THE BOUNDARIES OF REWARD MECHANISM IN PROVISION OF PUBLIC GOODS GAME

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Contents

Abstract

In this paper, we investigate an extended public goods game of two stages with opportunities to reward other group members at different costs to examine whether the opportunities to reward at lower costs would motivate more cooperation in a one-shot situation. This study shows that the opportunities to reward at lower costs fail to increase the group account allocations or improve the group efficiency. However, the subjects who contribute more tokens to the group account receive more reward tokens when their contribution levels are higher than the group average.

Keywords: public goods game, voluntary provision, VCM, reward, lower cost, cooperation

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1. Introduction

1.1 Public goods provisions and predictions from economic theories

Many experimental studies are reported on the voluntary provision of public goods, or as we call it, the voluntary contributions mechanism (VCM). In a traditional VCM game, subjects are randomly divided into groups of four individuals to make investment decisions. Each subject is given a number of tokens by the experimenter and decides what percentage of his/her tokens to retain in his/her private account and what percentage to invest in the group account. A token placed in one's own private account gives a fixed amount of money to himself/herself as return. A token invested in the group account returns a larger amount of money, but that money belongs to and will be shared by all the group members probably equally. If group members allocate all their tokens to the group account, the group earnings are maximized and they also get maximum individual earnings, which is the Pareto optimal level of 100% contributions. If subjects make investment decisions to maximize their own earnings separately, they will keep all their tokens to their private accounts and no tokens in the group account, which is the Nash equilibrium.

The stylized results from these experiments are that the number of tokens allocated to the group accounts is above the level of zero which is predicted from the standard economic theory (the Nash equilibrium), but is much lower than the Pareto optimal level of contributions i.e. 100%. Allocations in the group account often decrease dramatically when the game is repeated and tends to diminish compared with their initial levels (Ledyard, 1995). Moreover, there are significant differences on the individual contribution levels.

The Free-Rider Hypothesis is used to explain the underprovision of public goods by economic theorists like Olson (1968), Olson & Zeckhauser (1966) and Samuelson (1954). The public goods are typically characterized by their consumption nonexcludability, which means that, once purchased, they are available for consumption not only to the purchasers but to other

individuals as well. Buchanan (1968, p. 87) argues that the voluntary provisions of public goods may not happen because everyone can benefit from them without need to pay the costs by free riding. Olson, in his work "The Logic of Collective Action" (1968), has investigated under what conditions and at what amount the public goods are provided voluntarily. He concludes that nonexcludability directly results in the nonprovision or zero contribution. This is called "the strong free-rider hypothesis" by Brubaker (1975). At the same time, Olson criticizes the theories of interest group which promise that groups will take actions to reach their group targets if necessary. He argues that these theories can't well predict the group behaviour in public goods provisions because of their no careful consideration of the free-rider problem.

Samuelson (1954) presented the weaker free-rider hypothesis, which suggests that the public goods are provided in a suboptimal amount. A few individuals provide a limited amount of the good because of their particular interests in its availability. Free-riding on this amount of the good, other members do not provide any more because the marginal value to them is lower than its cost. Thus, the good provision is less than the optimal amount decided by a single individual on his own economic judgment.

1.2 Free rider problem and selective incentives

Free rider problem is the economic version of another more general problem in social sciences, that is, under what conditions will a collectivity take action to maximize its collective interests even though this action obstructs its individuals to maximize their own short-term interests separately? (Marwell & Ames, 1979). This is a problem about collective action, which also appears in psychology as the problem of prisoner's dilemma and in political sciences as the problem of irrationality of voting. Free-riding is a pervasive phenomenon in social lives.

A typical example of the free-rider problem has been presented by Hardin (1968). Many dairy farmers can use a common area to graze their cattle freely. If a farmer increases his herd

grazed in that area, he will get a little more grass from the commons. But if all farmers increase their cattle, they will probably overgraze the commons and reduce the grass production at last. On the contrary, if a farmer cuts his cattle, every farmer will benefit from the improvement of the grass production. But, the benefit for that farmer is less than his loss associated with the cattle reduction, while the other farmers will get a little more profit by "free riding" on the grass increase. So the best strategy for any farmer is to increase one's own herd and let others cut their cattle as much as possible. Every farmer knows this logic and follows the same one, hence reduction in herds will not happen, and the grass production can't be sustained steadily.

Selective incentives are very important to solve the free-rider problem in public goods provision. Olson favours the conclusion that the voluntary provisions of public goods are irrational (so no provisions), which is criticized by Chamberlin (1974), Frohlich et al. (1975), Schofield (1975) and Smith (1976). They argue that Olson's problem is in his restrictive assumptions, based on which he gets the conclusion. In fact, the question, whether a provision is rational or not, is a very complicated one to answer. Its answer changes from case to case and depends on quite a few parameters like the good cost, the group size and its value to the subject etc. Provisions can be rational if there are selective incentives present in their back ground conditions. Hence selective incentives are of great importance for the rationality of provisions (Oliver 1980). Olson has also recognized that the instances of voluntary provisions exist because of selective incentives, and emphasised that the incentives have to be separate and selective (1968, p. 51).

Recently, researchers focus their VCM studies on investigating various alternative institutional arrangements to examine their effectiveness. The ultimate target is to design efficient institutions with selective incentives to establish, facilitate and maintain group cooperation in public goods provisions.

1.3 The demands for rewards and sanctions in VCM

Rewards and sanctions are often used to promote cooperation in our daily lives and social activities. For instance, if we have had a happy dinner with good service in a restaurant, we may leave a generous tip as a reward, otherwise we may give less as a sanction. We like to sanction our unfriendly colleagues by shunning them and reward friendly ones with gifts. Striking workers threaten the breakers to hurt or ostracize them to promote cooperation (Oliver 1980).

Fehr & Gächter (2000) have observed that people have strong aspirations to sanction free riders. During the oil crisis at 1970s, some of the drivers, who pushed into the queue to cut their waiting time at gas stations, were beaten by other drivers, one was even killed (Frank, 1994, p. 31). This example indicates that when people have the opportunity they do punish free riders even if this action brings them no potential bonus but costs only. It is also observed that responders give up the maximization of their own earnings to reward more generous opponents and punish less ones in the proposer responder experiments of Andreoni et al. (2003) and Offerman (2002). Sefton et al. (2007) have shown that people have many opportunities to reward or sanction others in the real world.

