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Reciprocity and exclusion in informal financial institutions: an experimental study of rotating savings and credit associations

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Abstract

Rotating savings and credit associations (Roscas) are worldwide informal financial institutions, in which all participants contribute to a fund and one of them receives it in rotation. A crucial problem is that participants have incentives to default on contributing after receiving the fund. We conducted an experiment and found that Roscas were sustained using a rule of excluding defaulters from the group by voting. We observed that group members behave reciprocally and revengefully: a member contributed (or did not contribute) to the fund of other members who had (or had not) contributed to theirs. This voluntary behavior sustained Roscas.

Keywords: Rosca, Exclusion, Reputation, Reciprocity, Punishment

Classification codes: C92, D71, G21

1. Introduction

Rotating savings and credit associations (Roscas) are informal financial institutions that exist all over the world. They are common in developing countries and among migration groups in developed countries (Geertz 1962; Ardener 1964; Light 1972; F. Bouman 1977, 1995; Bonnett 1981; Ardener and Burman 1995; Schreiner 2000; Chamlee-Wright 2002). Some microfinance organizations, such as Grameen Bank, and credit cooperatives have their origins in Roscas (Armendáriz and Morduch 2010). Ardener (1964) simply defined Roscas as "association(s) formed upon a core of participants who agree to make regular contributions to a fund which is given, in whole or in part, to each contributor in rotation." If n participants join a Rosca, the meeting is held n times regularly. At every meeting, each participant contributes a fixed amount of money to a fund, and the fund is given to one of the participants. Therefore, after the end of the n-th meeting, all the participants have contributed n times and received the fund once. The Rosca participants use the fund to buy durable goods (Timothy Besley and Levenson 1996), invest in the business (Light 1972), or make precautionary savings for unplanned expenses (Handa and Kirton, 1999). The merit of joining a Rosca is that except for the last receiver, participants obtain the money earlier than if they had saved the same amount on their own. In general, there are three types of Roscas according to the manner of determining the order of receiving the fund: a random Rosca; a fixed Rosca; and a bidding Rosca. With the random Rosca, the receiver is selected randomly by lottery at every meeting from among the participants who have not hitherto been chosen. On average, participants can receive the fund at the $(n+1)/2$-th meeting. With the fixed Rosca, the order is determined before the first meeting. With the bidding Rosca, the participants bid for the fund at each meeting, and the bidder whose contribution or one-time dividend is the highest receives the fund.

One important characteristic of Roscas is that contributions to the fund are voluntary. If all participants contribute to the fund after they have received the payment, the Rosca is managed successfully. If some participants default on their contribution after receiving the fund, the defaulters save the money that they should have contributed at the meeting. If this occurs, the other participants obtain a lower amount than they should have received. So without any external enforcement, how can Roscas prevent defaulters?

Social connectedness among Rosca participants is key to preventing this default problem (Coleman 1990; Putnam 1993; Besley, Coate, and Loury 1993). Participants can obtain information about defaulters based on their social connections, and potential participants' reputation for honesty and reliability is important in the formation of Rosca groups. Excluding unreliable participants avoids the risk of the default problem, and group members are deterred from defaulting by threat of exclusion. Koike et al. (2010) conducted evolutionary game simulations to investigate the effect of excluding unreliable Rosca members based on their reputation—termed peer selection—on sustaining Roscas. In addition to peer selection, the forfeiture rule is applied: this prevents a member from receiving the fund if that member has not previously made a contribution. The forfeiture rule can be interpreted as a costless punishment in a mutual-aid game (Sugden, 1986). Koike et al. (2010) showed that the combination of peer selection and the forfeiture rule can prevent defaulters and maintain Roscas.

In the present study, we conducted a laboratory experiment to examine whether these two factors prevented subjects from becoming defaulters and sustained Roscas in the case of the fixed Rosca, where the participants are shuffled randomly for each cycle. Our experiment showed that peer selection based on voting increases the contribution rate before and after receiving the fund by excluding low contributors from the groups and allowing medium and high contributors to participate. Accordingly, the mean payoff for subjects who participated in the Rosca with peer selection was significantly higher than that of those who participated in the Rosca without it. However, the difference between our result and that of Koike et al. (2010) is that the forfeiture rule did not increase the contribution rates. That is because almost all subjects retaliated against a defector who had not contributed to their own funds by refusing to contribute to the fund that the defector would have received without the forfeiture rule. Therefore, our results suggest that the exclusion of defaulters based on their reputation can solve the default problem of Roscas even without external enforcement.

This paper proceeds as follows. In the next section, we review the related literature. Section 3 describes the design of our experiment and theoretical prediction based on evolutionary game simulations. Sections 4 and 5 present our results and our conclusions, respectively.

2. Related Literature

Several theoretical studies have investigated the conditions for solving the default problem and sustaining Roscas. Besley et al. (1993) showed in the case of the random Rosca that the Rosca is maintained if the benefit to the first receiver after defaulting is not greater than the default cost. The default cost represents social sanctions: a bad reputation being spread about defaulters, their being excluded from other Roscas in the future, or damage to their personal property. Anderson et al. (2009) investigated random and fixed Roscas, in which the same participants joined the Roscas repeatedly. The authors showed that the first receiver is always inclined to leave and chooses to defect—even if the player is excluded from all future meetings. Their field survey in Kenya reported that Rosca members enforced social punishment, such as confiscating the defaulter’s property. However, the argument of Anderson et al. (2009) depends on the assumption that the same members join the same Rosca repeatedly: they did not investigate whether exclusion can prevent defaulters if there are changes in the Rosca membership.

