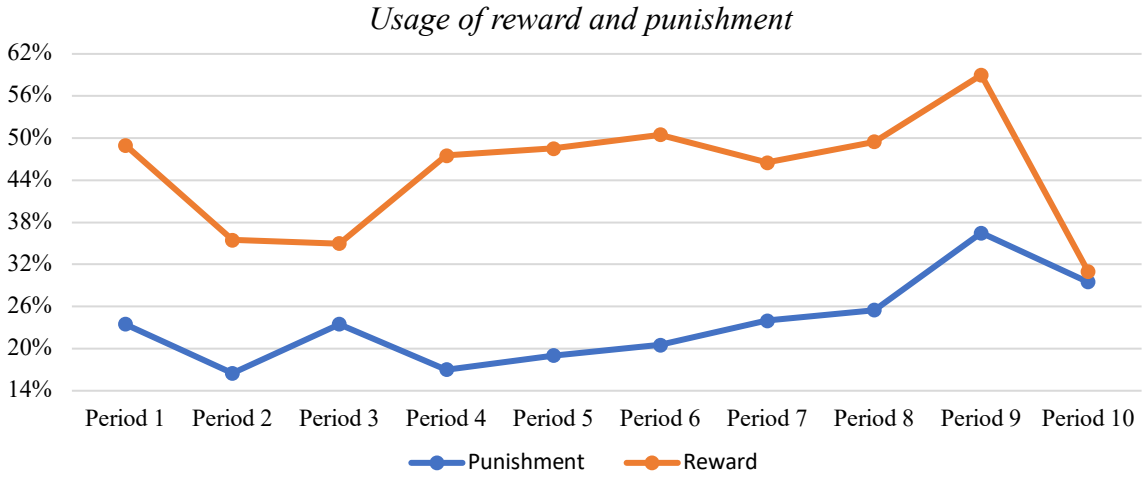

Figure 14 – Usage of reward and punishment.

In addition, we observe in period 9, in both punishment and reward, how the use of incentives surges, most likely to affect the behavior of others when there is still one round left and, therefore, there is still hope to boost cooperation. However, if participants lead themselves just for the sake of cooperation and to increase the social payoff, punishment in the last round should be non-existent because participants do not have the opportunity to affect future actions of their group members. As a result, we must approach this surprisingly high rate of punishment in the last round as the result of acts of revenge or attempts to harm the payoff of other participants. For the case of reward, however, it is a different story. In the last round, what would have boosted the social and individual payoffs would have been the assignment of the highest number allowed of "Reward Points", as each point creates a social welfare gain of two points. However, the usage of reward in the last round has been 30%, most likely because participants cared more about their individual payoff and therefore were afraid of assigning points without the certitude that their group members were about to the same thing.

Regarding the efficiency of incentives —i.e. in our framework, the points that are added or subtracted for each assigned "Reward" or "Deduction Point"—, I want to highlight that it has been the same for both punishment and reward —equal to three. Therefore, the claim by Szolnoki & Perc (2010) stating that for rewards to work equally well as punishment, the ratio between the benefit and the cost of rewarding must be significantly higher than in case of punishment is challenged by the results of this experiment. Furthermore, regarding the efficiency of "Reward Points" I must add a final remark. Setting an efficiency of 3 points for each assigned "Reward Point", I have unintentionally created an additional rational strategy. For each assigned "Reward Point" a social welfare gain of 2 m.u. is created, while for each point contributed to the group project the social gain is lower, just 1.6 m.u. For such reason, the social welfare maximizing strategy for this game became assigning the maximum number of "Reward Points" allowed while also contributing as many points available to the group project. However, looking at the results one by one, I have seen that just two players conducted this strategy.

The emergence of this last strategy, has caused that the maximum payoff that could be achieved through the PGG with peer rewarding is much higher than in the other two variations of the game. The maximum group payoff that could be achieved in each round in the reward treatment was 1040 points, while in the other variations —the standard game and the punishment treatment— was only 640. **In Figure 15**, we observe how the Standard PGG has achieved the highest

percentage of maximum payoff. However, it goes without saying that if we equate the denominator for all games, peer rewarding would have achieved the higher maximum payoff in each round, as it was the incentive that gave rise to the highest mean payoffs.

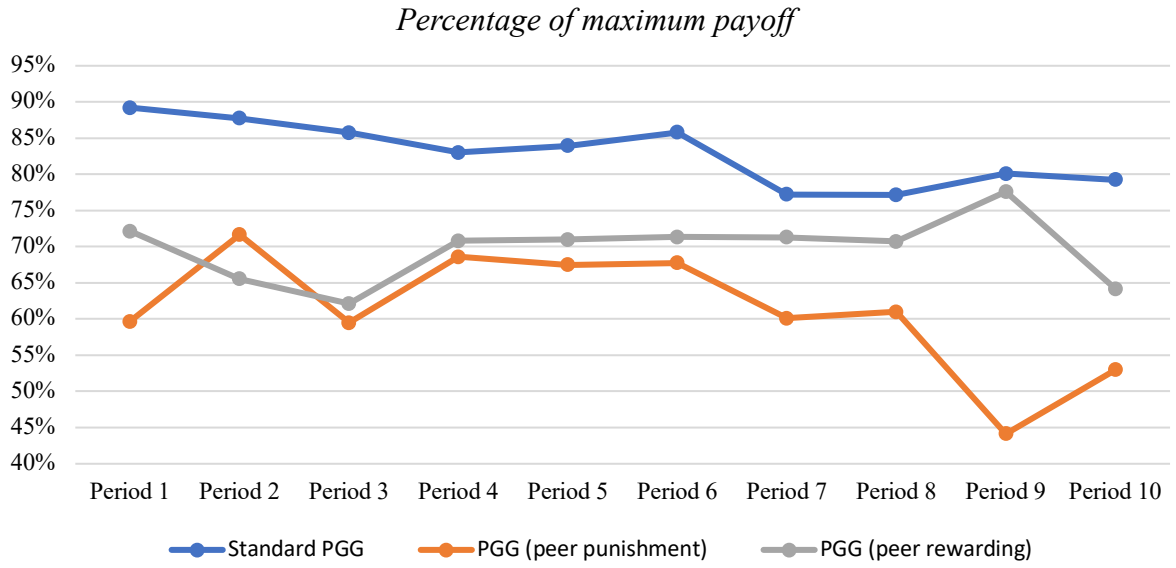

Figure 15 – Percentage of maximum payoff in each variation of the PGG.

Summarizing, the results of the experiment indicate that —at the same efficiency rate— peer reward can be as effective as punishment for several reasons. Although punishment has been clearly superior at incentivizing high levels of contribution, it entails large costs that many times cannot be offset by the increase in cooperation. This has been the case for this experiment, as the relatively higher levels of contribution that we observed in the PGG experiment with peer punishment could not prevent the lowest mean payoff of the three observed cases. This phenomenon was already pointed out on 2010 by Boyd et al. (2010), who postulated the need of coordinated punishment to capture the fact that the total cost of punishing a free-rider declines as the number of punishers increases. However, in the case of reward, participants have managed to achieve significantly higher payoffs with relatively low contributions. Consequently, as we do not want cooperation for the sake of cooperation itself but for the larger payoffs it renders, we can conclude that reward can be the optimal incentive scheme, not to promote cooperation itself, but to promote higher payoffs.

7. Conclusion

This study provides empirical evidence that both punishment and reward succeed at sustaining cooperation in the PGG setting; although it is undeniable that punishment has led to higher contributions, I have concluded that reward can be the optimal force to trigger higher payoffs. To reach such concluding remarks, I have conducted my own PGG experiment in order to compare the outcome of the Standard Iterated PGG with two variations of the game where peer —non-centralized— incentives were present. In the first variation, I have allowed for punishment opportunities and, in the second one, there were rewarding opportunities. Then, I have analyzed the results of each variation and I have compared them against each other. This methodology has been quite useful to establish several similarities and divergences between them, as well the strengths and downsides of each of the incentives.

Finally, I would suggest for future research on this field the following remarks. On the one side, peer punishment on should be studied on a more realistic framework where the tokens subtracted through "Deduction Points" were added to the group project instead of just vanishing. And similarly, for the case of reward, I would suggest avoiding setting efficiencies above the multiplier factor of the public pot, otherwise we are creating another social payoff maximizing strategy where it is better to not contribute some tokens and put them in the rewarding stage. On the other, I would suggest to further study public good games when there are initial economic disparities among the members of a given group —i.e. when the initial endowments differ across participants.

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Annexes

Annex 1: Review Version of the Standard PGG experiment:

Welcome

In the setup of this experiment, you will be playing in a group together with three **real people** who also accepted to participate in this experiment, who are completing it **at the same time**. It is therefore important that you complete it **without interruptions**.

Including the time for reading these instructions, the experiment will take about 20 minutes to complete.

During the experiment, please **do not close this window** or leave the experiment web pages in any other way.
If you do close your browser or leave the task, you will not be able to re-enter!

In this experiment you will play a game with the same people for 10 rounds. In these rounds, you can earn Points.

Continue

Instructions

Your task

At the beginning of each round, **each participant receives 20 Points.** You have to decide how many of the 20 Points you want to **contribute to a group project**. The other three members of your group make this decision at the same time.

The Points you do not contribute, you **keep for yourself**. These Points are added to your total.

After all group members have made their decision, all Points contributed to the **group project** are added up, and this number of Points is **multiplied by 1.6**.

The resulting number of Points is then **divided equally among the group members** (irrespective of how much they individually contributed to the group project).

In summary, **Your income in a round** = The Points you keep for yourself *plus* The Points you receive from the group project

Group project - Example 1

- All 4 players contribute 20 Points to the group project.
- Sum of contributions is 80 Points.

