# Public Goods Provision via Emails

*By CHEUNG Chun Yeung, CHOI Yan Sze, FU Chi Lok,*
*LAU To Ping and WU Tung Fai*

This study examines individual behaviors using three public goods games with different conditions, a pure public goods game, an introduction of an audience and a punishment condition, to investigate whether punishment would be more effective in eliciting a higher level of contribution and whether these games, lasting for a longer period of time, would exhibit different behavioral pattern than previous researches. We find out that punishment can significantly induce a higher level of contribution than the introduction of an audience. Moreover, the effect of social image resulted from an audience has vanished. Subjects' contributions under the treatment of an existence of audience converge to that of the pure public goods game. Overall, our findings are different from previous research findings quite significantly.

## 1. Introduction

There are several ways to increase people's contribution to a public goods. Contribution is an amount that an individual devote to a group, where he/she belongs to, in order to facilitate the provision of a public goods. There are several experimental findings which show a positive effect on the contribution to public goods. Ozbay and Ozbay (2013) introduced an audience into the public goods game and concluded that the audience can effectively increase the level of contribution. Fehr and Gachter (2000) found that punishment condition in a public goods game makes the subjects fully cooperate. These public goods experiments only lasted for, at most, a few hours. However, we are interested in which way would be the more effective in inducing a higher level of contribution, and whether there are any behavioral differences if the experiments are launched for a longer period of time? Finding a more effective way to increase people's contribution can greatly affect the provision of public goods in a society.

In this study, we use three public goods games to compare the effect between treatments, and the findings from these three games are compared with the previous research findings. The first treatment is a typical public goods game without any condition. Subjects are free to decide their contribution to the public goods without influences. However, the second and the third treatment has an audience and a punishment condition respectively.

The main feature of our experiment is that our games are conducted through emails, lasting for a longer period of time. And we tried to find out which way can be more effective in eliciting a higher contribution level in public goods provision. This can affect the conditions of providing public goods in the society. Besides, we studied the rationale behind punishment acts.

Our experiment has a total of five results. First, only contributions in the audience treatment dropped over time, which means the effect of social image has vanished. Secondly, punishment is more effective in inducing a higher level of contribution. Thirdly, marginal average acceptable levels of contributions and payoffs are consistent to the findings. Fourthly, punishment decisions are initiated by

self-pre-punishment payoff instead of others' contribution. Lastly, our findings are different from the previous research findings quite significantly.

## 2. Experimental Design

Our experiment consists of a total of three treatments, which are done through emails. Fundamentally, we conducted three public goods games, where one public goods game represents one treatment, at the same period of time. Each treatment lasted for ten consecutive days, from April 27, 2015, to May 8, 2015. Each day represents one round of the treatment. All rounds started at 00:00 (12:00 a.m.) and ended at 23:55 (11:55 p.m.) every day. Two trial rounds for each treatment were conducted before the commencement of the real experiment. We recruited 90 students, from the City University of Hong Kong, as subjects for our experiment. They all faced the same advertisement and did not know we have three treatments. After we had recruited them, they were randomly allocated into the three treatments. Each treatment has 30 subjects. Every subject received a participation fee of HK$15. Reminders of decision submission would be sent to subjects, who had not yet submitted their decision, two hours before the deadline. We stated clearly that any late submission will be disqualified immediately and the subject will not be able to get any reward, including the participation fee.

We did not utterly follow the experimental design of Fehr and Gachter (2000), where the same subject played both no-punishment and punishment conditions within one treatment. Instead, we believe the same subject, playing both conditions in a single treatment, would exhibits experimenter's bias, resulting in the outcomes favoring the experimenter's expectation. This is because, with varying conditions in one treatment, subjects may believe the experimenter is expecting a different outcome and, as a result, act differently from the previous condition. Thus, their beliefs affect the outcomes and may not necessarily reveal their actual behavior. Additionally, this intrapersonal outcome may not be relevant for our comparison of the effectiveness between the audience condition and the punishment condition. Hence, we conducted each treatment with only one condition. In the first treatment, subjects are under the condition of no-audience and no-punishment. While the second treatment involves an audience in each group, the third treatment only contains the punishment condition.

Besides, we conducted our experiment through emails to see if there are any behavioral differences between physical laboratory experiment, which lasted for only a few hours, and our virtual laboratory experiment, which lasted for a much longer period of time.

### *2.1 First Treatment*

The first treatment is a typical public goods game, acting as a baseline for comparison. In this treatment, subjects were randomly allocated into six groups, which means five subjects per group, for every round. Each subject is endowed with HK$10. They had to decide on investing in a public goods or not, where the amount they invested in the public goods would be multiplied by a factor and divided equally among subjects within the group. All subjects would only know which group they are in, but they did not know who the other group members are.