To the best of our knowledge, no experimental study has been undertaken about Roscas. Using public goods experiments, several studies have found that exclusion based on reputation can promote the contribution level by expelling low contributors from the game (Cinyabuguma, Page, and Putterman 2005; Maier-Rigaud, Martinsson, and Staffiero 2010; Feinberg, Willer, and Schultz 2014). This exclusion can be interpreted as costless punishment. By contrast, a number of experimental studies have investigated costly punishment. Costly punishment to free riders has been found to increase the contribution level in public goods experiments (Yamagishi and Cook 1993; Ostrom, Walker, and Gardner 1992; Fehr and Gächter 2002; Fehr and Gächter 2000; Bochet, Page, and Putterman 2006; Page, Putterman, and Unel 2005; Carpenter 2007). However, Herrmann et al. (2008) suggested that antisocial punishment, which they defined as a free rider punishing contributors with paying a punishment cost, is observed in societies with weak norms of civic cooperation and a weak rule of law. Under some social conditions, costly punishment is ineffective in increasing the contribution level (Nikiforakis 2008; Gächter and Herrmann 2009; Gächter and Herrmann 2011).

We would expect that the exclusion of defaulters from Rosca groups would make Roscas sustainable. There is a critical difference between Roscas and the public goods game: with a Rosca, one player can receive the fund at each meeting, whereas all players receive the same fund in the public goods game. The incentive to default with Roscas depends on the order of receiving the fund; by contrast, all players have the incentive to choose defection in the public goods game. Thus, we conducted a laboratory experiment to examine whether the exclusion of defaulters makes Roscas sustainable.

3. Experiment

3.1 Design

The experiment consisted of four types of sessions: Treatment B; Treatment P; Treatment V; and Treatment VP. Figure 1 is a summary of the experimental procedure for each treatment. The experimental procedure with Treatment B is as follows. With each treatment, each session consisted of 10 rounds, each of which consisted of four periods. At the beginning of a session, each of 20 subjects was assigned to one computer in a laboratory and received instructions (the instruction sheet for Treatment B appears in Appendix A). After the experimenter read the instructions aloud to the subjects, they were randomly divided into five groups, each consisting of four members. At the beginning of each round, the order for receiving the fund was randomly determined; that order for each group appeared on the computer screens, and each member knew the order for all members. The member who received the fund in the *n*-th period was termed the *n*-th receiver.

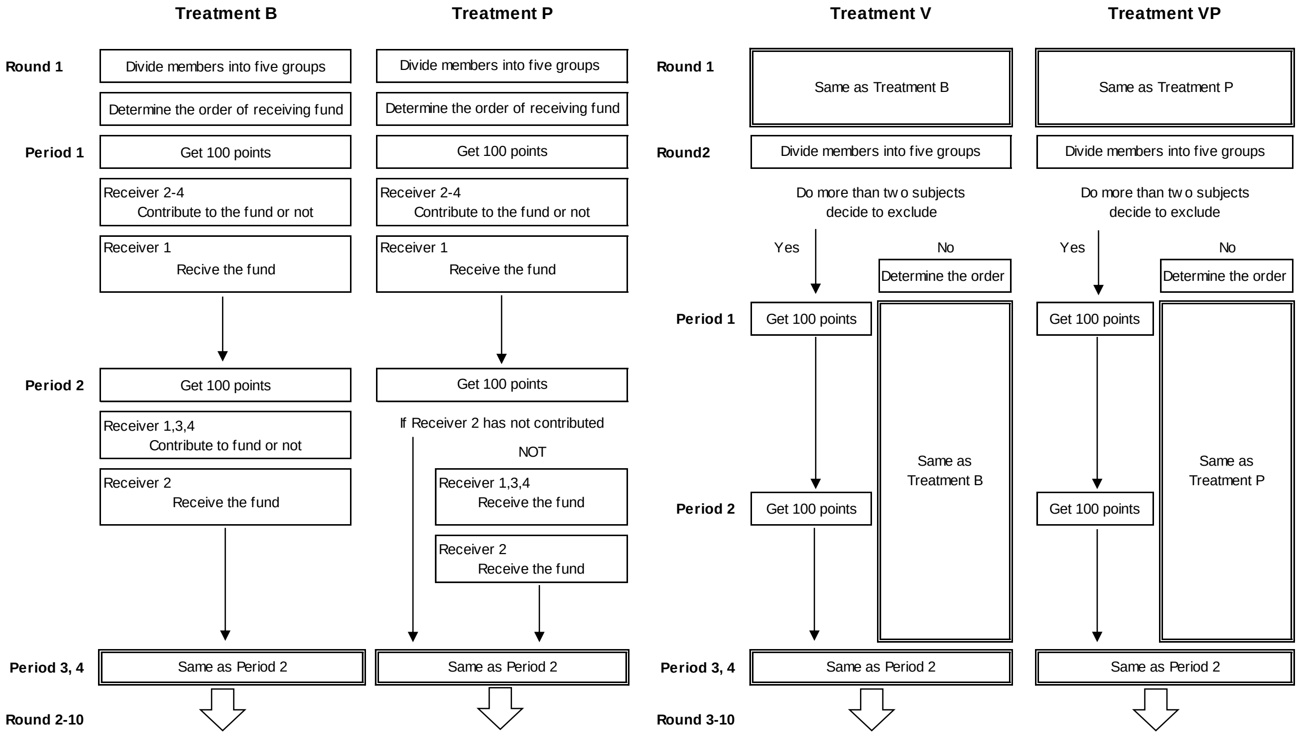

Fig. 1. Experimental procedures with the four treatments

In each period, the experimenter gave 100 points to all the members, and all members except the receiver had to choose whether or not to contribute those 100 points to the fund. If some members decided to contribute to the fund, they lost 100 points; if they decided not to contribute to the fund, they saved 100 points. We assumed that members who received the fund earlier would profit more than those who received the fund later. This was because the earlier a member received the fund, the earlier they could purchase durable goods and invest in their business and then make a profit. If m_C is the number of contributing members and n is the number of periods, the payoff of receiving the fund is

$$\pi_{m_{C},\, n} = 100\left(\frac{m_C}{(1+\delta)^{n-4}} + 1\right),$$

where δ is the discount factor.