In their public goods game with sanction opportunities, Fehr & Gächter (2000) have presented experimental evidence that subjects like to sanction the free riders at their own costs without expectation of any benefits. And the more they free-ride, the more they are sanctioned.

1.4 Effects of rewards and sanctions in VCM

Fehr & Gächter (2000) conducted a punishment experiment of two stages with non-linear pay-offs. In the first stage, subjects played the standard game of public goods provision. In the second stage, group members were given opportunities to punish other members after knowing anonymously their allocations to the group account in the first stage. Public goods

provisions increase significantly in this experiment with the introduction of opportunities to punish. However, the average group payoff in the punishment treatments is lower than that in the no-punishment treatments at the beginning periods, which is partially due to the sanction costs taken by both the member punished and the member imposing the punishment, and rises steadily when the game is repeated. By the last period, approximately 20% increase in group payoff is achieved.

Sefton et al. (2007) have extended the experiment of Fehr & Gächter (2000) with opportunities to sanction or reward or both sanction and reward in linear pay-off setting. In the first stage of their experiment (a traditional public goods game), a subject earned 10 cents from each token invested in his/her private account, and each of the four group members earned 5 cents from each token allocated to the group account. In fact, in both stages for all the treatments, a subject always had the choice to place his/her tokens in his/her private account and would get 10 cents from each that token. In the second stage, subjects had opportunities to sanction other group members for the sanction treatment, to reward them for the reward treatment, and to both sanction and reward them for the sanction and reward treatment according to their contributions to the group account in stage 1. In the reward treatment, a group member earned 10 cents for each token which he/she received from another group member as a reward. In the sanction treatment, a group member got a loss of 10 cents for each token which he/she received from another group member as a sanction. In the sanction and reward treatment, tokens could be used to sanction and/or to reward, the pay-offs were the same as those in the sanction or reward treatment. The cost to the subject giving the sanction or reward was the foregone earnings in his/her private account. Hence group earnings decreased by 20 cents for each sanction token. However, rewards didn't reduce or increase the group pay-off.

Sefton's (2007) experiment shows that the highest levels of contributions and earnings are achieved in the sanction and reward treatment. The opportunities to sanction are able to

increase provisions of public goods and sustain contributions effectively. The opportunities to reward are by themselves insufficient to maintain contributions, while they do initially increase the contributions but subsequently reduce them to the level lower than that without the opportunities to reward. The subjects contributing more (less) tokens are more (less) willing to reward and sanction others and are more likely to get rewards (sanctions). The use of rewards is initially more frequent, but reduces at a faster rate and, in later rounds, is less frequent than the use of sanctions.

Walker & Halloran (2004) have investigated the effects of the opportunities to reward and sanction in one-shot games. They find that the reward or sanction opportunities can't improve cooperation though some subjects are willing to use their resources as rewards and sanctions. This result from one-shot games is contrary to that from previous repeated games. In a proposer-responder game, rewards alone have little influence on cooperation and have a strong one when combined with punishments (Andreoni et al., 2003).

Sanctions initially reduce group efficiency because of their high costs, only when the public goods game is repeated enough times, group efficiency can be improved (Sefton et al., 2007). Sanctions also contradict the model of pure altruism (Andreoni, 1990) since an altruistic individual would never be likely to reduce the others' payoffs. On the contrary, rewards can be used at low costs by group members to induce others to cooperate without any loss of the group efficiency, they can even increase the group's welfare as they do in our experiment. Moreover, rewards can be more easily implemented than punishments in real life. Given these facts, we would like to improve the reward approach to make it more effective and efficient.

Andreoni & Miller's study (2002) may shed a light on this problem. They design a Dictator Game in which the price of a given token varies. A token is worth the same to both the first player (dictator) and the second player in original dictator games, but it is worth different in this game due to different budget rules. When the price of given tokens becomes lower, i.e.

it costs the first player less money, the average amount of tokens passed to the second player increases dramatically, suggesting that the low cost of giving is probably a powerful motivator.

In fact, there is a real-life example showing that low costs make help more available and sustainable. In China there are many people who are registered as members in an on-line organisation and offer help for other members. Every member can win a chance to seek help from other members by solving the problems posted on the website by someone else. These problems can be efficiently solved at very low costs because of the professional skills owned and the resources endowed by the members. For example, a student member, who plans to prepare his/her resume, may receive a professional assistance from a HR member who can do this job in less time with higher quality than the student can. Low costs may be very helpful in sustaining mutual help.

With the hints from this example and the facts mentioned above, we like to propose our research question: If the costs of provisions become lower, will people cooperate and contribute more to the group account in a public goods game?

The setting of our experiment is parallel to that of Sefton et al. (2007). Their reward treatment is our baseline treatment. In our experiment (lower-cost) treatment, the pay-off of a reward token is more than it is in the baseline treatment. Thus, rewards increase the group earnings by themselves in our lower-cost treatment, while they don't increase or decrease the group earnings in our baseline treatment (i.e. Sefton's reward treatment). The rewards are stronger ones in our lower-cost treatment, or in other words, the costs of rewarding others are lower. Our experiment is also a one-shot game like that of Walker and Halloran (2004).

2. Experiment

2.1 Experimental design

This experiment is an expanded one-shot public goods game with two stages (see Figure 1). The subjects are randomly divided into groups of four individuals to play the game. In the first stage, every subject is given with 6 tokens and needs to allocate them between his/her private account and the group account. A subject earns 50 cents from each token allocated to his/her private account, and each group member earns 25 cents from each token allocated to the group account. The total earnings from a token put in the group account are 1 euro (doubled), which is shared by the four group members equally. All the group members make the allocation decisions simultaneously and privately so that they are not influenced by the choices of other members.