Subjects were required to submit their decision through emails before 23:55 (11:55 p.m.) every day. Then, they would know about how much each group member received before 00:00 (12:00 a.m.) of another day. The monetary payoff for each subject *i* in the group is given by

$$(1)\quad \pi_{i,n}^{First}\left(g_{i,n}, g_{-i,n}\right) = \$10 - g_{i,n} + 2.5 \times \left(g_{i,n} + g_{-i,n}\right) \div 5$$

in each round. Player *i*'s payoff, $\pi_{i,n}^{First}$, for round *n* in the first treatment is a function of the amount of his/her contribution to the public goods in that round, $g_{i,n}$, from his/her endowment and the amount of his/her group members' contribution to the public goods in that round, $g_{-i,n}$. All group members' contribution within a group was multiplied by 2.5, and then divided equally among the five group members. Contribution and payoff of each group member are a common knowledge after the announcement, but other subjects' identities are unknown to a specific subject.

Subjects of the first treatment will be rewarded by the participation fee plus the average payoff they got from the ten rounds.

### *2.2 Second Treatment*

The second treatment introduced an audience into the group without punishment. Subjects were randomly allocated into five groups, which means six subjects per group, for every round. Among these six subjects, one of them will randomly be chosen as the audience, while other five subjects, namely "investors", make their decision on investing in a public goods or not. According to Ozbay and Ozbay (2013), when investors were being observed by a third party in the laboratory experiment, their contribution increases significantly. The effect of social image successfully induced higher contribution. Because we conducted our experiment through emails, one way to make the effect of social image significant in the Internet is to use Facebook. We required all subjects in the second treatment to submit their own Facebook account. After that, we added their Facebook using our newly opened Facebook account and checked whether the subject has his/her own profile picture. If a subject rejects to submit his/her Facebook because of privacy issues, we will reallocate him/her into another treatment, but we did not receive any rejection throughout the experiment. The sole purpose of using Facebook is to allow the audience to observe the contribution of a specific investor and to enable an investor to see his/her group members' contribution to the public good after the announcement of everyone's payoff. Hence, nothing have been posted on Facebook.

At 00:00 (12:00 a.m.) every day, investors would only know the name of their audience, but they were not informed about who are the other investors within the group. This can avoid possible communication or collusion between investors. Audiences would only know that they are the ones who observe, which means no investors' names were provided.

The audience was not endowed with any money. But he/she had to report the five investors' contribution to the public goods to us in order to earn his/her reward for that round. On the other hand, investors were endowed with HK$10, which is the same as the first treatment. Investors were required to submit their decisions to us and to the audience through emails before 18:00 (6:00 p.m.) every day. After all decisions were made, audiences had to report the contribution of each investor within the group before 23:55 (11:55 p.m.). Subjects would be informed about how much each group member received before 00:00 (12:00 a.m.) of another day. The monetary payoff for an investor, $\pi_{i,n}^{Investor}$, is the same as the payoff in the first treatment, and is given by

$$(2) \quad \pi_{i,n}^{Investor}(g_{i,n}, g_{-i,n}) = \$10 - g_{i,n} + 2.5 \times (g_{i,n} + g_{-i,n}) \div 5$$

in each round. All investors' contribution within a group was multiplied by 2.5, and then divided equally among the five investors in order to ensure the comparability with other treatments. The mon-

**Table 1 Punishment Point and Punishment Cost in Treatment 3**

| **Punishment Point (PP)** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Punishment Cost (PC)** | 0 | 0.5 | 1 | 1.5 | 2.5 | 3.5 | 5 | 7 | 9 | 12 | 15 |

etary payoff for an audience is each correct reporting of one investor's contribution multiplied by HKD$3.50. Contribution, payoff and identity of each group member are a common knowledge after the announcement.

Subjects of the second treatment will be rewarded by the participation fee plus the average payoff they got from the ten rounds.

### *2.3 Third Treatment*

The third treatment involves the punishment condition but there is no audience. It is a two stage public goods game. According to Fehr and Gachter (2000), punishment can make subjects more disciplined and, therefore, exhibits a higher level of contribution. In this treatment, subjects were randomly allocated into six groups, which means five subjects per group, for every round. Each subject is endowed with HK$10 as well. All subjects would only know which group they are in, but they did not know the identity of other group members even after the announcement of each subject's pre-punishment payoff.

In the first stage, subjects were required to submit their decisions through emails before 18:00 (6:00 p.m.) every day. After that, they would know how much each group member received before 18:15 (6:15 p.m.). The monetary payoff for each subject *i* in the group is given by

$$(3)\quad \pi_{i,n}^{Pre}\left(g_{i,n}, g_{-i,n}\right) = \$10 - g_{i,n} + 2.5 \times \left(g_{i,n} + g_{-i,n}\right) \div 5$$

in each round. This pre-punishment payoff function, $\pi_{i,n}^{Pre}$, is the same as the first and second treatment such that outcomes can be comparable. Contribution and pre-punishment payoff of each group member are a common knowledge after the first announcement at 18:15 (6:15 p.m.), but other subjects' identities are unknown to a specific subject.