We used δ = 0.3, and the payoffs for receiving the fund in each period are presented in Table 1. After receiving the fund, all members were informed which members had contributed to the fund as well as the payoffs to all members in that period (Fig. 2). After the fourth period, the total payoffs to all members in that round were shown to all members. At the beginning of the next round, new groups were randomly formed. If some members belonged to the same group as in previous rounds, they were unaware of that fact. After the end of the 10th round, the subjects answered a questionnaire and were paid a reward in proportion to their total payoff in that session.

Table 1.

Payoffs for receiving the fund in each period in $\delta = 0.3$

Period	**Number of members who contribute to the fund**			
	0	1	2	3
First	100	320	539	759
Second	100	269	438	607
Third	100	230	360	490
Fourth	100	200	300	400

With Treatment P, we introduced a forfeiture rule: no member who had not contributed in the preceding periods could receive the fund. For example, if the third receiver did not contribute in the first or second period, they could not receive the fund in the third period but saved 100 points. The other members also saved 100 points because they did not need to contribute 100 points. Following Sugden (1986), we term the forfeiture rule the punishment rule in this experiment.

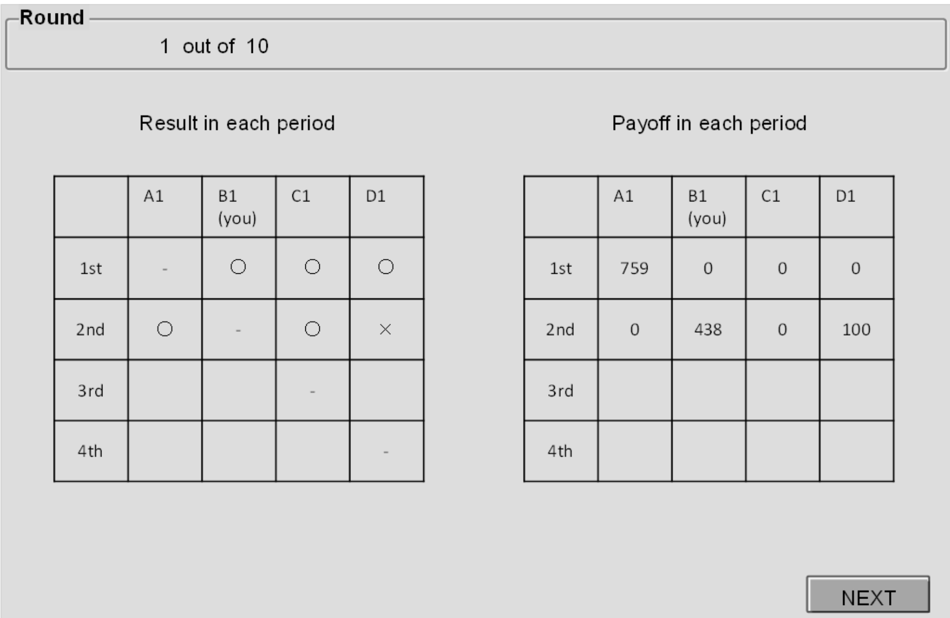

Fig. 2. Example of a confirmation screen

With Treatment V, we introduced a voting system. In this system, 20 subjects were randomly divided into five groups at the beginning of each round. All members in each group were aware of how many times each member had actually contributed in the previous rounds and how many times each member could decide to contribute in the previous rounds. Based on this information, each member decided who should be excluded from the group. This voting system was not applied in the first round. If more than two members chose to exclude a particular member, that member was expelled from the group. The excluded members could not participate in that round and received 400 points. At the end of each round, the 20 subjects were randomly divided into five groups for the next round. Therefore, subjects excluded from the group in a previous round had the chance to join the group in the next round. Treatment VP was the same as Treatment P with the addition of the voting system (Fig. 1).

We conducted two sessions for each treatment at Tokyo Institute of Technology from December 2011 to June 2013 using the program z-Tree (Fischbacher 2007). We recruited 160 (20 × 4 × 2) subjects from a Tokyo Institute of Technology subject pool. They consisted mainly of undergraduate students who had never participated in similar experiments. The average payment made to the subjects was 3,506 yen (approximately 35.06 US dollars at a rate of 1 US dollar = 100 yen).

3.2 Theoretical Predictions

We analyzed the game with Treatment B, in which four players played four periods and obtained the subgame-perfect equilibrium, whereby every player paid no contribution at each period (the proof appears in Appendix B). We were unable to evaluate games corresponding to Treatments V, P, and VP within the framework of game theory. Koike et al. (2010) studied random Roscas by means of an evolutionary game simulation: they investigated the sustainability of Roscas through the effect of peer selection based on reputation and the forfeiture rule. The authors showed that the combination of the forfeiture rule and peer selection resulted in the greatest contribution rate before receiving the fund; the forfeiture rule produced the second-highest rate; peer selection the third-highest rate; and the baseline model lacking both the forfeiture rule and peer selection resulted in the worst rate. Therefore, we predicted that the order of the contribution rate before receiving the fund in our experiment would be VP = P > V > B. Accordingly, the order of the contribution rate after receiving the fund in our experiment was predicted as VP > P = V > B.

In the following sections, we will compare the theoretical prediction by Koike et al. (2010) with the results of our experiment.