After the first stage is finished, each subject is informed of the allocation decisions of his/her own group members, that is, the number of tokens allocated by each group member into his/her private account and into the group account. This is done without revealing the subjects' real names but with linking to the labels "participant 1" - "participant 4". In the second stage, every subject is endowed with another 6 tokens and needs to allocate them to his/her own private account to keep to himself/herself or to the private accounts of the other group members as rewards. Subjects should decide whether or not and how many tokens to reward any one of the other three group members, and how many tokens to keep to themselves. Subjects can't use the tokens received at Stage 1 to reward. A subject earns 50 cents for each token that he/she places in his/her private account. For each token that a subject receive from his/her fellow group members as rewards, he/she earns 50 cents in the baseline treatment and 75 cents in the lower-cost treatment. In this experiment setting, we hope to examine whether the introduction of opportunities to reward at lower costs will help to motivate cooperation in the public goods

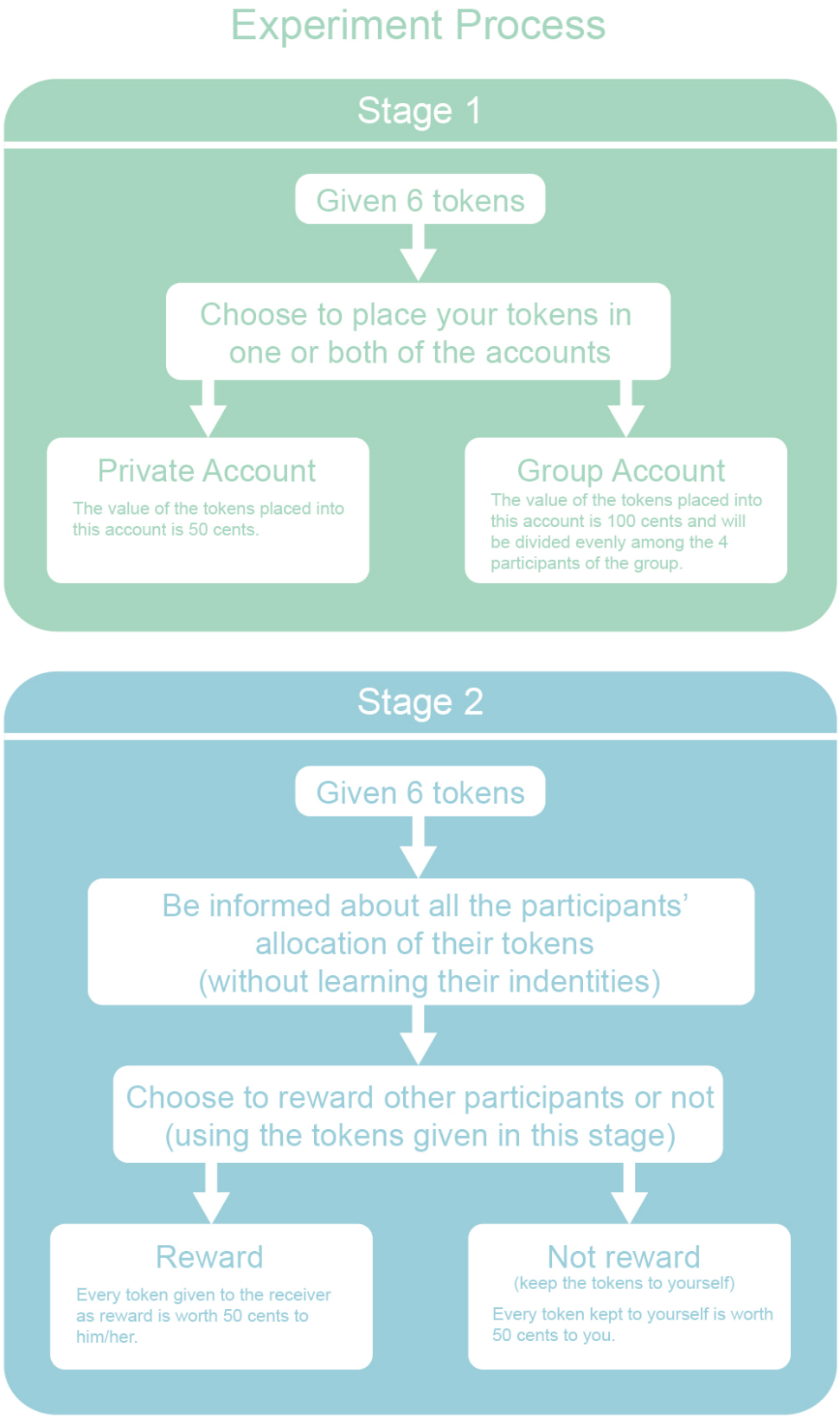

Figure 1. Experiment process

games. The phrase "lower-cost" means that it costs a subject a less number of tokens to give

the same amount of reward money in the lower-cost treatment. For example, a subject, who wants to reward another group member by 1.5 euro, will have to give 3 tokens in the baseline treatment but only 2 tokens in the lower-cost treatment. In this view, the costs of rewards are lowered.

2.2 Conducting the experiment

The experiment was conducted in May, 2015 and included two sessions, each session for one treatment. There were 22 female and 10 male subjects involved in this experiment who had Bachelor's degrees at least and were 21 to 33 years old. Half of them were students and the other half were working individuals. All the subjects were friends of the experimenter. According to the inquiries, none of them had any pre-knowledge about the public goods game before the experiment, therefore the influence of related learning or experiencing was excluded. Every subject was asked to keep the experiment confidential.

The experimenter kept contacts with the subjects individually, gave them all the information they needed by emails (see Figure 2) and collected the experiment data. There was no direct communication or contact between the subjects.

Every subject received four emails in total for the experiment (see Appendix for the contents of these emails). In the first email, subjects received instructions on how to do the experiment, including a few examples to help them to understand the process better and faster as they had no knowledge about the public goods game. The other three emails included the directions and the data sheets which should be filled by the subjects.

When the experiment was completed, one subject was randomly selected from each group and was given his/her earnings in real money, which, as we know, depended on the decisions of both the winner and his/her partners from the same group.

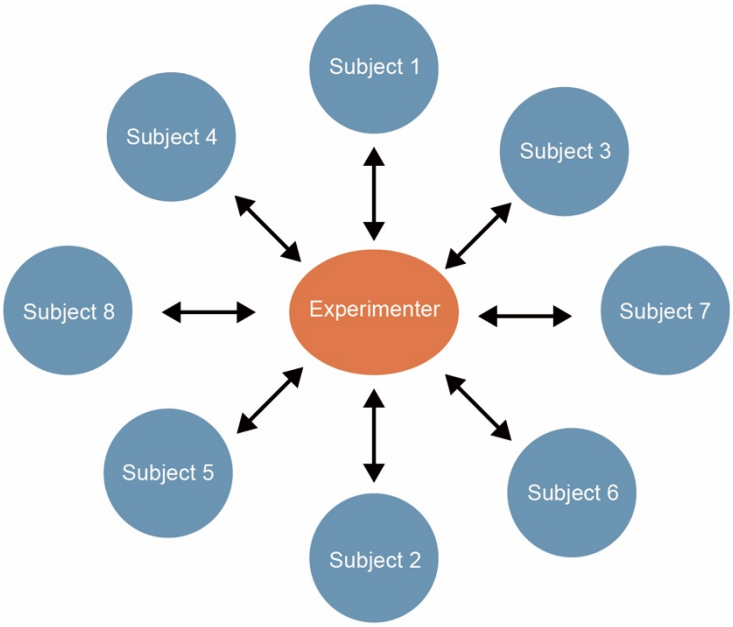

Figure 2. How the experiment is conducted.