- This amount is multiplied by 1.6, resulting in 128 Points.
- Each participant receives (128 / 4 =) 32 Points from the group project.

- Therefore, the income of each player is 32 Points.

Group project - Example 2

- Participants A, B and C contribute each 20 Points to the group project.
- Participant D contributes 0 Points.
- Sum of contributions is 60 Points.
- This amount is multiplied by 1.6, resulting in 96 Points.
- Each participant receives (96/4 =) 24 Points from the group project.

- Therefore, the income of Participants A, B and C is 24 Points.
- The income of Participant D is 44 Points (20 kept for himself *plus* 24 from the group project).

Please make your decisions within the time limit shown on your screen. If you fail to do so, you will be removed from the experiment.

After all members of your group have made their decision, the **results** of the round **will be shown** to you.
Once all players in your group are finished, a new round will begin. Again, you will receive 20 Points to start with.
After 10 rounds the experiment is over. A brief questionnaire will conclude this experiment.

Please click the link below if you understood the instructions. Before the experiment itself starts, a brief quiz will check whether you understand your task.

Continue

Control questions

Please answer all control questions. These serve as a test for your understanding of the experiment.

1. At the start of a round, each group member receives 20 Points. Suppose nobody (including you) contributes any Points to the project.

How many Points would you earn?

How many Points would each of the other group members earn?

2. Suppose the other three members of your group each contribute 20 Points to the project.

How many points would you earn if you contribute 20 Points?

How many points would you earn if you contribute 0 Points?

Continue

Back to instructions

Round 1 of 10

A new round has started.
You received **20 Points** to start with.

Your contribution to the group project is...

Continue

You must click "Continue" before time runs out.

Round 1 of 10

Results

Your contribution to the group project: 5.
Average contribution in your group: 7.5.

Sum of contributions in your group: 30.
This amount is multiplied by 1.6, yielding **48.0**.
Each group member receives **an equal share: 12.0.**

Your earnings

Points kept for yourself: **15**.
Your share from the group project: **12.0**.

Your total earnings in this round: 27.0.
Your total earnings including this round: **27.0**.

Continue

Questionnaire

What is your age?

What is your gender?

male female other

Finish

Total points

During this experiment you have earned 299.20000000000005 Points.

Now, you can close this window. I thank you for participating in the study.

Annex 2: Review Version of the PGG experiment with peer punishment:

Welcome

In the setup of this experiment, you will be playing in a group together with three **real people** who also accepted to participate in this experiment, who are completing it **at the same time**. It is therefore important that you complete it **without interruptions**.

Including the time for reading these instructions, the experiment will take about 20 minutes to complete.

During the experiment, please **do not close this window** or leave the experiment web pages in any other way.
If you do close your browser or leave the task, you will not be able to re-enter!

In this experiment you will play a game with the same people for 10 rounds. In these rounds, you can earn Points.

Continue

Instructions

Your task

In your group of four, you will make decisions in a game of 10 rounds. Each round consists of two Stages.

Stage I

At the beginning of each round, **each participant receives 20 Points.** You have to decide how many of the 20 Points you want to **contribute to a group project**. The other three members of your group make this decision at the same time.

The Points you do not contribute, you **keep for yourself**. These Points are added to your total.

After all group members have made their decision, all Points contributed to the **group project** are added up, and this number of Points is **multiplied by 1.6**.

The resulting number of Points is then **divided equally among the group members** (irrespective of how much they individually contributed to the group project).

In summary, **Your earnings in Stage I** = The Points you keep for yourself *plus* The Points you receive from the group project

Group project - Example 1

- All four players contribute 20 Points to the group project.
- Sum of contributions is 80 Points.

- This amount is multiplied by 1.6, resulting in 128 Points.
- Each participant receives (128/4=) 32 Points from the group project.

- Therefore, in Stage I each participant earns 32 Points.

Group project - Example 2

- Participants A, B and C contribute each 20 Points to the group project.
- Participant D contributes 0 Points.
- Sum of contributions is 60 Points.

- This amount is multiplied by 1.6, resulting in 96 Points.
- Each participant receives (96/4=) 24 Points from the group project.

- Therefore, in Stage I Participants A, B and C each earn 24 Points.
- Participant D earns 44 Points (20 kept for themselves *plus* 24 from the group project).

At the end of Stage I, you will be informed of the average contributions to the group project, and your earnings in the round so far. Then, Stage II begins.

Stage II

At the beginning of Stage II, you are informed of the contributions to the group project of each of the other group members.
You will have the **opportunity to assign Deduction Points** to each of them.

For each Deduction Point you assign, **3** Points will be deducted from the total of the recipient, and **1 Point will be deducted from your total**.

In each round, you can assign **between 0 and 10 Deduction Points** to each of the other members of your group.

Deduction Points - Example

- You are informed of the contributions of each of the other members of your group.
- You assign the following Deduction Points to Participants A, B and C: 2, 0 and 3.
- This reduces your earnings in this round by (2+0+3=) 5 Points.

- The other participants assign a total of 4 Deduction Points to you.
- This reduces your earnings in this round by (4x3=) 12 Points.

- In Stage II of this round, your total *earnings reduction* due to Deduction Points is (5+12=) 17 Points.

Please make your decisions within the time limit shown on your screen. If you fail to do so, you will be removed from the experiment.

Continue

Control questions

Please answer all control questions. They serve as a test for your understanding of the experiment.

1. At the start of a round, each group member receives 20 Points. Suppose nobody (including you) contributes any Points to the project.

How many Points do you earn in Stage I?

How many Points do the other members of your group earn in Stage I?

2. At the start of a round, each group member receives 20 Points. Suppose the other three group members contribute a total of 40 Points in total to the group project. Now suppose you contribute 0 Points to the group project.

How many Points will each player receive *from the group project*?

How many Points will you earn in Stage I of this round?

3. At the start of a round, each group member receives 20 Points. Suppose that again, the other three group members contribute a total of 40 Points to the group project. Now suppose you contribute 10 Points to the group project.

How many Points will each player receive *from the group project*?

How many Points will you earn in Stage I of this round?

4. Suppose that in Stage II you assign the following Deduction Points to the other members of your group: 2, 0 and 5.

How many Points will be deducted from your total by assigning these Points?

5. Suppose that in Stage II the other members of your group assign a total of 5 Deduction Points to you.

How many Points will be deducted from your total by having these Points assigned to you?

Continue

Round 1 of 10

A new round has started.
You received **20 Points** to start with.

Your contribution to the group project is...

Continue

You must click "Continue" before time runs out.

Round 1 of 10

Results Stage I

Your contribution to the group project: **5**.
Average contribution in your group: **8.5**.

Sum of contributions in your group: **34**.
This amount is multiplied by 1.6, yielding **54.4**.
Each group member receives **an equal share**: **13.6**.

Your earnings:

In this round you have earned **15** Points kept for yourself
plus your share from the group project: **13.6**, yielding **28.6** in total.

Continue

Round 1 of 10

Deduction stage

Below you find the contributions to the group project of each of the other members of your group. **The average contribution** in your group was: **8.5**.

For each you can now indicate how many Deduction Points (0-10) you want to assign to them. Remember, **each Deduction Point you assign reduces your Earnings by 1 and the recipient by 3.**

(You cannot assign Deduction Points to yourself)

Contribution of this participant: 12.
How many Deduction Points (0-10) do you want to assign to this participant?

Contribution of this participant: 9.
How many Deduction Points (0-10) do you want to assign to this participant?

Contribution of this participant: 8.
How many Deduction Points (0-10) do you want to assign to this participant?

Contribution of this participant: 5.
How many Deduction Points (0-10) do you want to assign to this participant?

Continue

Round 1 of 10

Results Stage I and II

Your earnings in Stage I: **28.6**.

Your **costs of assigning Deduction Points** to others in Stage II: **2**.
Number of **received** Deduction Points in Stage II: **10**.
Earnings reduction through Deduction Points: **30**.

Your earnings

Your total earnings in this round: -3.4.
Your total earnings including this round: **0.0**.

Continue

Questionnaire

What is your age?

What is your gender?

male | female | other

Finish

Total points

During this experiment you have earned 299.20000000000005 Points.

Now, you can close this window. I thank you for participating in the study.

Annex 3: Review Version of the PGG experiment with peer rewarding:

Welcome

In the setup of this experiment, you will be playing in a group together with three **real people** who also accepted to participate in this experiment, who are completing it **at the same time**. It is therefore important that you complete it **without interruptions**.

Including the time for reading these instructions, the experiment will take about 20 minutes to complete.

During the experiment, please **do not close this window** or leave the experiment web pages in any other way.
If you do close your browser or leave the task, you will not be able to re-enter!

In this experiment you will play a game with the same people for 10 rounds. In these rounds, you can earn Points.

Continue

Instructions

Your task

In your group of four, you will make decisions in a game of 10 rounds. Each round consists of two Stages.

Stage I

At the beginning of each round, **each participant receives 20 Points.** You have to decide how many of the 20 Points you want to **contribute to a group project**. The other three members of your group make this decision at the same time.

The Points you do not contribute, you **keep for yourself**. These Points are added to your total.

After all group members have made their decision, all Points contributed to the **group project** are added up, and this number of Points is **multiplied by 1.6**.

The resulting number of Points is then **divided equally among the group members** (irrespective of how much they individually contributed to the group project).

In summary, **Your earnings in Stage I** = The Points you keep for yourself *plus* The Points you receive from the group project

Group project - Example 1

- All four players contribute 20 Points to the group project.
- Sum of contributions is 80 Points.

- This amount is multiplied by 1.6, resulting in 128 Points.
- Each participant receives (128/4=) 32 Points from the group project.