Then, in the second stage, subjects can base on the results to decide on punishing other group members or not. Each subject can choose punishment points to lower another subject's payoff within his/her group. However, as shown in Table 1, punishment points are costly to the subject. Moreover, an additional punishment point will progressively cost more. The punishment decisions needed to be sent to us through emails before 23:55 (11:55 p.m.). The post-punishment payoff of player *i* is given by

$$(4)\quad \pi_{i,n}^{Post}\left(g_{i,n}, g_{-i,n}, PC_{i,n}, PP_{-i,n}\right) = max\left\{\pi_{i,n}^{Pre}\left(g_{i,n}, g_{-i,n}\right) - PC_{i,n} - PP_{-i,n}, 0\right\}$$

in each round. In other words, the post-punishment payoff, $\pi_{i,n}^{Post}$, is a function of the pre-punishment payoff, the expense of punishment cost, $PC_{i,n}$, and the punishment points received from other group members, $PP_{-i,n}$, in round *n*. The minimum payoff one can get is $\pi_{i,n}^{Post} = 0$. Subjects would know the post-punishment payoff of each group member before 00:00 (12:00 a.m.) of another day. Punishment points, punishment cost and post-punishment payoff of each group member are a common knowledge after the second announcement, but identities of the group members are unknown to a specific subject. In the email of post-punishment payoff announcement, we have sent a question to each subject, asking why they punished or did not punish his/her group members. This punishment rationale has been kept confidential.

Subjects of the third treatment will be rewarded by the participation fee plus the average post-punishment payoff they got from the ten rounds.

### *2.4 Questionnaire*

After the end of each treatment, a questionnaire was sent to each subject as well. The questionnaire asked about what is the marginal acceptable level of contribution and payoff, or pre-punishment payoff for the third treatment. For the subjects in the third treatment, we asked an additional question about whether he/she made the punishment decision depending on everyone's contribution and/or payoff.

## 3. Predictions

If subjects are perfectly rational and their selfishness are a common knowledge, the game theory prediction with regard to $g_{i,n}$ for every treatment is the same, where all subjects will not contribute to the public goods at all.

In the first treatment, if a subject knows that other subjects in the group are selfish, any positive amount of contribution will lower his/her monetary payoff. The selfishness of other subjects means they will not contribute to the public goods, where $g_{-i,n} = 0$. According to the payoff function (1), an additional HK$1 contributing to the public goods causes that subject's payoff to decrease by HK$0.50. As a result, the dominant strategy of the first treatment is to perfectly free-ride, where $g_{i,n} = 0$.

Although social image is introduced in the second treatment, this effect should not be significant for a rational investor. Because a rational individual only maximizes his/her monetary payoff and a better social image will not bring about a higher payoff, he/she will not contribute to the public goods as well. An investor should expect other subjects to act identically due to the common knowledge of others' selfishness. Any positive contribution will result in a decrease in one's monetary payoff. Therefore, given the payoff function of (2), the Nash equilibrium for every rational investor in the second treatment is not to contribute at all.

Backward induction can be used to solve for the subgame perfect Nash equilibrium of the third treatment. In the second stage, a rational subject will not punish others, $PC_{i,n} = 0$, because punishment is costly for him/her. Since the selfishness of other subjects are a common knowledge, the existence of punishment does not alter the behavioral incentive in the first stage. Consequently, every subject will choose $g_{i,n} = 0$ at stage one.

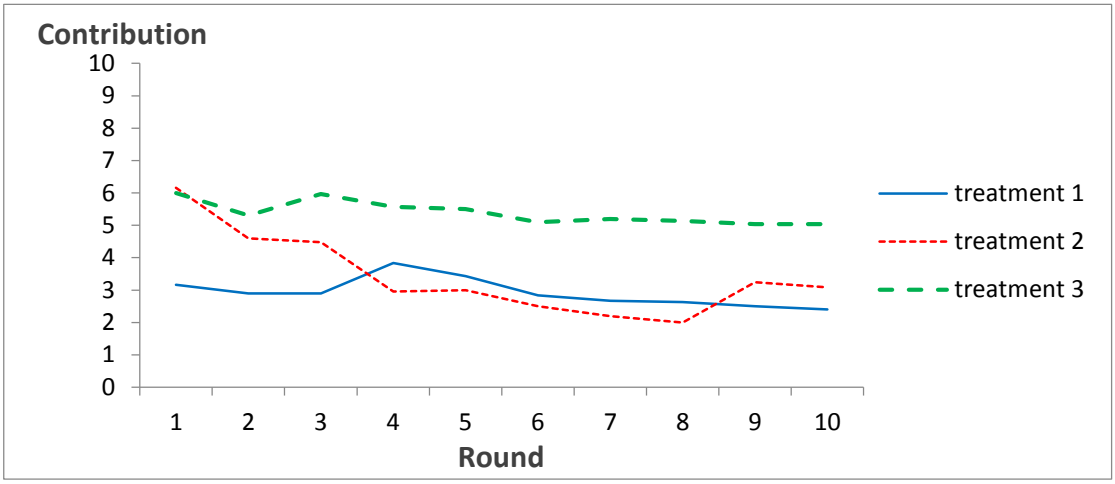
A lot of evidence for a typical public goods game, like the first treatment, has been shown. It is well known that contribution strongly deteriorates over time and reaches rather low levels in the final period (Andreoni, 1988; Ledyard, 1995; Fehr and Schmidt, 2000). The average contribution rate of subjects is approximately 50% of their endowment at the beginning of the game while $g_{i,n}$ approaches zero in the latter rounds.