4. Results

4.1 Average contribution rates and total profit

We consider first the contribution rate in each treatment. We categorized the contribution rates into two types: the contribution rate before receiving the fund (β_0) and the contribution rate after receiving the fund (α_0). Figure 3a shows the average value of β_0 in each round. In Treatments B and P, the average values of β_0 in the first round were 0.42 and 0.59, respectively; however, the rate was not always higher in Treatment P (thin line) than in Treatment B (thick line). The average value of β_0 in Treatment V (dot-dashed line) was the highest among the four treatments except in the 10th round. In the first half of the rounds, the average value of β_0 in Treatment VP (dashed line) was between that of Treatments V and B, but it showed a declining trend in the second half of the rounds. In the final round, the end-game effect caused the average values of β_0 in Treatments VP and V to decrease. This tendency is the same as in results observed in public goods experiments (Cinyabuguma, Page, and Putterman 2005; Maier-Rigaud, Martinsson, and Staffiero 2010)

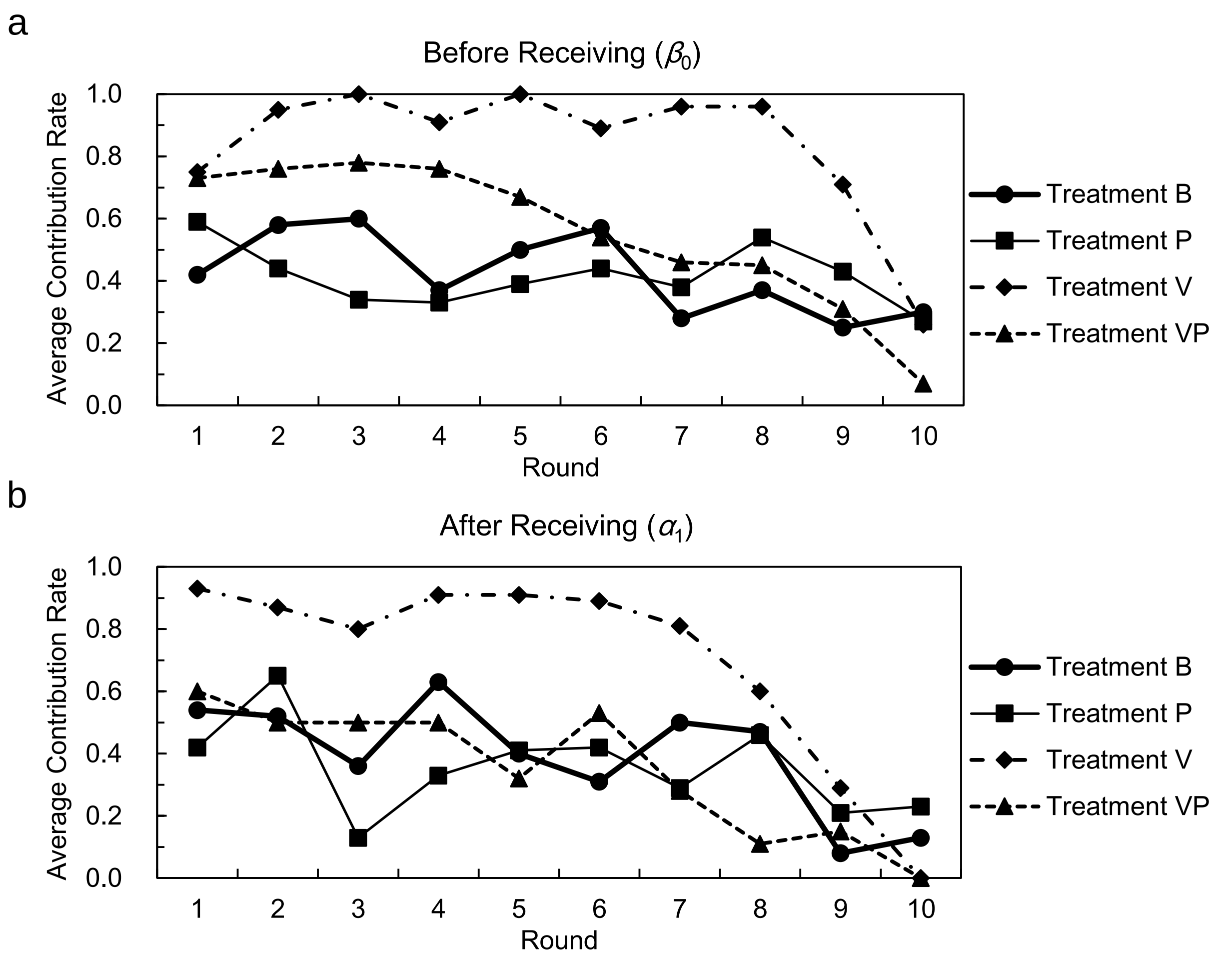

Fig. 3. Average contribution rates in each round

Table 2 presents the average contribution rates over 10 rounds. To compare the average values of β_0 in the four treatments, we conducted Pearson's chi-squared test. The average values of β_0 in Treatments B and P were both 0.42 and were not significantly different ($p = 0.93$). With the voting system in Treatment V, the average value of β_0 was 0.82, which was significantly higher than that in Treatment B ($p < 0.001$). However, in Treatment VP, which had the punishment rule and voting system, the average value of β_0 was 0.56; that was significantly smaller than in Treatment V but higher than in Treatments B and P ($p < 0.001$).

We categorized the contribution rate after receiving the fund (α_0) into three types: the contribution rate that a focal player contributed to the receiver who has contributed to both the focal player and other members (α_1); the contribution rate that a focal player contributed to the receiver who has contributed to the focal player but not contributed to other members (α_2); and the contribution rate that a focal player contributed to the receiver who has not contributed to the focal player (α_3). The punishment rule prohibited subjects from contributing to the receiver who had not previously contributed, and so α_0 in Treatments P and VP was represented by α_1. α_0 in Treatments B and V was represented by the contribution rate that a focal player contributed to the receiver regardless of the receiver's past behavior. Hereafter, we do use not α_0 but α_1 in comparing the contribution rate after receiving the fund in the four treatments under the same criteria.

Figure 3b shows the average value of α_1 in each round. In Treatment V, the average value of α_1 was the highest among the four treatments except for the 10th round; however, no marked differences were observed in the average values of α_1 among Treatments B, P, and VP. The average values of α_1 over the 10 rounds in Treatments B, P, and VP were 0.40, 0.38, and 0.42, respectively; they were not significantly different ($p > 0.10$) (Table 2). In Treatment V, the average value of α_1 over the 10 rounds was 0.76, which was significantly higher than in Treatments B, P, and VP ($p < 0.001$) (Table 2).

Table 2.