- Therefore, in Stage I each participant earns 32 Points.

Group project - Example 2

- Participants A, B and C contribute each 20 Points to the group project.
- Participant D contributes 0 Points.
- Sum of contributions is 60 Points.

- This amount is multiplied by 1.6, resulting in 96 Points.
- Each participant receives (96/4=) 24 Points from the group project.

- Therefore, in Stage I Participants A, B and C each earn 24 Points.
- Participant D earns 44 Points (20 kept for themselves *plus* 24 from the group project).

At the end of Stage I, you will be informed of the average contributions to the group project, and your earnings in the round so far. Then, Stage II begins.

Stage II

At the beginning of Stage II, you are informed of the contributions to the group project of each of the other group members.
You will have the **opportunity to assign Reward Points** to each of them.

For each Reward Point you assign, **3** Points will be added to the total of the recipient, and **1 Point will be deducted from your total**.

In each round, you can assign **between 0 and 10 Reward Points** to each of the other members of your group.

Reward Points - Example

- You are informed of the contributions of each of the other members of your group.
- You assign the following Reward Points to Participants A, B and C: 2, 0 and 3.
- This reduces your earnings in this round by (2+0+3=) 5 Points.

- The other participants assign a total of 4 Reward Points to you.
- This increases your earnings in this round by (4x3=) 12 Points.

- In Stage II of this round, your total *earnings increase* due to Reward Points is (12-5=) 7 Points.

Please make your decisions within the time limit shown on your screen. If you fail to do so, you will be removed from the experiment.

Continue

Control questions

Please answer all control questions. They serve as a test for your understanding of the experiment.

1. At the start of a round, each group member receives 20 Points. Suppose nobody (including you) contributes any Points to the project.

How many Points do you earn in Stage I?

How many Points do the other members of your group earn in Stage I?

2. At the start of a round, each group member receives 20 Points. Suppose the other three group members contribute a total of 40 Points in total to the group project. Now suppose you contribute 0 Points to the group project.

How many Points will each player receive *from the group project*?

How many Points will you earn in Stage I of this round?

3. At the start of a round, each group member receives 20 Points. Suppose that again, the other three group members contribute a total of 40 Points to the group project. Now suppose you contribute 10 Points to the group project.

How many Points will each player receive *from the group project*?

How many Points will you earn in Stage I of this round?

4. Suppose that in Stage II you assign the following Reward Points to the other members of your group: 2, 0 and 5.

How many Points will be deducted from your total by assigning these Points?

5. Suppose that in Stage II the other members of your group assign a total of 5 Reward Points to you.

How many Points will be added to your total by having these Points assigned to you?

Continue

Round 1 of 10

A new round has started.
You received **20 Points** to start with.

Your contribution to the group project is...

Continue

You must click "Continue" before time runs out.

Round 1 of 10

Results

Your contribution to the group project: 5.
Average contribution in your group: 7.5.

Sum of contributions in your group: 30.
This amount is multiplied by 1.6, yielding **48.0**.
Each group member receives **an equal share: 12.0.**

Your earnings

Points kept for yourself: **15**.
Your share from the group project: **12.0**.

Your total earnings in this round: 27.0.
Your total earnings including this round: **27.0**.

Continue

Round 1 of 10

Rewarding stage

Below you find the contributions to the group project of each of the other members of your group. **The average contribution** in your group was: **6.0**.

For each you can now indicate how many Reward Points (0-10) you want to assign to them. Remember, **each Reward Point you assign reduces your Earnings by 1 and increases recipient's earnings by 3.**

(You cannot assign Reward Points to yourself)

Contribution of this participant: 3.
How many Reward Points (0-10) do you want to assign to this participant?

Contribution of this participant: 14.
How many Reward Points (0-10) do you want to assign to this participant?

Contribution of this participant: 2.
How many Reward Points (0-10) do you want to assign to this participant?

Contribution of this participant: 5.
How many Reward Points (0-10) do you want to assign to this participant?

Continue

Round 1 of 10

Results Stage I and II

Your earnings in Stage I: **24.6**.

Your **costs of assigning Reward Points** to others in Stage II: **3**.
Number of **received** Reward Points in Stage II: **20**.
Earnings increase through Reward Points: **60**.

Your earnings

Your total earnings in this round: 81.6.
Your total earnings including this round: **0.0**.

Continue

Questionnaire

What is your age?

What is your gender?

male | female | other

Finish

Total points

During this experiment you have earned 299.20000000000005 Points.

Now, you can close this window. I thank you for participating in the study.

Annex 4: Datasets of the Stander Iterated PGG experiment.

A. DATA COLLECTED IN THE EXPERIMENT

Player number	Group number	Subject number	Period	q1a	q1b	q2a	q2b	Contri-bution	Earnings Period	Total Earnings	Age	Gender
1	2	1	1	20	20	32	44	20	24,4	24,4		
1	2	1	2					20	26,4	50,8		
1	2	1	3					12	32,4	83,2		
1	2	1	4					10	30,8	114		
1	2	1	5					8	30,8	144,8		
1	2	1	6					6	33,6	178,4		
1	2	1	7					6	25,7	204,1		
1	2	1	8					10	22,3	226,4		
1	2	1	9					2	24,9	251,3		
1	2	1	10					8	17,9	269,2		
1	2	1	11								34	1
2	2	2	1	20	20	20	0	16	28,4	28,4		
2	2	2	2					16	30,4	58,8		
2	2	2	3					14	30,4	89,2		
2	2	2	4					12	28,8	118		
2	2	2	5					14	24,8	142,8		
2	2	2	6					8	31,6	174,4		
2	2	2	7					6	25,7	200,1		
2	2	2	8					8	24,3	224,4		
2	2	2	9					4	22,9	247,3		
2	2	2	10					3	22,9	270,2		
2	2	2	11								21	1
3	2	3	1	20	20	32	32	20	24,4	24,4		
3	2	3	2					20	26,4	50,8		
3	2	3	3					20	24,4	75,2		
3	2	3	4					20	20,8	96		
3	2	3	5					20	18,8	114,8		
3	2	3	6					20	19,6	134,4		
3	2	3	7					20	17,5	152,9		
3	2	3	8					15	20,4	173,3		
3	2	3	9					15	19,2	192,5		
3	2	3	10					0	24,4	216,9		
3	2	3	11								56	1
4	2	4	1	20	20	20	20	5	39,4	39,4		
4	2	4	2					10	36,4	75,8		

4	2	4	3					15	29,4	105,2			
4	2	4	4					10	30,8	136			
4	2	4	5					5	33,8	169,8			
4	2	4	6					15	24,6	194,4			
4	2	4	7					10	21,7	216,1			
4	2	4	8					5	27,3	243,4			
4	2	4	9					7	19,9	263,3			
4	2	4	10					0	25,9	289,2			
4	2	4	11								54		2
5	1	1	1	0	0	32	24	10	36	36			
5	1	1	2					14	32,4	68,4			
5	1	1	3					15	23,8	92,2			
5	1	1	4					13	32,2	124,4			
5	1	1	5					14	28,4	152,8			
5	1	1	6					14	32	184,8			
5	1	1	7					15	15,8	200,6			
5	1	1	8					14	16,4	217			
5	1	1	9					13	27,4	244,4			
5	1	1	10					13	21	265,4			
5	1	1	11								19		2
6	1	2	1	20	20	32	44	20	26	26			
6	1	2	2					15	31,4	57,4			
6	1	2	3					10	28,8	86,2			
6	1	2	4					10	35,2	121,4			
6	1	2	5					10	32,4	153,8			
6	1	2	6					20	26	179,8			
6	1	2	7					10	20,8	200,6			
6	1	2	8					0	30,4	231			
6	1	2	9					10	30,4	261,4			
6	1	2	10					10	24	285,4			
6	1	2	11								51		2
7	1	3	1	0	20	32	44	15	31	31			
7	1	3	2					17	29,4	60,4			
7	1	3	3					2	36,8	97,2			
7	1	3	4					20	25,2	122,4			
7	1	3	5					12	30,4	152,8			
7	1	3	6					11	35	187,8			
7	1	3	7					0	30,8	218,6			
7	1	3	8					10	20,4	239			
7	1	3	9					8	32,4	271,4			

7	1	3	10					12	22	293,4			
7	1	3	11								22		1
8	1	4	1	20	0	40	32	20	26	26			
8	1	4	2					20	26,4	52,4			
8	1	4	3					20	18,8	71,2			
8	1	4	4					20	25,2	96,4			
8	1	4	5					20	22,4	118,8			
8	1	4	6					20	26	144,8			
8	1	4	7					2	28,8	173,6			
8	1	4	8					2	28,4	202			
8	1	4	9					20	20,4	222,4			
8	1	4	10					0	34	256,4			
8	1	4	11								59		1
9	1	1	1	0	0	24	24	13	31	31			
9	1	1	2					10	34	65			
9	1	1	3					15	25,8	90,8			
9	1	1	4					8	30	120,8			
9	1	1	5					12	31,6	152,4			
9	1	1	6					2	36	188,4			
9	1	1	7					8	32,4	220,8			
9	1	1	8					13	21,8	242,6			
9	1	1	9					12	29,6	272,2			
9	1	1	10					20	22,8	295			
9	1	1	11								19		2
10	1	2	1	0	0	32	24	10	34	34			
10	1	2	2					15	29	63			
10	1	2	3					16	24,8	87,8			
10	1	2	4					16	22	109,8			
10	1	2	5					17	26,6	136,4			
10	1	2	6					16	22	158,4			
10	1	2	7					18	22,4	180,8			
10	1	2	8					17	17,8	198,6			
10	1	2	9					10	31,6	230,2			
10	1	2	10					10	32,8	263			
10	1	2	11								19		2
11	1	3	1	20	20	8	20	17	27	27			
11	1	3	2					15	29	56			
11	1	3	3					5	35,8	91,8			
11	1	3	4					7	31	122,8			
11	1	3	5					15	28,6	151,4			