However, with the presence of a social image or a punishment condition, higher contribution rate of subjects can be induced (Andreoni and Petrie, 2004; Ozbay and Ozbay, 2013; Fehr and Schmidt, 2000). The effect of social image by various means can significantly increase subjects' contribution by about 20%, which means more cooperation occurred. On the other hand, the existence of punishment opportunities causes a large increase in the average contribution. The average contribution rate is about 58% of the endowment.

## 4. Experimental Results

In the section, results from our three treatments will be presented. Several behaviors observed from the results, which are mainly determined by a subject's perception and expectation on others' choices,

**Figure 1 Average Contributions in All Treatments**




will be discussed. On average, a subject's monetary payoff in the first, second and third treatment was HK$14.44, HK$15.5333 and HK$16.7 respectively.

RESULT 1: *Only contributions in the audience treatment dropped over time, which means the effects of social image has vanished.*

Figure 1 plots the average contributions among all rounds in the three treatments while Table 2 shows the significance of changes in contribution in each treatment. The first treatment has a seemingly stationary trend, except the slightly increase in contribution in the round 4. Because this increase in contribution would not be rational, the contribution gradually dropped back to the previous level. A decreasing trend occurred in the second treatment. The third treatment has a roughly stationary trend as well. The significance of these trends can be revealed from Table 2, where t-statistics has been used. The first column in Table 2 represents the contribution of the first round (R1) compared with another round. For example, R1 vs. R2 means the contribution of round 1 is compared with that of round 2, and the mean difference is calculated by a subject's contribution in round 1 minus that subject's contribution in round 2. A positive coefficient means a decrease in contribution while a negative coefficient means an increase in contribution. In the

**Table 2 Statistical Significance of Changes**

| | Mean Difference (e.g. R1-R2) | | |
|---|---|---|---|
| R1 vs. | T1 | T2 | T3 |
| R2 | 0.2667<br>(0.7793) | 1.6*<br>(1.9095) | 0.7<br>(1.6011) |
| R3 | 0.2667<br>(0.7951) | 1.5238*<br>(2.0023) | 0.0333<br>(0.0674) |
| R4 | -0.6667<br>(-1.0814) | 3.0476***<br>(4.0575) | 0.4333<br>(0.9288) |
| R5 | -0.2667<br>(-0.4573) | 2.7619***<br>(2.8892) | 0.5<br>(1.0189) |
| R6 | 0.3333<br>(0.8064) | 2.5***<br>(2.9281) | 0.9<br>(1.5959) |
| R7 | 0.5<br>(1.0389) | 3.6190***<br>(4.0050) | 0.8<br>(1.3837) |
| R8 | 0.5333<br>(1.2457) | 3.75***<br>(3.7123) | 0.8667<br>(1.4347) |
| R9 | 0.6667<br>(1.4965) | 4.25***<br>(5.0631) | 0.9667<br>(1.3997) |
| R10 | 0.7667*<br>(1.8628) | 3.55***<br>(3.6731) | 0.9667<br>(1.5673) |

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level. R= round. T= treatment.

**Table 3 Average Contribution Difference between Treatments**

| | Mean Difference (e.g. T1-T2) |
|---|---|
| T1 vs. T2 | -0.6003<br>(-0.9998) |
| T1 vs. T3 | -2.4567***<br>(-3.5885) |
| T2 vs. T3 | -1.8563***<br>(-2.5977) |

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level. T= treatment.

second column of Table 2, the fluctuations in contributions of the first treatment is insignificant until the last round. But the 0.7667 decrease in contribution is only significant at 10% level. The third column shows the significant change of contribution in the second treatment. Starting from round 4, contribution of subjects decreases significantly. The largest drop appears in the latter period of the treatment, where all mean differences is larger than 3.5 with 1% significant level. On the contrary, the third treatment has no significant deviation of contribution at all.

Besides, the second treatment's average contributions in the first two rounds are significantly larger than that in the first treatment, but become insignificant after round 2. This indicates that the effect of social image, elicited by an audience, has vanished over time.

RESULT 2: *The punishment condition is significantly more effective than an audience, or a social image, in terms of inducing a higher level of contribution.*

Given different trends in the three treatments with various conditions, a more interesting question would be which treatment is the most effective in inducing higher contribution. The average contributions among all rounds of the first, second third treatment are 2.9267 (29%), 3.5270 (35%) and 5.3833 (54%) respectively.

The effectiveness of an audience and a punishment condition is shown in Table 3. It shows the significance of the difference of average contribution between two treatments. For example, T1 vs. T2 means the average contribution of the first treatment is compared with that of the second treatment. In this case, the mean difference is calculated by the average contribution in the T1, which is the summation of a subject's contributions in all rounds divided by ten, minus the average contribution in T2. A negative coefficient means the latter treatment has a higher contribution than the former one. Table 3 shows that the average contribution of the second treatment does not deviate significantly from that of the first treatment, but the average contribution in the third treatment is significantly larger than that of the first treatment. In other words, punishment condition can significantly increase contribution but an existence of social image has no significant effect on contribution. Therefore, the effect of social image has vanished in our experiment.