The experimenter contacted subjects individually to ensure anonymity.

3. Results

The descriptive statistics of the experiment are presented in Table 1. In order to check if the experiment outcomes under the two treatments are significantly different, five nonparametric Mann-Whitney U tests (two-tailed) are performed, and the test results are also listed in Table 1.

Table 1. Average group account allocations, Rewards and Earnings, and Mann-Whitney U test results

The difference between the baseline treatment and the lower-cost treatment is the pay-offs of rewards. The pay-off for each reward token is 50 cents in the baseline treatment, but 75 cents in the lower-cost treatment.

The p-values and z-scores are the statistics of the Mann-Whitney U test (95% significance level, two-tailed), which examines whether the experiment outcomes in two settings are significantly different from each other. If the p-value exceeds 5%, then the experiment outcomes in the two settings are not significantly different from each other.

Treatment or test statistics	**Group Account Allocations**	**Rewards**		**Individual Earnings**	
	Number of tokens	Number of tokens	Value of tokens	After stage 1	After stage 2
Baseline treatment (0.5) (median)	4.19 (4.5)	2.00 (2.5)	1.00 (1.25)	5.09 (5.125)	8.09 (8.125)
Lower-cost treatment (0.75) (median)	3.25 (3.5)	1.75 (1)	1.31 (0.75)	4.63 (4.5)	8.06 (8.25)
p-value of the Mann-Whitney U test (z-score)	0.1802 (1.3380)	0.6818 (0.4146)	0.8808 (0.1508)	0.1936 (1.3003)	0.8966 (-0.1319)

3.1 Group account allocations

The average number of tokens placed in the group account is 4.19 for the baseline treatment and 3.25 for the lower-cost treatment. The ratio of this contribution to the initial endowment of each group member, which is calculated and displayed in Table 2, is 69.79% for the baseline treatment and 54.17% for the lower-cost treatment. While the percentage for the baseline treatment is higher, the percentage for the lower-cost treatment is lower and very near to 53%, which is the approximate level of group allocations reported by Sefton et al. (2007)

and Walker & Halloran (2004) in their earlier literature.

***Table 2**. **Average group account allocations as a percentage of the initial endowment to each group member**. Numbers in parentheses are standard deviations.*

Treatments	**Group account allocations**	
	Number of tokens	As a percentage to the initial endowment (6 tokens)
Baseline treatment (0.5)	4.19 (1.97)	69.79% (32.90%)
Lower-cost treatment (0.75)	3.25 (1.88)	54.17% (31.33%)

The difference between the group account allocations under the two treatments is not statistically significant, suggesting that the reduction of reward costs does not increase the contributions in the public goods game on a one-shot basis.

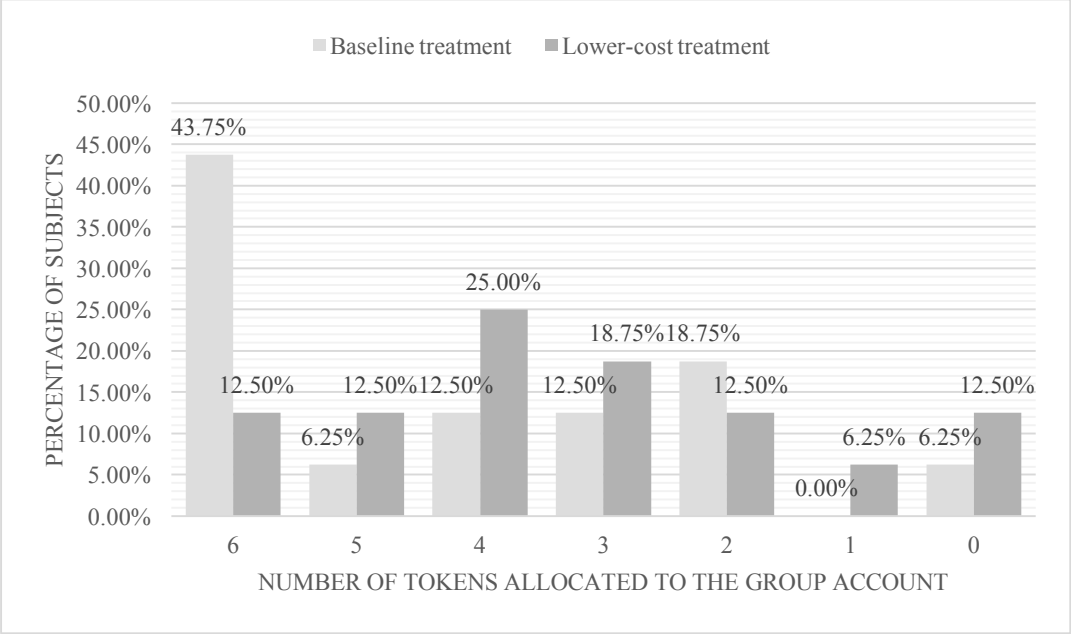

Figure 3. Distributions of individual's allocations in the group accounts

The distributions of group account allocations are shown in Figure 3 for both treatments. These two distributions are quite deferent from each other in their styles. In the lower-cost treatment, the percentage of subjects contributing 4 tokens and 3 tokens to the group account is the highest (25%) and the second (18.75%). In the baseline treatment, the percentage of

subjects contributing all their tokens and 2 tokens is the highest (43.75%) and the second (18.75%). The subject percentage contributing nothing is 6.25% for the baseline treatment and 12.5% for the lower-cost treatment, and they are all much lower than the level of 29.2% which is reported by Walker & Halloran (2004). In their experiment, the subject percentage contributing nothing and all is the highest and the second (27.1%).