11	1	3	6					17	21	172,4			
11	1	3	7					17	23,4	195,8			
11	1	3	8					7	27,8	223,6			
11	1	3	9					20	21,6	245,2			
11	1	3	10					17	25,8	271			
11	1	3	11								19		2
12	1	4	1	20	20	24	44	20	24	24			
12	1	4	2					20	24	48			
12	1	4	3					16	24,8	72,8			
12	1	4	4					14	24	96,8			
12	1	4	5					15	28,6	125,4			
12	1	4	6					10	28	153,4			
12	1	4	7					8	32,4	185,8			
12	1	4	8					0	34,8	220,6			
12	1	4	9					12	29,6	250,2			
12	1	4	10					10	32,8	283			
12	1	4	11								24		1
13	1	1	1	20	20	0	20	7	35,4	35,4			
13	1	1	2					4	36,4	71,8			
13	1	1	3					8	29,2	101			
13	1	1	4					5	30,2	131,2			
13	1	1	5					2	30	161,2			
13	1	1	6					12	22	183,2			
13	1	1	7					1	29	212,2			
13	1	1	8					6	24,8	237			
13	1	1	9					20	16	253			
13	1	1	10					10	20,4	273,4			
13	1	1	11								18		2
14	1	2	1	20	20	32	24	14	28,4	28,4			
14	1	2	2					14	26,4	54,8			
14	1	2	3					13	24,2	79			
14	1	2	4					13	22,2	101,2			
14	1	2	5					10	22	123,2			
14	1	2	6					10	24	147,2			
14	1	2	7					11	19	166,2			
14	1	2	8					10	20,8	187			
14	1	2	9					10	26	213			
14	1	2	10					12	18,4	231,4			
14	1	2	11								20		2
15	1	3	1	20	20	32	44	15	27,4	27,4			

15	1	3	2					15	25,4	52,8			
15	1	3	3					10	27,2	80			
15	1	3	4					10	25,2	105,2			
15	1	3	5					8	24	129,2			
15	1	3	6					8	26	155,2			
15	1	3	7					5	25	180,2			
15	1	3	8					5	25,8	206			
15	1	3	9					5	31	237			
15	1	3	10					0	30,4	267,4			
15	1	3	11								36		1
16	1	4	1	20	20	32	44	20	22,4	22,4			
16	1	4	2					18	22,4	44,8			
16	1	4	3					12	25,2	70			
16	1	4	4					10	25,2	95,2			
16	1	4	5					10	22	117,2			
16	1	4	6					5	29	146,2			
16	1	4	7					8	22	168,2			
16	1	4	8					6	24,8	193			
16	1	4	9					5	31	224			
16	1	4	10					4	26,4	250,4			
16	1	4	11								21		1
17	1	1	1	20	5	4	5	20	20	20			
17	1	1	2					5	29	49			
17	1	1	3					6	30,4	79,4			
17	1	1	4					2	26,8	106,2			
17	1	1	5					2	38,8	145			
17	1	1	6					5	33,8	178,8			
17	1	1	7					12	20,8	199,6			
17	1	1	8					15	21	220,6			
17	1	1	9					20	15,5	236,1			
17	1	1	10					10	21,2	257,3			
17	1	1	11								47		2
18	1	2	1	20	20	20	0	10	30	30			
18	1	2	2					15	19	49			
18	1	2	3					5	31,4	80,4			
18	1	2	4					0	28,8	109,2			
18	1	2	5					20	20,8	130			
18	1	2	6					15	23,8	153,8			
18	1	2	7					5	27,8	181,6			
18	1	2	8					15	21	202,6			

18	1	2	9					5	30,5	233,1			
18	1	2	10					10	21,2	254,3			
18	1	2	11								54		2
19	1	3	1	20	20	32	44	10	30	30			
19	1	3	2					10	24	54			
19	1	3	3					15	21,4	75,4			
19	1	3	4					10	18,8	94,2			
19	1	3	5					10	30,8	125			
19	1	3	6					20	18,8	143,8			
19	1	3	7					10	22,8	166,6			
19	1	3	8					10	21,2	187,8			
19	1	3	9					5	24,8	212,6			
19	1	3	10					5	24	236,6			
19	1	3	11								49		2
20	1	4	1	20	20	32	44	10	30	30			
20	1	4	2					5	29	59			
20	1	4	3					15	21,4	80,4			
20	1	4	4					10	18,8	99,2			
20	1	4	5					20	20,8	120			
20	1	4	6					7	31,8	151,8			
20	1	4	7					5	27,8	179,6			
20	1	4	8					0	36	215,6			
20	1	4	9					4	31,5	247,1			
20	1	4	10					1	30,2	277,3			
20	1	4	11								52		2
21	1	1	1	10	4	32	0	10	28	28			
21	1	1	2					15	24,6	52,6			
21	1	1	3					13	29,8	82,4			
21	1	1	4					10	28,4	110,8			
21	1	1	5					16	24	134,8			
21	1	1	6					12	29,6	164,4			
21	1	1	7					0	32,4	196,8			
21	1	1	8					0	26,8	223,6			
21	1	1	9					0	30	253,6			
21	1	1	10					20	16	269,6			
21	1	1	11								21		1
22	1	2	1	0	0	32	24	15	23	23			
22	1	2	2					13	26,6	49,6			
22	1	2	3					18	24,8	74,4			
22	1	2	4					10	28,4	102,8			

22	1	2	5					8	32	134,8			
22	1	2	6					16	25,6	160,4			
22	1	2	7					5	27,4	187,8			
22	1	2	8					16	10,8	198,6			
22	1	2	9					20	10	208,6			
22	1	2	10					15	21	229,6			
22	1	2	11								22		1
23	1	3	1	20	20	32	44	10	28	28			
23	1	3	2					10	29,6	57,6			
23	1	3	3					15	27,8	85,4			
23	1	3	4					15	23,4	108,8			
23	1	3	5					15	25	133,8			
23	1	3	6					15	26,6	160,4			
23	1	3	7					15	17,4	177,8			
23	1	3	8					0	26,8	204,6			
23	1	3	9					5	25	229,6			
23	1	3	10					5	31	260,6			
23	1	3	11								21		1
24	1	4	1	20	6	32	24	10	28	28			
24	1	4	2					11	28,6	56,6			
24	1	4	3					11	31,8	88,4			
24	1	4	4					11	27,4	115,8			
24	1	4	5					11	29	144,8			
24	1	4	6					11	30,6	175,4			
24	1	4	7					11	21,4	196,8			
24	1	4	8					1	25,8	222,6			
24	1	4	9					0	30	252,6			
24	1	4	10					0	36	288,6			
24	1	4	11								22		1
25	1	1	1	0	0	20	20	20	24,8	24,8			
25	1	1	2					10	30	54,8			
25	1	1	3					10	28,4	83,2			
25	1	1	4					5	31	114,2			
25	1	1	5					10	20,4	134,6			
25	1	1	6					10	31,2	165,8			
25	1	1	7					15	19,4	185,2			
25	1	1	8					10	32,4	217,6			
25	1	1	9					10	27,6	245,2			
25	1	1	10					10	28,4	273,6			
25	1	1	11								25		2

26	1	2	1	20	20	32	24	17	27,8	27,8			
26	1	2	2					17	23	50,8			
26	1	2	3					16	22,4	73,2			
26	1	2	4					15	21	94,2			
26	1	2	5					13	17,4	111,6			
26	1	2	6					14	27,2	138,8			
26	1	2	7					16	18,4	157,2			
26	1	2	8					15	27,4	184,6			
26	1	2	9					17	20,6	205,2			
26	1	2	10					15	23,4	228,6			
26	1	2	11								19	2	
27	1	3	1	32	32	24	44	5	39,8	39,8			
27	1	3	2					3	37	76,8			
27	1	3	3					5	33,4	110,2			
27	1	3	4					2	34	144,2			
27	1	3	5					2	28,4	172,6			
27	1	3	6					15	26,2	198,8			
27	1	3	7					2	32,4	231,2			
27	1	3	8					19	23,4	254,6			
27	1	3	9					2	35,6	290,2			
27	1	3	10					18	20,4	310,6			
27	1	3	11								25	2	
28	1	4	1	20	20	32	44	20	24,8	24,8			
28	1	4	2					20	20	44,8			
28	1	4	3					15	23,4	68,2			
28	1	4	4					18	18	86,2			
28	1	4	5					1	29,4	115,6			
28	1	4	6					14	27,2	142,8			
28	1	4	7					3	31,4	174,2			
28	1	4	8					12	30,4	204,6			
28	1	4	9					15	22,6	227,2			
28	1	4	10					3	35,4	262,6			
28	1	4	11								25	1	

B. MAIN STATISTICS

	Sum of contributions	Sum of earnings	Mean Contribution	Mean payoff (Total payoff = S1+S2 if Incentives)	% of maximum possible payoff
Period 1	399	799,4	14,25	28,55	0,8922
Period 2	377	786,2	13,46	28,08	0,8775
Period 3	347	768,2	12,39	27,44	0,8574
Period 4	306	743,6	10,93	26,56	0,8299
Period 5	320	752,0	11,43	26,86	0,8393
Period 6	348	768,8	12,43	27,46	0,8580
Period 7	244	691,8	8,71	24,71	0,7721
Period 8	241	691,3	8,61	24,69	0,7715
Period 9	276	717,6	9,86	25,63	0,8009
Period 10	241	710,1	8,61	25,36	0,7925

C. CONTROL QUESTIONS DATA

	Understanding of Control Questions (% of correct answers)
Question 1	71,4286%
Question 2	64,2857%
Question 3	60,7143%
Question 4	39,2857%

Annex 5: Datasets of the PGG experiment with peer punishment.