The third row in Table 3 tests whether the level of average contribution in the third treatment is higher than that in the second treatment. The result is that the punishment condition is more effective than the social image at 1% significant level. Hence, a punishment condition is the most effective one in inducing a higher level of contribution.

RESULT 3: *Marginal average acceptable levels of contributions and payoffs are consistent with RESULT 2.*

We have asked the subjects to fill in a questionnaire, which asked about their marginal average ac-

**Table 4 Average Acceptability**

| Marginal average acceptable level of | T1 | T2 | T3 |
|---|---|---|---|
| Contribution | 1.0333 | 1.2 | 3 |
| Payoff | 10.9667 | 11.1667 | 13.4333^ |

T= treatment. ^= pre-punishment payoff.

ceptability of different outcomes. The average acceptable levels of contribution and payoff, or pre-punishment payoff, of each treatment (T1, T2 and T3) is shown in Table 4 (on the next page). The average acceptable levels of contribution are 1.0333 (10%), 1.2 (12%) and 3 (30%) in the first, second and third treatment respectively. With respect to the acceptable level, this reflects the lowest expectation of a subject on other subjects in the same group to contribute at or above such level. Similarly, because subjects in the second and third treatment expects a higher minimum contribution expectation to the public goods, their expected payoffs ($11.1667), or expected pre-punishment payoffs ($13.4333), are higher than that of the first treatment ($10.9667). Moreover, there is a significant difference in minimum expectation between the first and the third treatment, but this difference between the first and the second treatment is not significant. These minimum expectations are consistent with our results.

Since the acceptable levels of contribution in each treatment are significantly deviating from zero, subjects in all treatments has a common idea about what level of contribution would cause free-riding. Because of the positive acceptable levels, not only the zero contribution subjects, but also some positive contribution ones, are regarded as free-riders. As a result, we argue that free-riding is not necessarily zero contribution. Some subjects may still be free-riding other group members even they contributed a positive amount. This concept is defined as

**Table 5 Absolute Free-riding in the Third Treatment**

| | Number of absolute free-riders ($g_{i,n} = 0$) | Number of absolute free-riders being punished |
|---|---|---|
| R1 | 2 | 1 |
| R2 | 1 | 1 |
| R3 | 2 | 1 |
| R4 | 2 | 0 |
| R5 | 2 | 0 |
| R6 | 1 | 1 |
| R7 | 3 | 1 |
| R8 | 3 | 2 |
| R9 | 3 | 3 |
| R10 | 1 | 1 |
| Total | 20 | 11 (55%) |

R= round.

"relative free-riding", whereas the zero contribution is defined as "absolute free-riding". To generalize this concept, relative free-riders are identified by the perception of a group or a society under different conditions.

RESULT 4: *Punishment decisions are initiated by self-pre-punishment payoff instead of others' contribution.*

With regards to the punishment condition, we observed some interesting behavior in the third treatment. The average punishment cost and average punishment point conditional to punishment are HK$4.3289 and 2.0088 respectively. One of the two behaviors is presented in Table 5. It lists out the number of subjects, who are absolutely free-riding other group members, in each round and how many of them are being punished in the corresponding

**Table 6 Positive Contribution Being Punished in the Third Treatment**

| | Number of subjects with positive contribution being punished | Number of subjects being punished who are relative free-riders |
|---|---|---|
| R1 | 6 | 0 |
| R2 | 8 | 1 |
| R3 | 0 | 0 |
| R4 | 0 | 0 |
| R5 | 4 | 2 |
| R6 | 3 | 2 |
| R7 | 1 | 1 |
| R8 | 1 | 1 |
| R9 | 2 | 1 |
| R10 | 1 | 1 |
| Total | 26 | 9 (35%) |

R= round.

round. Even though there is an existence of absolute free-riders, only 55% of them are being punished.

Table 6 lists out the number of subjects, who contributed something to the group, being punished and the number of those subjects' contribution which are lower than the acceptable levels. It shows that there are only 35% of the subjects being punished are relative free-riders. However, this raised our concern about why 65% of the subjects, who are non-relative free-riders, are being punished, while 45% of the subject, who are absolute free-riders, are not being punished.

As we had a follow-up question about why subjects punish or not punish other group members, this allows us to figure out why they behave like this. The answer to this question is that the initiative for punishment is originated from the subject's own pre-punishment payoff instead of considering other group members' contribution to the public goods. Because subjects has an acceptable level of pre-punishment payoff, they would not punish other subjects if they already received an amount equal to or exceeding the acceptable level. Therefore, absolute free-riders may not be punished due to the satisfaction of pre-punishment payoff of other group members. This occurred when there is only a few absolute free-riders in the group, and other non-absolute free-riders were contributing more than a half of the endowment.