Average contribution rates in the four treatments over 10 rounds

Treatment	Before receiving	After receiving			
	β_0	α_0	α_1	α_2	α_3
Treatment B	0.42	0.18	0.40	0.31	0.04
Treatment P	0.42	0.38	0.38	-	-
Treatment V	0.82	0.64	0.76	0.60	0.15
Treatment VP	0.56	0.42	0.42	-	-
Pearson's chi-squared test					
***p* < 0.01**	1–3, 1–4, 2–3, 2–4, 3–4	-	1–3, 2–3, 3–4	1–3	1–3
Not significant	1–2	-	1–2, 1–4, 2–4		

Observation 1

a) The contribution rates before and after receiving the fund in Treatment V were significantly higher than those in Treatments B, P, and VP.

b) The contribution rates before and after receiving the fund in Treatments B and P were not significantly different.

We now consider the distribution of the total payoff at the end of the treatments (Fig. 4). Figure 4b shows that the payoffs for all subjects in Treatment V were greater than 4,000 points, which was the same as the amount that all subjects received during one treatment (100 points × 4 times × 10 rounds). The payoffs for seven, eight, and five subjects were lower than 4,000 points in Treatments B, P, and VP, respectively. The mean payoff in Treatment V was 4,980 points, and it was significantly higher than the mean payoffs in Treatment B, P, and VP, which were 4,681, 4,566, and 4,494, respectively ($p < 0.05$ in Student's t test). They were not significantly different ($p > 0.10$).

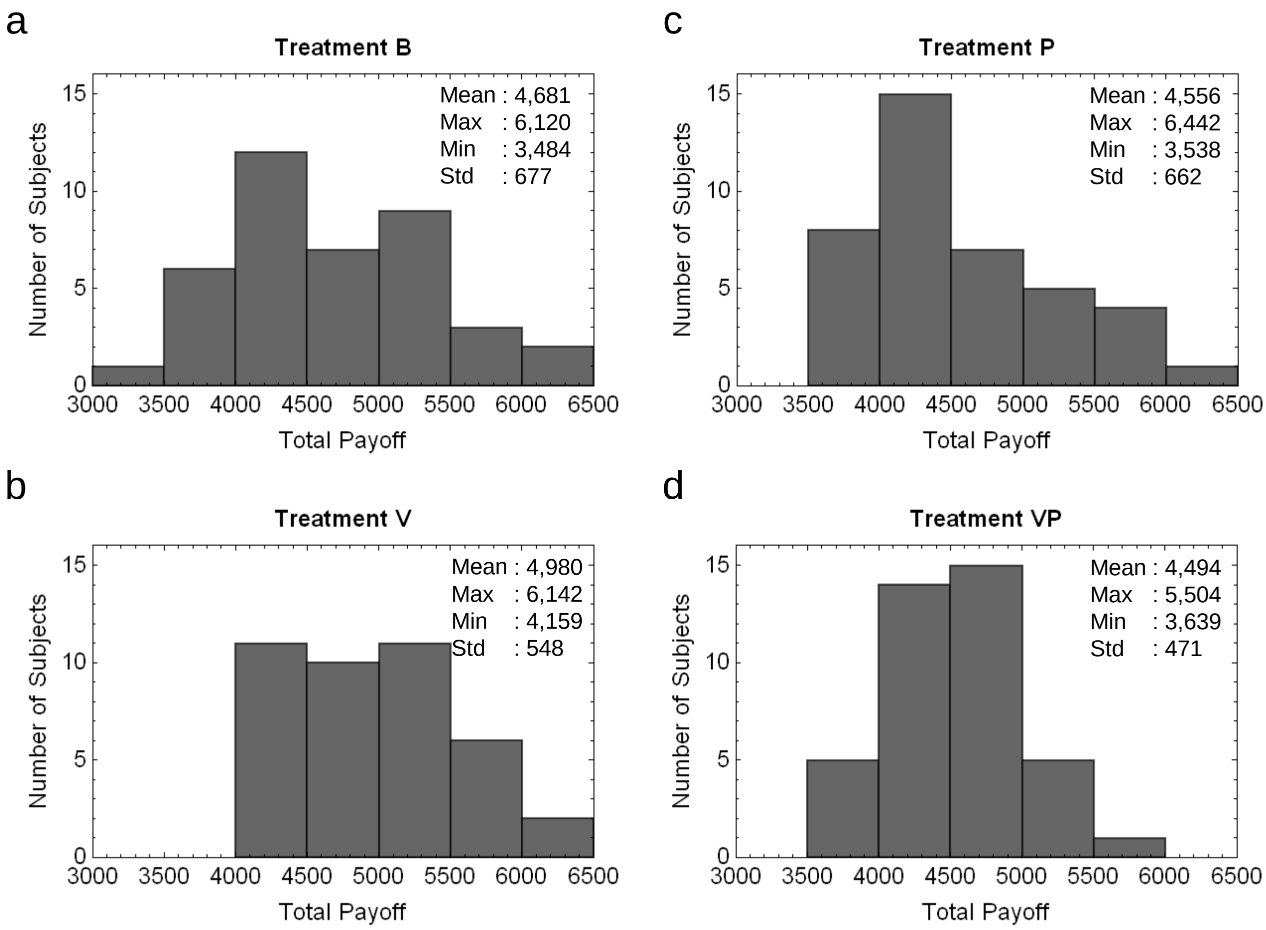

Fig. 4. Total profits after the treatments

Observation 2

a) The mean payoff in Treatment V was significantly higher than that in Treatments B, P, and VP.
b) The mean payoffs in Treatments B, P, and VP were not significantly different.

4.2 Why did the punishment rule not work well?

To determine why the contribution rates in Treatments B and P were not significantly different, we focus on the differences among the average values of α_1, α_2, and α_3. Table 2 shows that the average values of α_1, α_2, and α_3 in Treatment B were 0.40, 0.31, and 0.04, respectively. The average values of α_1 and α_2 were not significantly different (p = 0.21 by Pearson's chi-squared test), and the average value of α_3 was significantly smaller than the others (p < 0.001). This suggests that the subjects in Treatment B discriminated between receivers who had and had not contributed to them and also that they rejected non-contributors. This behavior can be interpreted as a kind of costless punishment to non-contributors. Hence, the subjects had a tendency to punish receivers who had not contributed to them in Treatment B. As a result, even though Treatment P is the combination of Treatment B and the punishment rule that prohibited subjects from contributing to the receiver who had not previously contributed, the contribution rates in Treatments B and P did not differ significantly.