A. DATA COLLECTED IN THE EXPERIMENT

Player Num.	Group Num.	Subject Num.	Pd.	q1a	q1b	q2a	q2b	Contribution	D1	D2	D3	D4	Deduct. Assigned	Deduct. Received	Deduct. Damage	Earnings Stage 2	Earnings InPeriod	Earnings ThusFar	age	Gdr.
1	1	1	1	20	20	16	36	13	0	0	0	0	0	1	3	-3	28,8	0		
1	1	1	2					15	0	0	0	0	0	0	0	0	30,6	28,8		
1	1	1	3					14	0	0	0	2	2	4	12	-14	18,4	59,4		
1	1	1	4					20	0	0	2	2	4	0	0	-4	23,6	77,8		
1	1	1	5					15	0	0	0	0	0	1	3	-3	28,8	101,4		
1	1	1	6					16	0	1	0	0	1	1	3	-4	26,8	130,2		
1	1	1	7					16	0	1	0	0	1	1	3	-4	26,8	157		
1	1	1	8					16	0	0	0	0	0	1	3	-3	27,4	183,8		
1	1	1	9					15	0	0	0	0	0	2	6	-6	25,8	211,2		
1	1	1	10					20	0	3	0	0	3	0	0	-3	27,4	237		
1	1	1	11																19	2
2	1	2	1	10	10	20	0	17	1	0	0	0	1	0	0	-1	26,8	0		
2	1	2	2					17	0	0	0	0	0	0	0	0	28,6	26,8		
2	1	2	3					17	2	0	0	0	2	0	0	-2	27,4	55,4		
2	1	2	4					17	0	0	0	0	0	0	0	0	30,6	82,8		
2	1	2	5					17	0	0	0	0	0	1	3	-3	26,8	113,4		
2	1	2	6					15	0	0	0	0	0	2	6	-6	25,8	140,2		
2	1	2	7					15	0	0	0	0	0	2	6	-6	25,8	166		
2	1	2	8					16	0	0	0	0	0	0	0	0	30,4	191,8		
2	1	2	9					16	0	0	0	0	0	1	3	-3	27,8	222,2		

2	1	2	10				17	0	0	0	0	0	5	15	-15	18,4	250		
2	1	2	11															19	2
3	1	3	1	20	20		15	0	0	0	0	0	0	0	0	29,8	0		
3	1	3	2				16	0	0	0	0	0	0	0	0	29,6	29,8		
3	1	3	3				17	1	0	0	0	1	0	0	-1	28,4	59,4		
3	1	3	4				16	0	0	0	0	0	2	6	-6	25,6	87,8		
3	1	3	5				19	1	1	0	1	3	0	0	-3	24,8	113,4		
3	1	3	6				18	1	1	0	0	2	0	0	-2	26,8	138,2		
3	1	3	7				19	1	1	0	0	2	0	0	-2	25,8	165		
3	1	3	8				17	1	0	0	0	1	0	0	-1	28,4	190,8		
3	1	3	9				18	1	1	0	0	2	0	0	-2	26,8	219,2		
3	1	3	10				20	0	1	0	0	1	0	0	-1	29,4	246		
3	1	3	11															19	2
4	1	4	1	20	20		17	0	0	0	0	0	0	0	0	27,8	0		
4	1	4	2				16	0	0	0	0	0	0	0	0	29,6	27,8		
4	1	4	3				18	1	0	0	0	1	2	6	-7	21,4	57,4		
4	1	4	4				16	0	0	0	0	0	2	6	-6	25,6	78,8		
4	1	4	5				16	0	0	0	0	0	1	3	-3	27,8	104,4		
4	1	4	6				18	0	0	0	0	0	0	0	0	28,8	132,2		
4	1	4	7				17	0	0	0	0	0	0	0	0	29,8	161		
4	1	4	8				17	0	0	0	0	0	0	0	0	29,4	190,8		
4	1	4	9				18	1	0	0	0	1	0	0	-1	27,8	220,2		
4	1	4	10				19	0	1	0	0	1	0	0	-1	30,4	248		
4	1	4	11															20	2

5	1	1	1	0	0	10	10	10	0	0	0	0	0	5	15	-15	17,4	0		
5	1	1	2					20	0	0	0	0	0	0	0	0	28,4	17,4		
5	1	1	3					20	0	0	0	0	0	0	0	0	30,8	45,8		
5	1	1	4					20	0	0	1	2	3	0	0	-3	26,6	76,6		
5	1	1	5					20	0	0	1	1	2	5	15	-17	13,4	103,2		
5	1	1	6					20	0	0	2	0	2	0	0	-2	29,2	116,6		
5	1	1	7					20	0	0	2	1	3	0	0	-3	27,8	145,8		
											1									
5	1	1	8					20	0	0	0	0	10	0	0	-10	14	173,6		
5	1	1	9					20	0	0	2	1	3	10	30	-33	-2,2	187,6		
			1																	
5	1	1	0					20	0	0	0	0	0	0	0	0	32	185,4		
			1																	
5	1	1	1																25	2
6	1	2	1	20	20	10	30	16	2	0	0	0	2	0	0	-2	24,4	0		
6	1	2	2					17	0	0	0	0	0	0	0	0	31,4	24,4		
6	1	2	3					20	0	0	1	0	1	0	0	-1	29,8	55,8		
6	1	2	4					20	0	0	0	1	1	0	0	-1	28,6	85,6		
6	1	2	5					20	0	0	1	1	2	2	6	-8	22,4	114,2		
6	1	2	6					20	0	0	2	0	2	0	0	-2	29,2	136,6		
6	1	2	7					20	0	0	2	0	2	0	0	-2	28,8	165,8		
											1									
6	1	2	8					20	0	0	0	0	10	0	0	-10	14	194,6		
6	1	2	9					20	0	0	0	0	0	10	30	-30	0,8	208,6		
			1																	
6	1	2	0					20	0	0	0	0	0	0	0	0	32	209,4		
			1																	
6	1	2	1																19	2
7	1	3	1	20	20	20	40	15	2	0	0	0	2	0	0	-2	25,4	0		
7	1	3	2					16	0	0	0	0	0	0	0	0	32,4	25,4		

7	1	3	3					18	0	0	0	0	0	1	3	-3	29,8	57,8	
7	1	3	4					18	0	0	0	1	1	1	3	-4	27,6	87,6	
7	1	3	5					18	5	2	0	0	7	2	6	-13	19,4	115,2	
7	1	3	6					18	0	0	0	0	0	4	12	-12	21,2	134,6	
7	1	3	7					18	0	0	0	0	0	4	12	-12	20,8	155,8	
7	1	3	8					0	0	0	0	0	0	27	81	-81	-37	176,6	
7	1	3	9					18	1 0	1 0	0	6	26	2	6	-32	0,8	139,6	
7	1	3	10					20	0	0	0	0	0	0	0	0	32	140,4	
7	1	3	11																25 2
8	1	4	1	20	20	16	36	15	1	0	0	0	1	0	0	-1	26,4	0	
8	1	4	2					18	0	0	0	0	0	0	0	0	30,4	26,4	
8	1	4	3					19	0	0	0	0	0	0	0	0	31,8	56,8	
8	1	4	4					16	0	0	0	0	0	4	12	-12	21,6	88,6	
8	1	4	5					18	0	0	0	0	0	2	6	-6	26,4	110,2	
8	1	4	6					20	0	0	0	0	0	0	0	0	31,2	136,6	
8	1	4	7					19	0	0	0	0	0	1	3	-3	28,8	167,8	
8	1	4	8					20	0	0	7	0	7	0	0	-7	17	196,6	
8	1	4	9					19	0	0	0	1	0	7	21	-21	10,8	213,6	
8	1	4	10					20	0	0	0	0	0	0	0	0	32	224,4	
8	1	4	11																25 1
9	1	1	1	0	0	0	0	15	0	0	0	1	1	3	9	8	23,8	0	
9	1	1	2					15	0	0	0	0	0	0	0	0	28,8	23,8	
9	1	1	3					16	0	0	0	0	0	0	0	0	10,6	52,6	
9	1	1	4					15	0	0	0	0	0	0	0	0	12	63,2	

9	1	1	5					16	0	0	0	0	0	0	0	0	17,4	75,2		
9	1	1	6					17	0	0	0	0	0	0	0	0	29,2	92,6		
9	1	1	7					16	0	0	0	0	0	4	12	12	17,4	121,8		
9	1	1	8					18	0	0	1	0	1	0	0	-1	28,6	139,2		
9	1	1	9					16	0	0	0	0	0	0	0	0	9,6	167,8		
9	1	1	10					16	0	0	0	0	0	0	0	0	-1,6	177,4		
9	1	1	11																20	2
10	2	2	1	20	20	10	10	20	0	0	5	0	5	0	0	-5	20,07	0,00		
10	2	2	2					15	0	3	7	7	14	1	3	-17	17,33	20,07		
10	2	2	3					17	0	0	6	6	12	2	6	-18	14,33	37,40		
10	2	2	4					15	0	3	0	5	5	3	9	-14	19,27	51,73		
10	2	2	5					18	0	0	5	5	10	1	3	-13	17,27	71,00		
10	2	2	6					18	0	0	5	7	12	1	3	-15	13,67	88,27		
10	2	2	7					18	0	0	7	5	12	1	3	-15	15,27	101,93		
10	2	2	8					15	0	5	5	0	5	3	9	-14	20,33	117,20		
10	2	2	9					10	0	0	6	6	12	3	9	-21	15,67	137,53		
10	2	2	10					10	0	0	5	5	10	1	3	-13	23,67	153,20		
10	2	2	11																21	2
11	2	3	1	0	0	10	10	7	0	0	0	0	0	6	18	-18	20,07	0,00		
11	2	3	2					20	0	0	0	0	0	7	21	-21	8,33	20,07		
11	2	3	3					20	0	0	0	0	0	6	18	-18	11,33	28,40		
11	2	3	4					18	0	0	0	0	0	0	0	0	30,27	39,73		
11	2	3	5					15	0	0	0	0	0	8	24	-24	9,27	70,00		