3.2 Reward tokens

The average number of tokens used by each group member to reward other ones is 2 for the baseline treatment and 1.75 for the lower-cost treatment, and its percentage to the second endowment of each subject is 33.3% and 29.2% respectively. On the other hand, the value of tokens used by each subject to reward others is higher in the lower-cost treatment (1.75×75 cents=1.31 euro) than that in the baseline treatment (2×50 cents=1 euro). These results are consistent with the intuition that subjects like to give higher reward values at lower costs (a less number of tokens), based on which this experiment is designed. However, these rewarding levels are very low compared to the average contributions to the group account in Stage 1, suggesting that rewarding the other members is so different from contributing to the common group account to subjects. More than half of subjects have used at least one token to reward in both treatments as displayed in Table 3. The difference between these reward results in the two treatments is not statistically significant.

Table 3. Reward tokens and percentage of subjects using reward

Treatments	**percentage of tokens used as rewards**	**Percentage of subjects giving a reward**
Baseline treatment (0.5)	33.33%	62.50%
Lower-cost treatment (0.75)	29.17%	56.25%

3.3 Individual and group earnings

Group earnings are the total earnings of the four members in one group and the average individual earnings are equal to the group earnings divided by four. At the end of Stage 1, the average individual earnings are 5.09 euro for the baseline treatment and 4.63 euro for the lower-cost treatment. At the end of the game, they are 8.09 euro and 8.06 euro for the baseline and lower-cost treatments respectively. Subjects in the two treatments get almost the same earnings after the experiment. However, as the maximal potential earnings are 10.5 euro in the lower-cost treatment and 9 euro in the baseline treatment because of the deferent pay-offs for a reward token, the subjects in the lower-cost treatment earn a lower percentage to their maximal potential earnings than their counterparts do in the baseline treatment.

3.4 Group efficiency

As a proxy for the game performance, group efficiency is defined as the actual group earnings as a percentage of the maximum possible group earnings. The maximal group earnings are attained when all the tokens of the four members are allocated to the group account in Stage 1 for the baseline treatment. But, for the lower-cost treatment, the maximal group earnings are attained only when all the endowments are allocated to the group account in Stage 1 and, at the same time, all endowments are used to reward other group members in Stage 2. The conditions to achieve maximal group earnings (efficiency) for both treatments are the same at the first stage but different at the second stage.

The average group efficiencies are calculated for the two treatments at both the end of the first stage and the end of the game. The results are shown in Table 4.

Table 4. Average group efficiencies of the two treatments

Treatments	**Group efficiency**	
	First stage only	Overall
Baseline treatment (0.5)	84.90%	89.93%
Lower-cost treatment (0.75)	77.08%	76.79%

The average group efficiency is lower in the lower-cost treatment at the end of Stage 1 than it is in the baseline treatment. The average group efficiency in the baseline treatment rises to the level of 89.9% and that in the lower-cost treatment falls a little to the level of 76.8% at the end of Stage 2, which makes the difference between the group efficiencies for the baseline and lower-cost treatments increase to 13.1%.

These results demonstrate that the opportunities to reward at lower costs cannot increase the group efficiency or facilitate cooperation in a one-shot situation. These results are consistent with those got by Walker & Halloran (2004).

3.5 Who receives rewards

Our data supply evidence for the characteristics of subjects who receive rewards in Stage 2. Following Fehr & Gächter (2000) and Sefton et al. (2007), we examine the relation between the number of reward tokens received by a subject and the deviation of his/her group account allocations from the average ones of the other three group members. This relation is plotted in Figure 4.

As shown in Figure 4, subjects, whose contributions to the group account are more than the average ones of the other group members, receive generally more reward tokens in both treatments. Further, by comparing the bars of both treatments in the intervals (1, 3] and (3, 5], we can see that the subjects contributing more in the baseline treatment receive more reward tokens than their counterparts do in the lower-cost treatment. Interestingly, subjects whose contributions are less than the others' average still receive some reward tokens in both treatments. This may be used to partially explain why reward opportunities are not successful in motivating cooperation. As mentioned in previous part, Oliver (1980) argues that incentives are efficient in motivating a small group of people to make large contributions, and this mechanism is built on the basis that relatively a few people can earn the incentives by making

contribution. If incentives are given to all individuals, including those who make no contributions, they are not attractive anyone.

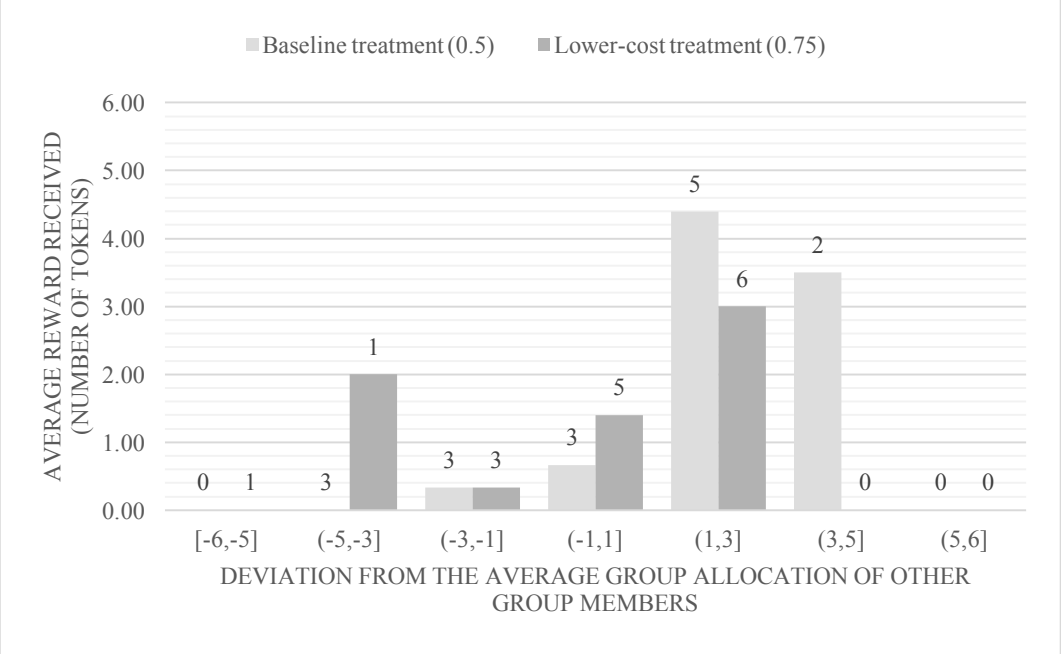

Figure 4. Average reward tokens in relation to the deviation from other members' average group allocation.

The number of subjects in each interval is marked on top of the bar. There are 16 subjects in each treatment.