Similarly, in Treatment V, the average values of α_1, α_2, and α_3 were 0.76, 0.60, and 0.15, respectively (Table 2). The average value of α_3 was significantly smaller than the others ($p < 0.001$). This suggests that the subjects in Treatment V also retaliated against their non-contributors.

4.3 Why did the voting system work well?

To show why the voting system itself promoted the contribution rates, we investigated the number of participants in each group and the number of subjects excluded from each group. In Fig. 5, the subjects are categorized into three types based on the cumulative contribution rate: low contributors, whose cumulative contribution rate was less than 0.40; medium contributors, whose cumulative contribution rate was 0.40–0.80; and high contributors, whose cumulative contribution rate was equal to or greater than 0.80. The upper section in each part of Fig. 5 shows the number of participants who were never excluded from the groups (non-excluded participants; white bars) and the number of participants who were excluded in previous rounds (excluded participants; gray bars). The lower section in each part of Fig. 5 indicates the number of subjects who were excluded from the groups (excluded subjects; black bars). The horizontal axis represents the number of rounds; the upper and lower vertical axes represent the number of participants and number of subjects, respectively. In Treatment V, low contributors were frequently excluded from the groups (Fig. 5a); medium and high contributors were not excluded from the groups so often (Fig. 5b, c). Over the 10 rounds in Treatment V, the voting system excluded 72% of low contributors and 6% of medium and high contributors. The difference was significant ($p < 0.001$). Therefore, because low contributors were excluded from the groups and the voting system made medium and high contributors participate in the groups, the contribution rates in Treatment V were higher than those in Treatments B and P, which lacked the voting system.

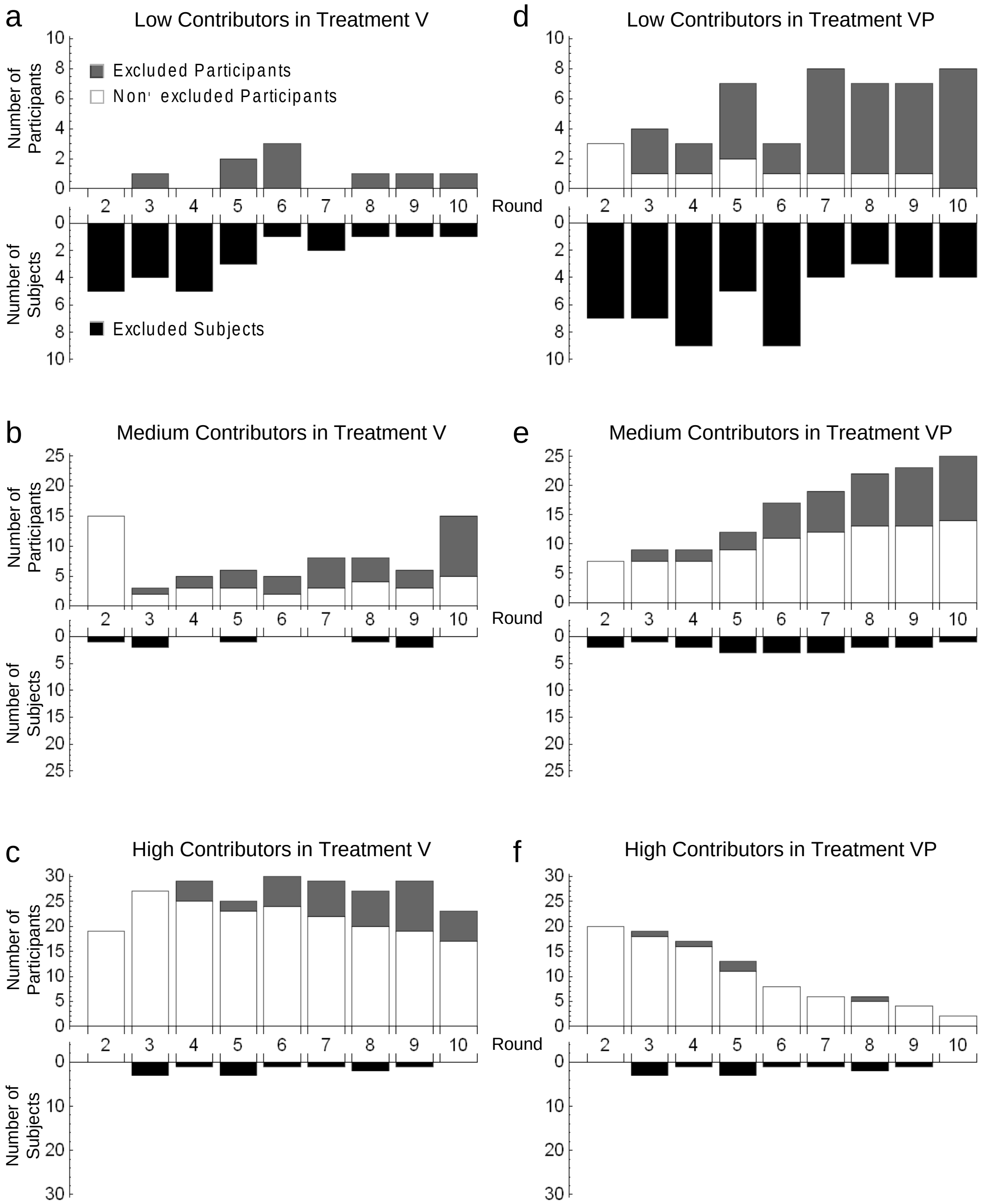

Fig. 5. Total number of participants and excluded subjects in each round over two sessions

Although low contributors were excluded from the groups, the average number of participants in each round in Treatment V was at least three out of four subjects (Fig. 6). The reason is as follows: in the upper part of Fig. 5a, all the low contributors who were allowed to participate in the groups were excluded participants. This suggests that the voting system gave the excluded low contributors a chance of participating in a group again, and as a result the number of group members was around three to four.