11	2	3	6					12	0	0	0	0	0	8	24	-24	10,67	79,27	
11	2	3	7					15	0	0	0	0	0	10	30	-30	3,27	89,93	
11	2	3	8					20	0	0	0	0	0	5	15	-15	14,33	93,20	
11	2	3	9					20	0	0	0	0	0	6	18	-18	8,67	107,53	
11	2	3	10					20	0	0	0	0	0	5	15	-15	11,67	116,20	
11	2	3	11																20 2
12	2	4	1	20	20	0	20	20	3	0	1	0	4	0	0	-4	21,07	0,00	
12	2	4	2					20	0	1	0	0	1	7	21	-22	7,33	21,07	
12	2	4	3					18	0	2	0	0	2	6	18	-20	11,33	28,40	
12	2	4	4					20	0	3	0	0	3	5	15	-18	10,27	39,73	
12	2	4	5					20	0	1	3	0	4	5	15	-19	9,27	50,00	
12	2	4	6					20	0	1	3	0	4	7	21	-25	1,67	59,27	
12	2	4	7					20	0	1	3	0	4	5	15	-19	9,27	60,93	
12	2	4	8					20	0	3	0	0	3	0	0	-3	26,33	70,20	
12	2	4	9					20	0	3	0	0	3	6	18	-21	5,67	96,53	
12	2	4	10					20	0	1	0	0	1	5	15	-16	10,67	102,20	
12	2	4	11																19 2
13	1	1	1	20	20	10	30	13	0	1	0	0	10	0	0	-10	8,2	0	
13	1	1	2					9	2	1	0	2	3	5	15	-18	11,4	8,2	
13	1	1	3					14	0	1	1	1	3	1	3	-6	14	19,6	
13	1	1	4					9	0	1	1	2	4	1	3	-7	19,6	33,6	
13	1	1	5					11	0	0	0	0	0	1	3	-3	23,6	53,2	
13	1	1	6					7	0	1	1	1	3	6	18	-21	10,4	76,8	
13	1	1	7					8	0	0	2	0	2	6	18	-20	4,4	87,2	

13	1	1	8					10	0	0	0	0	0	4	12	-12	17,2	91,6		
13	1	1	9					9	0	0	0	0	0	4	12	-12	17	108,8		
13	1	1	10					5	0	0	1	0	1	9	27	-28	7,4	125,8		
13	1	1	11																20	1
14	1	2	1	20	20	30	30	0	0	0	0	1	1	21	63	-64	-32,8	0		
14	1	2	2					20	4	0	1	1	6	1	3	-9	9,4	-32,8		
14	1	2	3					2	1	0	1	1	3	6	18	-21	11	-23,4		
14	1	2	4					7	1	0	0	1	2	3	9	-11	17,6	-12,4		
14	1	2	5					11	0	0	0	0	0	1	3	-3	23,6	5,2		
14	1	2	6					10	1	0	1	0	2	2	6	-8	20,4	28,8		
14	1	2	7					10	2	0	2	1	5	2	6	-11	11,4	49,2		
14	1	2	8					15	2	0	1	1	4	3	9	-13	11,2	60,6		
14	1	2	9					12	1	0	0	0	1	2	6	-7	19	71,8		
14	1	2	10					12	2	0	1	1	4	3	9	-13	15,4	90,8		
14	1	2	11																22	2
15	1	3	1	20	20	10	30	10	0	5	0	1	6	0	0	-6	15,2	0		
15	1	3	2					10	0	0	0	1	1	1	3	-4	24,4	15,2		
15	1	3	3					10	0	2	0	0	2	2	6	-8	16	39,6		
15	1	3	4					14	0	1	0	0	1	1	3	-4	17,6	55,6		
15	1	3	5					12	0	0	0	0	0	1	3	-3	22,6	73,2		
15	1	3	6					15	3	0	0	0	3	3	9	-12	11,4	95,8		
15	1	3	7					1	2	1	0	0	3	8	24	-27	4,4	107,2		
15	1	3	8					12	1	1	0	1	3	2	6	-9	18,2	111,6		
15	1	3	9					13	1	0	0	0	1	3	9	-10	15	129,8		

15	1	3	10					20	3	0	0	0	3	6	18	-21	-0,6	144,8		
15	1	3	11																21	1
16	1	4	1	20	20	10	30	5	0	6	0	0	6	2	6	-12	14,2	0		
16	1	4	2					7	1	0	0	0	1	4	12	-13	18,4	14,2		
16	1	4	3					9	0	3	0	0	3	2	6	-9	16	32,6		
16	1	4	4					9	0	1	0	0	1	3	9	-10	16,6	48,6		
16	1	4	5					10	1	1	1	0	3	0	0	-3	24,6	65,2		
16	1	4	6					14	2	1	1	0	4	1	3	-7	17,4	89,8		
16	1	4	7					12	2	1	4	0	7	1	3	-10	10,4	107,2		
16	1	4	8					11	1	2	1	0	4	2	6	-10	18,2	117,6		
16	1	4	9					11	2	2	3	0	7	0	0	-7	20	135,8		
16	1	4	10					14	4	3	4	0	11	1	3	-14	12,4	155,8		
16	1	4	11																22	2
17	1	1	1	32	32	16	16	15	0	1	2	0	3	1	3	-6	23,8	0		
17	1	1	2					15	0	1	1	1	3	0	0	-3	28,8	23,8		
17	1	1	3					16	0	1	2	1	4	5	15	-19	10,6	52,6		
17	1	1	4					15	0	1	1	1	3	6	18	-21	12	63,2		
17	1	1	5					16	0	1	1	1	3	4	12	-15	17,4	75,2		
17	1	1	6					17	0	1	1	1	3	0	0	-3	29,2	92,6		
17	1	1	7					16	0	1	1	1	3	4	12	-15	17,4	121,8		
17	1	1	8					18	0	1	1	1	3	0	0	-3	28,6	139,2		
17	1	1	9					16	0	1	2	1	4	6	18	-22	9,6	167,8		
17	1	1	10					16	0	1	2	1	4	10	30	-34	-1,6	177,4		
17	1	1	11																19	2

18	1	2	1	20	20			17	1	0	0	3	4	2	6	-10	17,8	0		
18	1	2	2					17	0	0	1	2	3	2	6	-9	20,8	17,8		
18	1	2	3					17	0	0	1	0	1	1	3	-4	24,6	38,6		
18	1	2	4					17	1	0	0	0	1	1	3	-4	27	63,2		
18	1	2	5					18	0	0	0	0	0	1	3	-3	27,4	90,2		
18	1	2	6					17	0	0	0	0	0	4	12	-12	20,2	117,6		
18	1	2	7					18	1	0	0	0	1	1	3	-4	26,4	137,8		
18	1	2	8					19	0	0	0	0	0	1	3	-3	27,6	164,2		
18	1	2	9					19	2	0	2	0	4	1	3	-7	21,6	191,8		
18	1	2	10					20	3	0	3	0	6	1	3	-9	19,4	213,4		
18	1	2	11																19	3
19	1	3	1	20	20	16	36	10	0	0	0	0	0	2	6	-6	28,8	0		
19	1	3	2					16	0	0	0	0	0	2	6	-6	24,8	28,8		
19	1	3	3					14	0	0	0	0	0	8	24	-24	7,6	53,6		
19	1	3	4					20	1	0	0	0	1	1	3	-4	24	61,2		
19	1	3	5					18	1	0	0	0	1	1	3	-4	26,4	85,2		
19	1	3	6					20	0	0	0	0	0	1	3	-3	26,2	111,6		
19	1	3	7					18	0	0	0	0	0	1	3	-3	27,4	137,8		
19	1	3	8					19	0	0	0	0	0	1	3	-3	27,6	165,2		
19	1	3	9					15	0	0	0	0	0	9	27	-27	5,6	192,8		
19	1	3	10					16	0	0	0	0	0	12	36	-36	-3,6	198,4		
19	1	3	11																24	1
20	1	4	1	20	20	43	33	20	0	1	0	0	1	3	9	-10	14,8	0		
20	1	4	2					19	0	1	0	0	1	3	9	-10	17,8	14,8		
20	1	4	3					17	5	0	5	0	10	1	3	-13	15,6	32,6		

20	1	4	4		18	4	0	0	0	4	1	3	-7	23	48,2			
20	1	4	5		19	3	0	0	0	3	1	3	-6	23,4	71,2			
20	1	4	6		19	0	3	0	0	3	1	3	-6	24,2	94,6			
20	1	4	7		19	3	0	0	0	3	1	3	-6	23,4	118,8			
20	1	4	8		18	0	0	0	0	0	1	3	-3	28,6	142,2			
20	1	4	9		19	4	0	5	0	9	1	3	-12	16,6	170,8			
20	1	4	10		19	7	0	7	0	14	1	3	-17	12,4	187,4			
20	1	4	11													22	1	

B. MAIN STATISTICS

	Sum of contributions	Sum of earnings	Mean Contribution	Mean payoff (Total payoff (S1+S2 if Incentives)	% of maximum possible payoff (920)	% Punishment Use
Period 1	270	381,8	13,5	19,09	0,5966	23,50%
Period 2	318	458,6	15,9	22,93	0,7166	16,50%
Period 3	313	380,8	15,65	19,04	0,5950	23,50%
Period 4	320	439	16	21,95	0,6859	17,00%
Period 5	327	432	16,35	21,60	0,6750	19,00%
Period 6	331	433,6	16,55	21,68	0,6775	20,50%
Period 7	315	384,8	15,75	19,24	0,6013	24,00%
Period 8	321	390,4	16,05	19,52	0,6100	25,50%
Period 9	324	282,4	16,2	14,12	0,4413	36,50%
Period 10	344	339,2	17,2	16,96	0,5300	29,50%

C. CONTROL QUESTIONS DATA

	Understanding of Control Questions (% of correct answers)
Question 1a	75%
Question 1b	75%
Question 2a	40%
Question 2b	35%
Question 3a	45%
Question 3b	35%
Question 4	50%
Question 5	60%

Annex 6: Datasets of the PGG experiment with peer rewarding.