On the other hand, some non-relative free-riders who are still being punished because their group members' pre-punishment payoff did not reach the acceptable level. Subjects, who punished other non-relative free-riders, explained that because they got an unsatisfactory payoff while other group members has a payoff higher than their acceptable level, they did slightly punish others, who had a lower level of contribution. Despite the fact that any punishment costs their pre-punishment payoff, this kind of punishment often occurred in the case where there is a few subjects who contributed largely to the public goods, but other group members only contributed slightly more than the average acceptable level. This means that the higher contribution subjects were benefiting other lower contribution subjects. In some extreme case, where there is only one subject contributing all endowments to the public goods while other four group members were absolutely free-riding, that full contributing subject did not punish others because he/she got too low pre-punishment payoff, which is far below his/her acceptable level, and would get nearly nothing if there he/she punishes.

This is different from the conventional belief that punishment occurs when there is an unsatisfactory contribution. On the contrary, an unsatisfactory outcome, which evokes an irrational act of a person, is the key to punishment.

RESULT 5: *Our findings are different from the previous research findings.*

Previous research findings showed a convergence of contribution to the game theory prediction of absolute free-riding. Andreoni (1988) also concluded that contributions in the final rounds will converge to the theoretical prediction. However, the average contribution of the first treatment, which is 2.9267, is significantly deviating from the theoretical prediction. In addition, the average contribution among ten round in our first treatment reveals a roughly stationary trend (Figure 1). One possible reason is that there is a major difference between our experiment and Andreoni's experiment. While his public goods game was done in a real laboratory, our game is conducted through emails, lasting for a much longer period of time. This distinction could be the cause of the difference between his and our findings.

Another significant difference happened in the second treatment. Since Ozbay and Ozbay (2013) found that an inclusion of an audience can successfully elicit higher contribution, our second treatment tried to mimic the effect of social image. As shown in Figure 1, this effect of social image dissipated in Facebook and the average contribution among ten rounds converges to the level where there is no audience and no punishment. Additionally, our finding is that the average contribution in the second treatment is not significantly higher than that of the first treatment (Table 3). Therefore, our result in the second treatment deviates greatly from previous findings.

Fehr and Gachter (2000) suggested that the existence of punishment condition would be a force that removes the behavior of free-riding, and would causes subjects to approach full cooperation ($g_{i,n} = 10$). Notwithstanding our argument that their experiment may exhibit experimenter's bias, our results deviates from their results in two ways. Firstly, ours shows a stationary trend of average contribution among ten rounds (Figure 1) while their result shows an increasing trend. Although the average contribution rate of the third treatment (54%) is similar to their findings of 58%, subjects may not increase their contribution simultaneously, because of a lack of experimenter's bias, and find the benefits of a higher degree of cooperation.

Apart from the quantitative difference, there is also a qualitative difference between our result and Fehr and Gachter's result. They belief that under the condition of punishment, subjects are more disciplined, such that they did not free-ride. Nevertheless, there was a persistence, in which absolute free-riding occurred in all ten rounds. As shown in Table 5, the average number of absolute free-rider in the third treatment is 2. This is not consistent with Fehr and Gachter's belief that subjects are disciplined. We argue that more reasonable explanations for punishment to induce higher contribution is that a punishment condition can make a subject belief that other subjects will contribute more to the public goods, or the inequality aversion of subjects may elicit a higher contribution to the group. Therefore, he/she increases his/her contribution accordingly so that every group members can get a higher payoff, revealing conditional reciprocity. But some more selfish subjects may think one more step ahead. Because others have conditional reciprocity or inequality aversion, if the more selfish subjects deviate from cooperation, they will be get much higher pre-punishment payoffs. Consequently, cooperation and absolute free-riding co-exist under the punishment condition.

## 5. Conclusion

This paper provides evidence that more long lasting public goods games with different conditions

have findings different from the previous researches. We conducted three treatments. In the first treatment, there is no audience and punishment condition. In the second treatment, we introduced an audience to elicit the effect of social image. In the third treatment, subjects are free to punish others. Our result shows that only contributions in the second, or audience, treatment declined over time, while the other two treatments exhibit a roughly stationary trend. Average contributions of the second treatment converges to that of the first treatment. We also showed that the punishment condition is a more effective way to induce a higher level of contribution. Acceptability of levels in contribution and payoffs is consistent with the results that we found. More importantly, punishment is initiated by self-pre-punishment payoff instead of others' contribution. An unsatisfactory level of one's outcome is the key to punishment. In addition, our findings are different from previous research findings in sense that the trends and average contribution levels are different. We have a different explanation for the punishment treatment eliciting a higher contribution level as well.

Overall, punishment is more effective in inducing a higher contribution level and public goods games, lasting for a longer period of time, have different results compared with the previous research findings.

## References


Andreoni, James (1988) Why Free Ride? *Journal of Public Economics*. 37(3): 291-304.

Andreoni James, and Petrie, Ragan (2004) Public Goods Experiments Without Confidentiality: A Glimpse into Fund-Raising. *Journal of Public Economics*. 88(7): 1605-1623.