To examine formally whether subjects know how to use rewards, we conduct the ordinary least-square (OLS) regressions for the two treatments separately. Following Fehr & Gächter (2000) and Sefton et al. (2007), we take the number of reward tokens received by a subject as the dependent variable, and the average contributions of the other group members and the negative and positive deviation of the subject's contributions from this average as independent variables. The variables neg_deviation and posi_deviation are calculated in the following way:

$$neg\_deviation = \max\{\overline{PA_{-i}} - PA_i, 0\}$$

$$posi\_deviation = \max\{PA_i - \overline{PA_{-i}}, 0\}$$

Here PA_i is the subject's contributions to the group account, and $\overline{PA_{-i}}$ is the average contributions of the other three group members. The regression results are presented in Table

5. We also conduct the same regressions with variables measured in monetary values, which we do not report in details[1] since the results are similar to this one's.

Table 5. Regression results. Dependent variable: Reward Tokens Received.

T-statistics are in parentheses.

*** denotes significance at 5% level.*

Independent variables	Baseline treatment	Lower-cost treatment
Constant	-5.351398 (-1.013)	-0.300181 (-0.1873)
Average allocation of other members	1.396793 (1.2560)	0.421971 (0.9205)
Neg_deviation	-0.416651 (-1.1290)	-0.258494 (-0.7715)
Posi_deviation	1.752054** (2.5207)	1.053157** (2.4123)

The posi_deviation coefficient is statistically significant at 5% level as shown in Table 5, which suggests that there is a positive relationship between the number of reward tokens received by a subject and the positive deviation of his/her contributions from the average group contributions. This is another evidence that the subjects contributing more tokens to the group account receive more reward tokens. The value of posi_deviation coefficient is higher (1.75) for the baseline treatment than it is (1.05) for the lower-cost treatment, indicating that the subjects, whose contributions are above the group average level, receive more reward tokens in the baseline treatment than their counterparts do in the lower-cost treatment.

It is meaningful that all the coefficients have the expected signs. Referring to its positive coefficient, the number of reward tokens received is positively correlated with the average group account contributions of other group members, showing that the subjects contributing more tokens to the group account use more tokens to reward. Neg_deviation is negatively

[1] See Appendix for these regression results.

correlated with the number of reward tokens received, suggesting that subjects, who contribute less tokens than the others' average, receive less reward tokens. But these relationships are not statistically significant.

4. Conclusion and discussion

In this paper we report a public goods game of two stages with opportunities to reward other group members at different costs. The experiment is designed to examine whether the opportunities to reward at lower costs will motivate more cooperation in provisions of public goods on a one-shot basis. Our results suggest that the opportunities to reward at lower costs fail to increase the group account allocations or improve the group efficiencies. Institutional arrangements to reduce reward costs are not likely to facilitate cooperation in the one-shot situation. However, the subjects contributing more tokens to the group account receive more reward tokens when their contributions are above the average level of other group members' contributions.

Our results further confirm that reward opportunities by themselves do not work well in motivating cooperation in one-shot public goods games, which is reported by Walker & Halloran (2004). This is still true when the reward costs are reduced.

The theory of intrinsic motivation may be employed to explain why reward opportunities are inefficient in facilitating cooperation. Deci (1971) and Harackiewicz (1979) argues that when an individual is engaged in an activity because of intrinsic motivation, an introduction of extrinsic rewards for that activity will undermine the intrinsic motivation. In public goods games, subjects are driven to a certain extent by intrinsic motivation to allocate their tokens to the group account, they probably lose their intrinsic motivation when the opportunities to get reward money appear and hence give up their cooperative behaviour to pursue gains.

The one-shot setting is probably another reason resulting in this failure. Walker & Halloran (2004) explain that subjects do not consider the rewards to be credible in a one-shot situation. If subjects choose not to reward but to retain the tokens to themselves, they will lose nothing but receive more earnings. However, in the repeated games the trade-off between

keeping the tokens and rewarding others will become more complicated, and acting in a selfish way is not costless anymore.

Sefton et al. (2007) presented that reward opportunities are less effective than sanction ones in the repeated public goods games, which may be explained with the prospect theory created in 1979 and developed in 1992 by Kahneman and Tversky. As shown in Figure 5, the value function is asymmetric on the two sides of the reference point. It decreases more on the loss side than it increases on the gain side, meaning that losses hurt more than gains help, i.e. people are loss-aversion. When sanction opportunities are introduced to the experiment, subjects have a stronger motivation to avoid being sanctioned by contributing more.

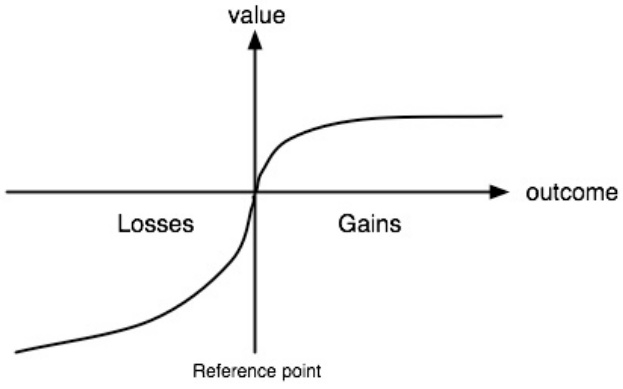

Figure 5. The value function of prospect theory

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Appendix

Templates of emails

First email

Thank you for participating in this experiment, which is conducted by email. You will receive four emails in total. This first one includes instructions on how to do the experiment, and the following three ones will show the directions what/how to do and the forms to be filled.

Please read carefully the instructions in the attachment. In fifteen minutes, you will receive the second email. Then you need to follow the directions, make your decisions, fill the form and email it back to me. If you have any question on the instructions, please inform me soon by email.

IMPORTANT: To guarantee the anonymity of this game, please DO NOT mention your participation in this experiment to anyone else.

Second email

THE GAME BEGINS

Now you are given 6 tokens, which you must put into the two accounts, your private account and the group account. How do you allocate them?

Please copy the sentence below in quotes into an answer email, fill in the blanks with your choices, and send the email back to me.

“I like to place ___ token(s) in the group account and ___ token(s) in my private account.”

*Directions:

• The value of each token placed in your private account is 50 cents. The money belongs to your own.

• The value of each token placed in the group account is 1 euro (doubled). This money belongs to you and your three partners from your group equally. This means that you and any other member in your group can earn 25 cents from each token in the group account.