In Treatment VP, the number of excluded subjects was not always higher than that of participants among low contributors (Fig. 5d); however, among medium and high contributors, the number of excluded subjects was lower than that of participants in each round (Fig. 5e, f). Because the average contribution rates (β_0, α_1) continued declining in the second half of rounds (Fig. 3), the number of high contributors also decreased and that of medium contributors increased. Over the 10 rounds in Treatment VP, the voting system excluded 51% of low contributors and only 8% of both medium and high contributors from the groups, respectively. These exclusion rates were significantly different ($p < 0.001$).

In a comparison of Treatments V and VP, the exclusion rates of high contributors were 6% and 8%, respectively; they were not significantly different ($p = 0.34$). The average exclusion rate of low contributors in Treatment V (72%) was significantly higher than that in Treatment VP (51%, $p < 0.038$). This is why the contribution rates in Treatment V were higher than those in Treatment VP.

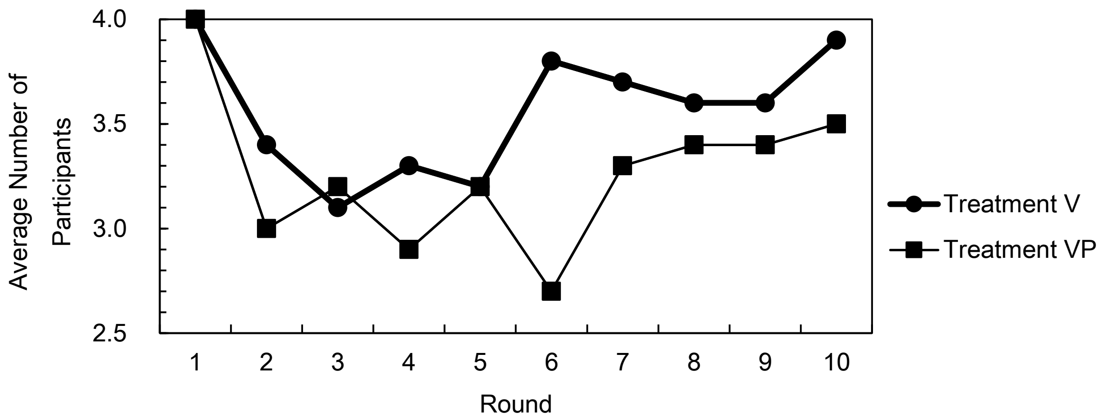

Fig. 6. Average number of participants in each round

Observation 3

a) The voting system excluded low contributors from the groups and let medium and high contributors participate in the groups.
b) The average exclusion rate of low contributors in Treatment V was significantly higher than that in Treatment VP.

4.4 Order effect of receiving the fund

In our experiment, each subject was informed of the order in which they received the fund in each round. Here, we examine how the order influenced the contribution rates.

In Table 3, the average value of β_0 of the second receivers was significantly higher than that of the third receivers in all the treatments. The average value of β_0 of the third receivers was significantly higher than that of the fourth receivers for all the treatments. Focusing on the discount factor (δ = 0.3), we explain this as follows: if the second receiver contributed to the fund for the first receiver, the first receiver may have been willing to contribute to the fund for the second receiver—at least if direct reciprocity worked and the first receiver was willing to contribute for the second receiver who had contributed for that first receiver. The fund of the second receiver is the total contribution multiplied by $(1+\delta)^2$. If direct reciprocity worked, the fourth receiver would contribute to the fund for the first, second, and third receivers, who would contribute to the fund for the fourth receiver. The fund of the fourth receiver is the total contribution multiplied by $(1+\delta)^0$. As a result, the second and the third receivers contributed more before receiving the fund than the fourth receivers.

The average values of α_1 among the first, second, and third receivers were not significantly different in all four treatments (Table 3). We expected that the average value of α_1 of the earlier receivers would be lower than that of the later receivers in Treatments B and P because the earlier receivers would not contribute to the fund after they had received it. However, because the subjects had the tendency to behave reciprocally, the order of receiving the fund did not change the average values of α_1 among the first, second, and third receivers.

Observation 4

a) The contribution rates before receiving the fund gradually decreased in the order of the second, third, and fourth receivers in all four treatments.

b) The contribution rates after receiving the fund among the first, second, and third receivers did not differ significantly in all four treatments.

Table 3.

Order effect of contribution rates

Order of receiving fund	**Treatment B**	**Treatment P**	**Treatment V**	**Treatment VP**
Contribution rate before receiving (β_0)				
First receiver	-	-	-	-
Second receiver	0.77	0.69	0.95	0.78
Third receiver	0.52	0.43	0.85	0.59
Fourth receiver	0.25	0.28	0.73	0.35
Pearson's chi-squared test				
$p < 0.01$	2–3, 3–4, 2–4	2–3, 3–4, 2–4	3–4, 2–4	2–3, 3–4, 2–4
$p < 0.05$			2–3	
Contribution rate after receiving (α_1)				
First receiver	0.39	0.34	0.77	0.42
Second receiver	0.42	0.42	0.76	0.43
Third receiver	0.38	0.45	0.74	0.36
Fourth receiver	-	-	-	-
Pearson's chi-squared test				
Not significant	1–2, 2–3, 3–4	1–2, 2–3, 3–4	1–2, 2–3, 3–4	1–2, 2–3, 3–4

5. Concluding Remarks

We conducted a laboratory experiment to show a mechanism for solving the default problem in the fixed Rosca whose participants are shuffled randomly for each Rosca cycle. We observed that the exclusion of defaulters based on voting increased the contribution rates before and after receiving the fund. We also found that the punishment rule, corresponding to the punishment rule of Sugden (1986) and the forfeiture rule of Koike et al. (2010), did not improve the contribution to the fund. In consequence, contrary to our theoretical prediction, the contribution rates and mean payoff of the subjects in Treatment V were significantly higher than those in the other treatments. These results support those of field studies of Roscas, in which social sanctions through exclusion suppressed the default problem even without external enforcement (Ardener 1964; Handa and Kirton 1999).