A. DATA COLLECTED IN THE EXPERIMENT

Player Num	Subject Num	Period	q1a	q1b	q2a	q2b	Contribution	R1	R2	R3	R4	Rewards Assigned	Rewards Received	Reward Benefit	Earnings Stage2	Earnings Period	Earnings ThusFar	age	Gender
1	1	1	20	20	16	36	20	2	0	2	2	4	5	15	11	40,6	0		
1	1	2					20	3	0	3	3	6	7	21	15	45,4	40,6		
1	1	3					20	3	0	0	3	3	11	33	30	58,8	86		
1	1	4					20	1	0	1	1	2	9	27	25	55,8	144,8		
1	1	5					20	2	0	2	1	3	11	33	30	53,6	200,6		
1	1	6					20	2	0	2	1	3	10	30	27	52,6	254,2		
1	1	7					20	2	0	2	2	4	7	21	17	44,2	306,8		
1	1	8					20	2	0	2	2	4	6	18	14	42	351		
1	1	9					15	0	0	2	2	4	7	21	17	48,8	393		
1	1	10					20	3	3	3	0	6	3	9	3	27	441,8		
1	1	11																59	1
2	2	1	20	20	16	36	14	1	0	1	1	3	0	0	-3	32,6	0		
2	2	2					16	2	0	2	2	6	2	6	0	34,4	32,6		
2	2	3					17	1	0	0	1	2	4	12	10	41,8	67		
2	2	4					17	1	0	1	1	3	2	6	3	36,8	108,8		
2	2	5					0	5	0	5	5	15	0	0	-15	28,6	145,6		
2	2	6					5	5	0	5	5	15	0	0	-15	25,6	174,2		
2	2	7					8	2	0	2	2	6	0	0	-6	33,2	199,8		
2	2	8					10	2	0	2	2	6	0	0	-6	32	233		
2	2	9					12	3	0	3	3	9	1	3	-6	28,8	265		
2	2	10					20	0	0	0	0	0	6	18	18	42	293,8		
2	2	11																19	2
3	3	1	20	20	16	36	20	3	0	3	3	6	3	9	3	32,6	0		
3	3	2					20	5	2	5	5	12	5	15	3	33,4	32,6		
3	3	3					15	5	4	0	5	14	0	0	-14	19,8	66		

3	3	4					20	6	2	6	6	14	4	12	-2	28,8	85,8		
3	3	5					20	6	0	6	4	10	7	21	11	34,6	114,6		
3	3	6					20	4	0	4	2	6	8	24	18	43,6	149,2		
3	3	7					20	4	0	4	4	8	5	15	7	34,2	192,8		
3	3	8					20	4	0	4	4	8	4	12	4	32	227		
3	3	9					20	2	1	5	5	8	9	27	19	45,8	259		
3	3	10					20	3	3	3	0	6	3	9	3	27	304,8		
3	3	11																51	2
4	4	1	0	0	16	36	20	1	0	0	0	1	6	18	17	46,6	0		
4	4	2					20	0	0	0	0	0	10	30	30	60,4	46,6		
4	4	3					20	5	0	0	5	5	9	27	22	50,8	107		
4	4	4					20	2	0	2	2	4	8	24	20	50,8	157,8		
4	4	5					19	0	0	0	0	0	10	30	30	54,6	208,6		
4	4	6					19	1	0	1	3	2	8	24	22	48,6	263,2		
4	4	7					20	1	0	1	0	2	8	24	22	49,2	311,8		
4	4	8					20	0	0	0	0	0	8	24	24	52	361		
4	4	9					20	2	0	4	4	6	10	30	24	50,8	413		
4	4	10					0	0	0	0	0	0	0	0	0	44	463,8		
4	4	11																22	1
5	1	1	0	0	16	16	10	0	0	0	0	0	14	42	42	68,4	0		
								1											
5	1	2					1	0	1	0	1	2	3	9	7	40	68,4		
								1											
5	1	3					1	0	0	0	1	1	1	3	2	27	108,4		
								1											
5	1	4					3	0	1	0	1	2	5	15	13	48,8	135,4		
								1											
5	1	5					10	0	0	0	3	3	9	27	24	48,4	184,2		
								1											
5	1	6					13	0	0	0	3	3	12	36	33	52,4	232,6		

5	1	7					0	10	0	0	0	0	6	18	18	51,6	285		
5	1	8					1	10	6	2	4	12	7	21	9	45,2	336,6		
5	1	9					15	10	0	0	6	6	15	45	39	63,2	381,8		
5	1	10					0	10	0	0	0	0	1	3	3	47	445		
5	1	11																21	1
6	2	1	0	0	16	16	10	5	5	6	5	16	7	21	5	31,4	0		
6	2	2					20	0	5	1	2	3	7	21	18	32	31,4		
6	2	3					1	0	0	1	3	4	2	6	2	27	63,4		
6	2	4					18	0	9	7	8	15	9	27	12	32,8	90,4		
6	2	5					7	5	4	3	7	15	2	6	-9	18,4	123,2		
6	2	6					0	6	0	1	8	15	3	9	-6	26,4	141,6		
6	2	7					19	0	10	0	8	8	10	30	22	36,6	168		
6	2	8					20	0	10	3	8	11	17	51	40	57,2	204,6		
6	2	9					8	8	4	5	10	23	6	18	-5	26,2	261,8		
6	2	10					20	0	10	0	0	20	4	12	-8	16	288		
6	2	11																22	1
7	3	1	11	0	16	16	11	7	5	10	3	15	8	24	9	34,4	0		
7	3	2					4	3	2	1	0	5	2	6	1	31	34,4		
7	3	3					3	1	2	3	4	7	2	6	-1	22	65,4		
7	3	4					11	5	5	5	5	15	9	27	12	39,8	87,4		
7	3	5					4	2	2	2	2	6	3	9	3	33,4	127,2		
7	3	6					3	4	3	0	7	14	1	3	-11	18,4	160,6		

7	3	7					0	6	6	1	1	13	0	0	-13	20,6	179		
										1									
7	3	8					7	7	8	0	2	17	5	15	-2	28,2	199,6		
7	3	9					5	5	5	5	5	15	5	15	0	34,2	227,8		
7	3	10					20	1	1	1	1	3	13	39	36	60	262		
7	3	11																22	1
8	4	1	20	20	10	30	10	2	2	2	2	6	8	24	18	44,4	0		
8	4	2					10	0	4	1	2	5	3	9	4	28	44,4		
8	4	3					10	0	0	1	3	1	8	24	23	39	72,4		
8	4	4					15	0	3	2	3	5	14	42	37	60,8	111,4		
8	4	5					15	2	0	0	3	2	12	36	34	53,4	172,2		
8	4	6					15	2	0	0	3	2	18	54	52	69,4	225,6		
8	4	7					15	0	4	0	1	4	9	27	23	41,6	295		
8	4	8					15	0	3	0	2	3	14	42	39	61,2	336,6		
8	4	9					20	2	1	0	4	3	21	63	60	79,2	397,8		
8	4	10					20	0	3	3	3	6	11	33	27	51	477		
8	4	11																21	1
9	1	1	0	0	0	0	10	0	0	0	1	1	3	9	8	30,4	0		
9	1	2					0	0	0	0	0	0	0	0	0	31,2	30,4		
9	1	3					0	0	0	0	0	0	0	0	0	28,4	61,6		
9	1	4					0	0	0	0	0	0	0	0	0	31,6	90		
9	1	5					7	0	0	0	0	0	0	0	0	25,8	121,6		
9	1	6					0	0	0	0	0	0	0	0	0	31,2	147,4		
9	1	7					17	0	0	0	0	0	4	12	12	30,2	178,6		
9	1	8					6	0	0	1	0	1	0	0	-1	23,8	208,8		
9	1	9					0	0	0	0	0	0	0	0	0	32,8	232,6		
9	1	10					0	0	0	0	0	0	0	0	0	32,8	265,4		
9	1	11																20	1
10	2	1	20	2	0	0	6	1	2	1	2	4	0	0	-4	22,4	0		
10	2	2					9	0	3	3	4	7	2	6	-1	21,2	22,4		
10	2	3					3	0	0	0	0	0	0	0	0	25,4	43,6		