After I collect all the answers, the first stage ends. Please wait for the second stage patiently.

Third email

The choices of all the members from your group in the first stage are shown in the following table.

Table 1: the members' allocations in stage 1

Participant	His/her choice		Earning
	Number of tokens placed in the **group account**	Number of tokens placed in one's **private account**	
1			
2			
3(you)			
4			

Your earnings in stage 1 are a*0.5+(b1+b2+b3+b4)*0.25 = c euro

Now the second stage of the game starts. You are given ANOTHER 6 tokens, which you must put into the four members' private accounts. Knowing the contributions of participant 1, 2, 3 and 4 to the public account in stage 1, you can reward anyone of them by putting the new token(s) into his/her private account. Of course, you can also put these tokens into your own private account to keep them to yourself. You have all the rights to make your allocation choices. How do you allocate your tokens? (The total number of tokens you can allocate is no other than 6.)

Please copy the following table into an answer email, fill it with your choices, and send the email back to me.

Table 2: Your allocations and rewards in stage 2

I reward __ tokens (in total) and give them to			I keep __ tokens to myself
Participant 1	Participant 2	Participant 3	

**Directions:*

- *For each token you keep to yourself, you will earn 50 cents.*
- *For each token you reward to someone, he/she will earn 50 cents*[2].

After I collect all the answers, the whole game ends. In the next email, you will be informed of your final earning and who from your group has been randomly selected to get his/her earning in real money.

Fourth email

Your final earnings in this game are (earnings in stage 1)+d×0.5 or 0.75+e×0.5 = f euros

The whole game ends.

Participant x has been randomly selected to get his/her earning in real money. Please inform me about your bank account so that I can transfer the money to you.

Thank you all again for participating in this game.

Have a nice day!

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[2] This is the email used in the baseline treatment. In the third email used in the lower-cost treatment, this value is 75 cents.

Emails in Chinese

第一封

非常感谢参加我的实验。本次实验通过邮件进行。一共将有四封邮件，第一封（就是你现在在读的这封）主要讲解实验流程，后面三封指导正式的实验。

附件中的实验说明详细讲解了实验流程和实验规则，请仔细阅读。十五分钟后实验随第二封邮件正式开始。参与者按照接下来每封邮件中的指导回复即可。

重要：为保证实验的保密性，请不要向任何人提起你曾经/正在/已经参加实验的事情。

现在请阅读实验说明，我们十五分钟后见~
如有任何关于实验规则的问题可以在这十五分钟内发邮件询问。

第二封

实验正式开始。
现在你已经拿到了 6 个实验币。请问你将如何分配这 6 个实验币？
请在以下模板中填上你的答案，然后复制该模板到邮件中进行回复。
“我选择将____个实验币放入**公共账户**中，将____个实验币放入我的**私人账户**中。”

**提醒：*

- *每将一个实验币放入你自己的私人账户，你都会获得 0.5 欧元。这 0.5 欧元是完全属于你自己的。*
- *每将一个实验币放入公共账户中，这个实验币的价值将翻倍变成 1 欧元，但这些钱暂时存于公共账户，最终由你们组四个成员均分，即你将收到公共账户总价值的四分之一。*

待所有参与者发回他们的选择之后，实验第一部分结束，然后进入第二部分。
请耐心等待下一封邮件。

第三封

以下表格显示了你们组成员在第一部分中是如何分配他们的实验币的。

参与者	每位参与者在上一阶段的决定		收益
	他/她放入**公共账号**的实验币数量	他/她放入**私人账号**的实验币数量	
1			
2			
3(你)			
4			

因此你在实验第一部分的收益一共是：

现在你拿到了另外的 6 个实验币，你可以选择用这些实验币奖励一个/两个/所有其他参与者或者选择留给你自己。请问你将如何分配这些实验币？（注意你用来奖励别人的实验币总数量不得超过 6）

请在以下表格中填上你的答案，然后将这个表格复制到邮件里进行回复。

我选择拿出____个实验币用于奖励以下参与者：			我选择将____个实验币留给自己
参与者 1	参与者 2	参与者 3	

**提醒*

- *你每奖励别人一个实验币，收到奖励的那位参与者都将获得 0.5 欧元的收益。*
- *你每留一个实验币给自己，你都将获得 0.5 欧元的收益。*

待所有参与者回复自己的选择之后，整个实验结束。之后会再发邮件告知每位参与者最终的收益以及哪一位参与者将获得现金奖励。

第四封

本次实验你的最终收益是：

本次实验结束。

经过随机抽选，参与者 x 将获得现金奖励。

再次感谢参与本次实验！

祝晚安~

The attachment in the first email (experiment instruction)

Instructions

All the experiment participants are randomly divided into groups of four individuals, hence you play this game with three other partners. The game consists of two stages, in which you and your three partners are given game tokens to allocate into deferent accounts. You and your three partners can earn various amount of money according to your and their allocations. When the game ends, one of the four group members is randomly selected to get his/her earnings in real money. Your identity will not be revealed to anyone else, but your decisions will be shown to the other members from your group WITHOUT associating with your identity. The entire game stays in anonymity. The game process is shown in the figure at the end of this instruction.

Stage 1

You are given 6 tokens which you must put into two accounts, your private account and the group account. You need to decide how many tokens you want to place in each of these two accounts. Tokens placed in different accounts value differently, you and/or your partners can earn some money for it.

• The value of each token placed in your private account is 50 cents, and the money belongs to yourself.

• The value of each token placed in the public account is 1 euro (doubled), which belongs to the four group members equally. This means that you and any other member in your group can earn 25 cents for each token in the group account.

After I collect all the answers, the first stage ends.

Here are some examples which help you to understand better.

Example 1:

If everyone in the group puts all his/her tokens into the group account, every member will earn 24×1 euro/4 = 6 euros. On the contrary, if everyone in the group places all his/her tokens into his/her private account, the earnings of each group member are 6×0.5 euro = 3 euros.

Example 2:

If you place 2 tokens into the group account and 4 tokens into your private account, and if there are 6 tokens in the group account at last, you will earn 4×0.5 euros = 2 euros from your

private account and 6×1 euros /4 = 1.5 euros from the public account. Your total earnings will be 2+1.5=3.5 euros.

Example 3:

If your three partners put all their tokens in the group account and you put all your tokens into your private account, you will earn 7.5 euro and each other member will earn 4.5 euros. If you place all your tokens into the group account and your partners put all their tokens into their private account, you will earn 1.5 euros and each of your partners will earn 4.5 euros.