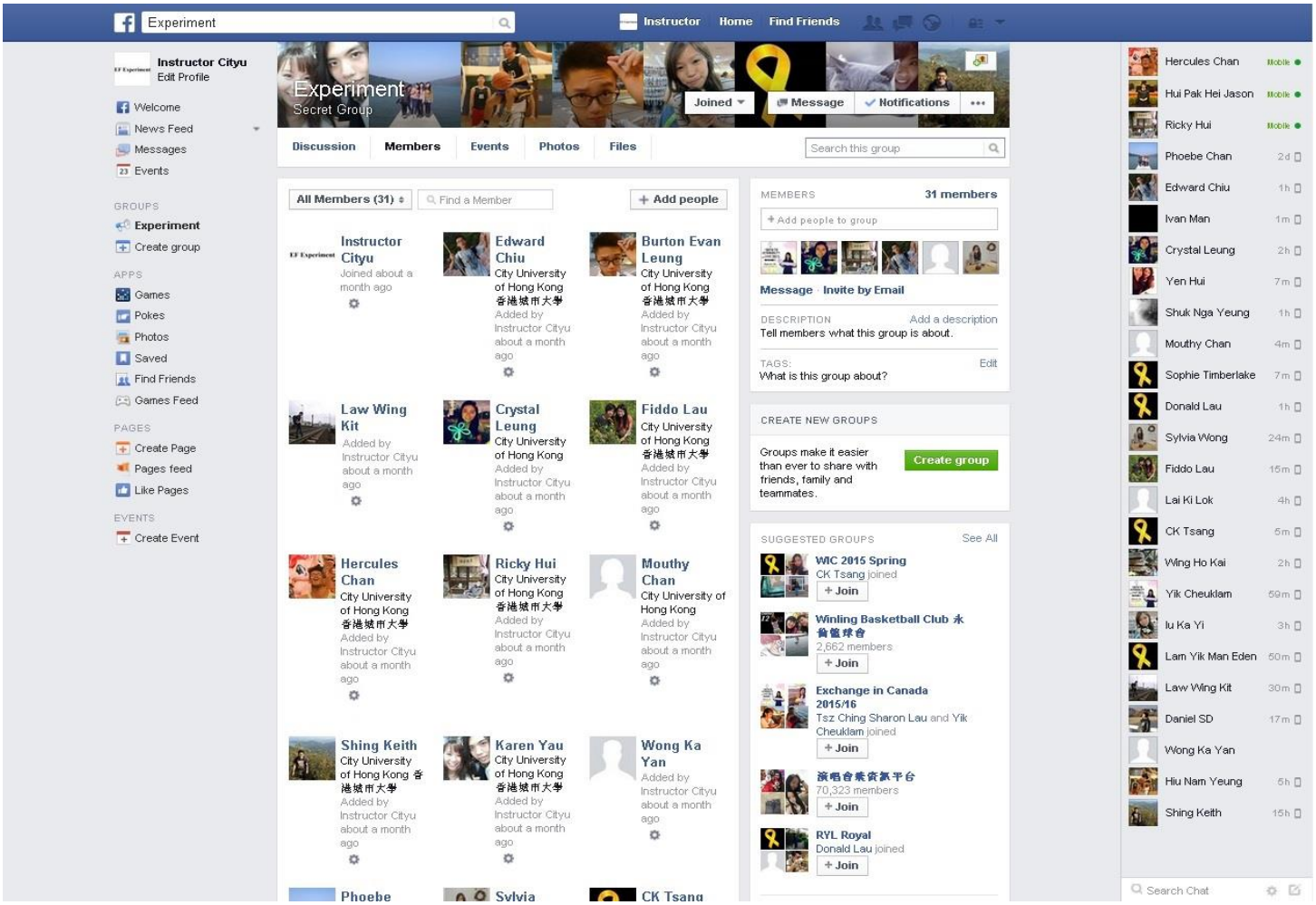
Fehr, Ernst and Schmidt, Klaus M. (2000) Cooperation and Punishment in Public Goods Experiments. *American Economic Review*. 90(4): 980-994

Ledyard, John O. (1995) Public Goods: A Survey of Experimental Research. *Handbook of Experimental Economics*. 111-94

Ozbay, Emel Filiz, and Ozbay, Erkut Y. (2013) Effect of an Audience in Public Goods Provision. *Experimental Economics*. 17(2): 200-214.

# Appendixes

Appendix 1. Facebook Experiment Group of the Second Treatment




This page was captured two weeks after the experiment. Therefore, some subjects' profile pictures have been changed.

Appendix 2. Instructions in the First Treatment

**Instructions**

Welcome to our experimental study on decision-making. You will receive a participation fee of HK$15. In addition, you can gain more money as a result of your decisions in the experiment. You will be paid in private and in cash at the end of the experiment. Our experiment will be conducted through emails, instead of inside the laboratory. Please make sure you can send back your decisions to us on time. We will send a reminder to you if you have not yet submit your decision 2 hours before the pre-determined deadline. **Any late submission will be disqualified**.

In this experiment, you are going to make several decisions about contributing to a project or not. Contribution is an amount that you devoted to the group, where you belong to, in order to facilitate the progress of the project. This experiment will run for 10 consecutive days. Each day represents one round.