10	2	4					8	0	1	1	0	1	2	6	5	28,6	69		
10	2	5					5	0	1	1	1	2	0	0	-2	25,8	97,6		
10	2	6					6	0	0	0	0	0	0	0	0	25,2	123,4		
10	2	7					10	0	1	1	0	1	3	9	8	33,2	148,6		
10	2	8					2	0	0	0	0	0	0	0	0	28,8	181,8		
10	2	9					12	0	0	0	0	0	4	12	12	32,8	210,6		
10	2	10					5	0	0	0	0	0	0	0	0	27,8	243,4		
10	2	11																22	2
11	3	1	0	0	0	0	5	1	0	0	1	2	1	3	1	28,4	0		
11	3	2					9	0	0	0	0	0	5	15	15	37,2	28,4		
11	3	3					8	0	0	0	3	3	1	3	0	20,4	65,6		
11	3	4					11	0	0	0	1	1	4	12	11	31,6	86		
11	3	5					10	0	0	0	1	1	3	9	8	30,8	117,6		
11	3	6					12	0	0	0	1	1	2	6	5	24,2	148,4		
11	3	7					11	0	2	0	0	2	2	6	4	28,2	172,6		
11	3	8					9	0	0	0	1	1	2	6	5	26,8	200,8		
11	3	9					10	0	1	0	0	1	2	6	5	27,8	227,6		
11	3	10					12	0	0	0	0	0	3	9	9	29,8	255,4		
11	3	11																22	2
12	4	1	0	0	0	0	10	1	0	0	1	1	4	12	11	33,4	0		
12	4	2					10	0	2	2	0	4	4	12	8	29,2	33,4		
12	4	3					10	0	0	1	0	1	3	9	8	26,4	62,6		
12	4	4					10	0	2	3	0	5	1	3	-2	19,6	89		
12	4	5					10	0	0	2	0	2	2	6	4	26,8	108,6		
12	4	6					10	0	0	2	0	2	1	3	1	22,2	135,4		
12	4	7					0	4	1	1	0	6	0	0	-6	29,2	157,6		
12	4	8					10	0	0	1	0	1	1	3	2	22,8	186,8		
12	4	9					10	0	3	2	0	5	0	0	-5	17,8	209,6		
12	4	10					15	0	0	3	0	3	0	0	-3	14,8	227,4		
12	4	11																21	1
13	1	1	20	20	64	36	5	3	2	4	7	13	0	0	-13	24	0		

13	1	2					5	2	3	0	0	3	0	0	-3	26,4	24		
13	1	3					15	2	0	0	3	3	6	18	15	39,6	50,4		
13	1	4					10	0	0	5	3	8	1	3	-5	26,2	90		
13	1	5					12	3	0	5	4	9	3	9	0	29,2	116,2		
13	1	6					10	2	0	3	4	7	0	0	-7	23,8	145,4		
13	1	7					5	1	1	1	1	3	0	0	-3	32,8	169,2		
13	1	8					7	2	3	4	4	11	0	0	-11	20	202		
13	1	9					17	0	2	3	5	10	4	12	2	29,4	222		
13	1	10					5	0	2	3	4	9	0	0	-9	25,2	251,4		
13	1	11																54	2
14	2	1	20	20	16	16	20	0	1	2	2	4	6	18	14	36	0		
14	2	2					1	0	0	0	0	0	3	9	9	42,4	36		
14	2	3					10	2	1	1	2	5	1	3	-2	27,6	78,4		
14	2	4					10	0	0	0	0	0	1	3	3	34,2	106		
14	2	5					5	1	0	1	1	3	0	0	-3	33,2	140,2		
14	2	6					10	0	0	0	0	0	0	0	0	30,8	173,4		
14	2	7					10	0	0	1	0	1	1	3	2	32,8	204,2		
14	2	8					10	0	0	0	0	0	3	9	9	37	237		
14	2	9					10	0	0	1	0	1	2	6	5	39,4	274		
14	2	10					12	0	0	0	0	0	3	9	9	36,2	313,4		
14	2	11																56	1
15	3	1	20	20	16	36	15	0	2	0	0	2	6	18	16	43	0		
15	3	2					18	0	0	0	1	1	5	15	14	30,4	43		
15	3	3					10	2	0	0	1	3	1	3	0	29,6	73,4		
15	3	4					18	0	0	0	2	2	7	21	19	42,2	103		
15	3	5					20	2	0	0	4	6	9	27	21	42,2	145,2		
15	3	6					16	0	0	0	2	2	5	15	13	37,8	187,4		
15	3	7					20	0	0	0	3	3	5	15	12	32,8	225,2		
15	3	8					14	0	0	0	2	2	5	15	13	37	258		
15	3	9					20	3	0	0	1	4	7	21	17	41,4	295		
15	3	10					16	0	0	0	0	0	5	15	15	38,2	336,4		

15	3	11																21	1
16	4	1	20	20			15	0	2	0	0	2	9	27	25	52	0		
16	4	2					12	0	0	5	0	5	1	3	-2	20,4	52		
16	4	3					14	2	1	0	0	3	6	18	15	40,6	72,4		
16	4	4					15	1	1	2	0	4	5	15	11	37,2	113		
16	4	5					16	0	0	3	0	3	9	27	24	49,2	150,2		
16	4	6					16	0	0	2	0	2	6	18	16	40,8	199,4		
16	4	7					17	0	0	3	0	3	4	12	9	32,8	240,2		
16	4	8					14	0	0	1	0	1	6	18	17	41	273		
16	4	9					14	1	0	3	0	4	6	18	14	44,4	314		
16	4	10					15	0	1	2	0	3	4	12	9	33,2	358,4		
16	4	11																19	3
17	1	1	0	0	16	36	9	0	5	3	4	12	1	3	-9	24,4	0		
17	1	2					15	2	3	3	1	7	3	9	2	30,2	24,4		
17	1	3					20	0	0	0	0	0	15	45	45	53	54,6		
17	1	4					16	0	0	0	5	5	6	18	13	32,2	107,6		
17	1	5					10	0	1	0	3	4	3	9	5	39	139,8		
17	1	6					15	0	0	5	6	11	6	18	7	35,2	178,8		
17	1	7					20	0	2	3	5	10	9	27	17	43,8	214		
17	1	8					13	0	0	1	5	6	8	24	18	42,6	257,8		
17	1	9					18	0	1	2	3	6	1	3	-3	29,8	300,4		
17	1	10					15	0	0	0	0	0	3	9	9	29,6	330,2		
17	1	11																20	2
18	2	1	20	20	16	36	20	0	0	0	0	0	9	27	27	49,4	0		
18	2	2					10	0	0	0	0	0	4	12	12	45,2	49,4		
								1											
18	2	3					0	0	0	0	0	10	0	0	-10	18	94,6		
18	2	4					1	1	0	0	1	2	1	3	1	35,2	112,6		
18	2	5					19	1	3	1	3	5	5	15	10	35	147,8		
18	2	6					8	2	1	2	3	7	1	3	-4	31,2	182,8		
18	2	7					20	3	3	0	3	6	8	24	18	44,8	214		

18	2	8					0	2	1 1	2 1	3	7	1	3	-4	33,6	258,8		
18	2	9					20	0	0	0	0	10	2	6	-4	26,8	292,4		
18	2	10					15	2	2	1	0	3	1	3	0	20,6	319,2		
18	2	11																22	1
19	3	1	20	20	16	36	7	1	1	1	1	3	3	9	6	41,4	0		
19	3	2					13	1	1	2	1	3	3	9	6	36,2	41,4		
19	3	3					0	0	0	0	0	0	0	0	0	28	77,6		
19	3	4					6	1	1	0	1	3	0	0	-3	26,2	105,6		
19	3	5					11	1	1	0	1	3	2	6	3	36	131,8		
19	3	6					15	1	1	0	1	3	10	30	27	55,2	167,8		
19	3	7					7	1	1	0	1	3	3	9	6	45,8	223		
19	3	8					11	1	1	0	1	3	3	9	6	32,6	268,8		
19	3	9					20	1	1	0	1	3	12	36	33	63,8	301,4		
19	3	10					9	1	1	0	1	3	1	3	0	26,6	365,2		
19	3	11																24	1
20	4	1	20	20	16	36	20	0	3	0	3	3	5	15	12	34,4	0		
20	4	2					20	2	0	0	6	2	2	6	4	27,2	34,4		
20	4	3					0	5	0	0	0	5	0	0	-5	23	61,6		
20	4	4					15	4	0	0	0	4	7	21	17	37,2	84,6		
20	4	5					20	1	3	1	6	5	7	21	16	40	121,8		
20	4	6					20	3	0	3	1 1	6	10	30	24	47,2	161,8		
20	4	7					20	5	5	0	0	10	9	27	17	43,8	209		
20	4	8					20	5	0	0	0	5	9	27	22	39,6	252,8		
20	4	9					19	0	0	0	0	0	4	12	12	43,8	292,4		
20	4	10					0	0	0	0	0	0	1	3	3	38,6	336,2		
20	4	11																22	2

B. MAIN STATISTICS

	Sum of contributions	Sum of earnings	Mean Contribution	Mean payoff (Total payoff (S1+S2 if Incentives)	% of maximum possible payoff	%Reward Use
Period 1	257	750,2	12,85	37,51	0,7213	49,00%
Period 2	233	681,8	11,65	34,09	0,6556	35,50%
Period 3	177	646,2	8,85	32,31	0,6213	35,00%
Period 4	244	736,4	12,2	36,82	0,7081	47,50%
Period 5	240	738	12	36,90	0,7096	48,50%
Period 6	233	741,8	11,65	37,09	0,7133	50,50%
Period 7	259	741,4	12,95	37,07	0,7129	46,50%
Period 8	229	735,4	11,45	36,77	0,7071	49,50%
Period 9	285	807	14,25	40,35	0,7760	59,00%
Period10	239	667,4	11,95	33,37	0,6417	31,00%

C. CONTROL QUESTIONS DATA

	Understanding of Control Questions (% of correct answers)
Question 1a	65%
Question 1b	60%
Question 2a	65%
Question 2b	50%
Question 3a	45%
Question 3b	35%
Question 4	90%
Question 5	90%