Stage 2

You are now informed about the choices of all the members in your group in the first stage with the following table. But you don't know who is participant 1, 2, 3 or 4 except yourself.

Table 1: The group members' allocations in Stage 1

Participant	His/her choice		Earning
	Number of tokens placed in **public account**	Number of tokens placed in **private account**	
1			
2			
3(you)			
4			

Now the second stage of the game starts. You are given ANOTHER 6 tokens, which you must put into the four members' accounts. Knowing the contributions of all your group members to the group account in Stage 1, you can reward them by putting the new tokens into their accounts. Of course, you can also put these tokens into your account to keep them to yourself. You have all the rights to make your allocation choices. The earnings and the owners from the new tokens are as follows:

- *For each token you keep to yourself, you will earn 50 cents.*
- *For each token you reward to someone else, he/she will get 50 cents*[3].

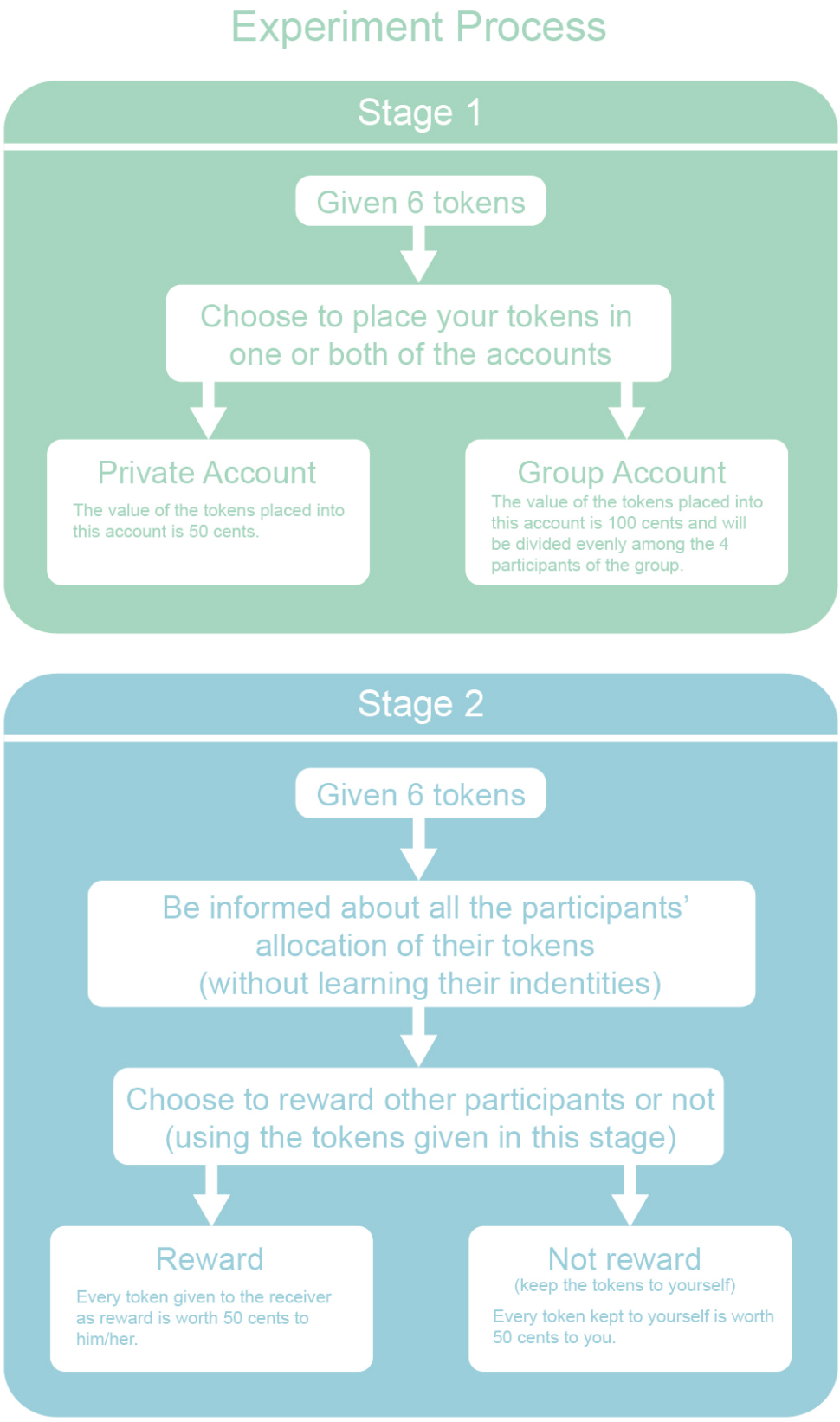
[3] This is the instruction for the baseline treatment. In the instruction for lower-cost treatment, this value is 75 cents.

You will be required to fill the following table with your allocations of the new tokens. The total number of tokens you can use is no other than 6.

Table 2: Your allocations and rewards in Stage 2

I reward __ tokens (in total) and give them to			I keep __ tokens to myself
Participant 1	Participant 2	Participant 3	

After you send your answer to me, the whole game ends. In the fourth email, you will be informed which participant is randomly selected to get his/her earnings in real money, which is equal to earnings in stage 1 + earnings in Stage 2.


Experiment Process
Stage 1
Given 6 tokens
Choose to place your tokens in one or both of the accounts
Private Account
The value of the tokens placed into this account is 50 cents.
Group Account
The value of the tokens placed into this account is 100 cents and will be divided evenly among the 4 participants of the group.
Stage 2
Given 6 tokens
Be informed about all the participants' allocation of their tokens (without learning their indentities)
Choose to reward other participants or not (using the tokens given in this stage)
Reward
Every token given to the receiver as reward is worth 50 cents to him/her.
Not reward
(keep the tokens to yourself)
Every token kept to yourself is worth 50 cents to you.

Regression results with variables measured in monetary values

Independent variables	Baseline treatment	Lower-cost treatment
Constant	-2.675699	-0.225136
	(-1.013)	(-0.1873)
Others' average allocation in the group account	0.698396	0.316478
	(1.2560)	(0.9205)
Neg_deviation	-0.208326	-0.193871
	(-1.1290)	(-0.7715)
Posi_deviation	0.876027**	0.789868**
	(2.5207)	(2.4123)