In each round, you will be divided into groups randomly. Each group will have 5 people. Everyone will be endowed with HK$10 for each round, which will be reset every round. Your contribution can be any integer between HK$0 and HK$10. For each dollar spent on investing the project, it will be put into a public account of the group. The aggregated amount contributed from all group members will be multiplied by 2.5. The multiplied amount in the account will be divided and shared equally among all of the group members. Please send your decision to us through email **before 22:55 (11:55 p.m.) every day**. An announcement will be made to inform you about the contribution and payoff of each group member in a specific round before the start of another round at 00:00 (12:00 a.m.), but you will not know the identities of other group members.

You will be awarded rewarded by the participation fee plus the average payoff you got from the 10 rounds.

If you have any questions, please feel free to ask through email, we will answer your questions as soon as possible. Please DO NOT communicate with any other participants.

Appendix 3. Instructions in the Second Treatment

**Instructions**

Welcome to our experimental study on decision-making. You will receive a participation fee of HK$15. In addition, you can gain more money as a result of your decisions in the experiment. You will be paid in private and in cash at the end of the experiment. Our experiment will be conducted through emails, instead of inside the laboratory. Please make sure you can send back your decisions to us on time. We will send a reminder to you if you have not yet submit your decision 2 hours before the pre-determined deadline. **Any late submission will be disqualified**.

In this experiment, you are going to make several decisions about contributing to a project or not. Contribution is an amount that you devoted to the group, where you belong to, in order to facilitate the progress of the project. This experiment will run for 10 consecutive days. Each day represents one round. In each round, you will be divided into groups randomly. Each group will have 6 people. One of the 6 will randomly be chosen to be an audience while other 5 are investors.

Moreover, you need to submit your most frequently used Facebook account with your own profile picture. We will add your Facebook as soon as possible. The sole purpose of using Facebook is to allow the audience to observe the contribution of a specific investor and to enable an investor to see his/her group members' contribution to the public good after the announcement of everyone's payoff. Hence, nothing have been posted on Facebook If you reject to provide your Facebook account, we will reallocate you into another experiment.

An audience will not endow with any money. But he/she will have to report the five investors' contribution to the public goods to us in order to earn his/her payoff for that round. An audience's payoff is each correct reporting of one investor's contribution multiplied by HKD$3.50.

Every investor will be endowed with HK$10 for each round, which will be reset every round. Your contribution can be any integer between HK$0 and HK$10. For each dollar spent on investing the project, it will be put into a public account of the group. The aggregated amount contributed from investors will be multiplied by 2.5. The multiplied amount in the account will be divided and shared equally among all investors. **Please send the decision to us and to the audience through email before 18:00 (6:00 p.m.) every day**. Then, the audience has to send the contribution of each investors within the group to us **before 23:55 (11:55 p.m.)**. An announcement will be made to inform you about the identity, contribution and payoff of each group member in a specific round before the start of another round at 00:00 (12:00 a.m.).

You will be awarded rewarded by the participation fee plus the average payoff you got from the 10 rounds.

If you have any questions, please feel free to ask through email, we will answer your questions as soon as possible. Please DO NOT communicate with any other participants.

Appendix 4. Instructions in the Third Treatment

**Instructions**

Welcome to our experimental study on decision-making. You will receive a participation fee of HK$15. In addition, you can gain more money as a result of your decisions in the experiment. You will be paid in private and in cash at the end of the experiment. Our experiment will be conducted through emails, instead of inside the laboratory. Please make sure you can send back your decisions to us on time. We will send a reminder to you if you have not yet submit your decision 2 hours before the pre-determined deadline. **Any late submission will be disqualified**.

In this experiment, you are going to make several decisions about contributing to a project or not, and to punish other group members or not. Contribution is an amount that you devoted to the group, where you belong to, in order to facilitate the progress of the project. This experiment will run for 10 consecutive days. Each day represents one round.

In each round, you will be divided into groups randomly. Each group will have 5 people. Everyone will be endowed with HK$10 for each round, which will be reset every round. Your contribution can be any integer between HK$0 and HK$10. For each dollar spent on investing the project, it will be put into a public account of the group. The aggregated amount contributed from all group members will be multiplied by 2.5. The multiplied amount in the account will be divided and shared equally among all of the group members. Please send your decision to us through email **before 18:00 (6:00 p.m.) every day**. The first announcement will be made to inform you about the contribution and payoff of each group member before 18:15 (6:15 p.m.) of that day, but you will not know the identities of other group members.

**Table 1.**

| **Punishment Point** | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Punishment Cost** | 0 | 0.5 | 1 | 1.5 | 2.5 | 3.5 | 5 | 7 | 9 | 12 | 15 |

After the first announcement, you can base on the results to decide on punishing other group members or not. You can choose punishment points to lower another group member's payoff within your group. However, as shown in Table 1, punishment points are costly. The punishment decisions needed to be sent to us through emails **before 23:55 (11:55 p.m.).** The second announcement will be made to inform you about the contribution and payoff of each group member in a specific round before the start of another round at 00:00 (12:00 a.m.), but you will not know the identities of other group members.

You will be awarded rewarded by the participation fee plus the average after-punishment-payoff you got from the 10 rounds.

If you have any questions, please feel free to ask through email, we will answer your questions as soon as possible. Please DO NOT communicate with any other participants.