Previous studies using the public goods game have shown that exclusion promoted the contribution rate (Cinyabuguma et al. 2005; Maier-Rigaud et al. 2010; Feinberg et al. 2014). The present investigation also supported those results even though our game structure was different from the public goods game. However, an interesting finding in our Rosca game was the observed voluntary direct reciprocity and voluntary retaliation (Treatment B and V). These two phenomena are not observed in the public goods game, where all the players contribute to the fund, which is distributed equally to all players. Another interesting finding with the present study was that even though we introduced an explicit costless punishment rule (the forfeiture rule), it did not improve the contribution rate (Treatments P and VP). In our experiment, we were unable to determine how voluntary direct reciprocity and voluntary retaliation influenced explicit punishment and vice versa.

Voluntary direct reciprocity and voluntary retaliation are reminiscent of the repeated game between two players, in which a player can behave reciprocally and revengefully toward their opponent. However, the Rosca game is not the same as the repeated game: the order of receiving the fund influences reciprocity and retaliation in the Rosca game. Further investigation of the Rosca game should give us new viewpoints on this game.

Hechter (1988) examined Roscas and argued that members can suppress non-contribution before receiving the fund without difficulty. This is because if a member fails to contribute to the fund before receiving, the other members can prevent that member from obtaining the fund. However, in our treatments, the subjects often failed to make a contribution before receiving the fund despite the forfeiture rule prohibiting such non-contributors from receiving the fund. This result reinforces the importance of exclusion based on reputation.

Exclusion based on majority voting has two characteristics: (1) low contributors are mainly excluded from groups; and (2) low contributors who have been excluded sometimes have a chance to participate in a group again. Item (1) is in accordance with the results of public good experiments (Cinyabuguma, Page, and Putterman 2005; Maier-Rigaud, Martinsson, and Staffiero 2010), but no experimental studies about exclusion have examined item (2). Sugden (1986) proposed a mutual-aid game based on informal health insurance in England: insurance members pay a subscription and one member chosen randomly from the group members receives the insurance money each period; because the choice is random, that member may receive the fund again even after having previously received it. The mutual-aid game differs from Roscas in that every member has an equal chance of receiving the fund in each period. Sugden's theoretical analysis showed that a kind of tit-for-tat strategy, which has the three features of "brave reciprocity," "punishment," and "reparation," is a stable equilibrium. Our results correspond to Sugden's tit-for-tat strategy: in our experiment, the subjects behaved reciprocally and punished defectors by excluding them from the group. Thus, we consider that allowing excluded members to join a group again gives those members a chance to make reparation for their past defaults.

In this study, we investigated how social exclusion based on peer selection can prevent the default problem in the fixed Rosca; however, future research is needed to examine the effectiveness of such social exclusion in the random and bidding Roscas so as to verify the robustness of our results. In the random Rosca, the subjects cannot use a retaliation strategy because the receiver is chosen randomly after they have decided to contribute. Therefore the forfeiture rule, which did not work in the fixed Rosca in our experiment, may be needed to sustain the Rosca. Because our study did not assume costly punishment, it would be interesting to investigate how such costly punishment as confiscating the defaulter's property influences the sustainability of Roscas—even in the laboratory situation.

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Appendix A: Instruction Sheet for Treatment B

Instructions

Overview of the Experiment

The experiment consists of 10 rounds, each of which consists of four periods. Each group has four subjects. In the experiment, 100 tokens are given to you in each period. This does not mean that real token are given to you, but please imagine that you have 100 tokens. Then please decide whether “to give" 100 tokens to the fund of your group or “not to give”. One of the members receives the fund, and the fund grows as periods advance. The earlier you receive the fund or the more members give tokens to the fund, the more payoff you can obtain.

Your earnings are determined according to your payoff in the experiment. As your payoff become higher, you receive higher earnings. Your payoff depends on both your choice and the other members’.

Experiment Procedure

Step 1.

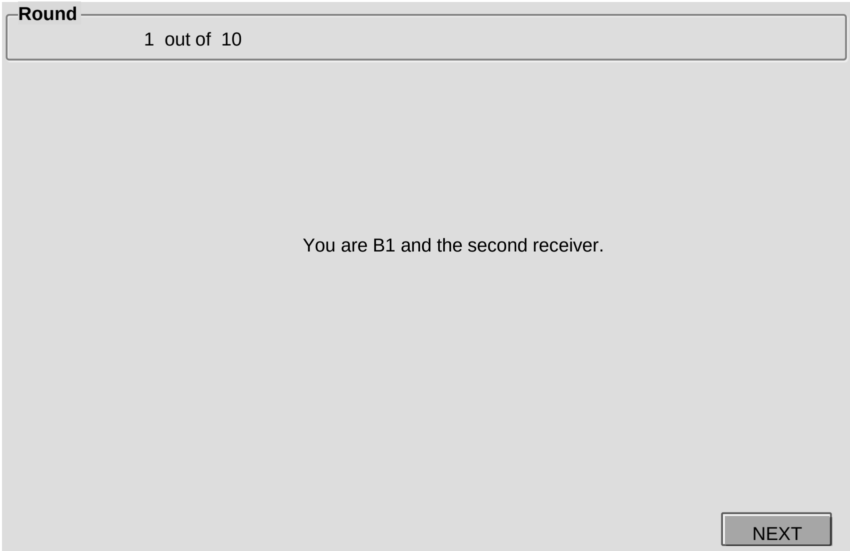
20 subjects are randomly made into five groups, each consisting of four subjects. You belong to one of the groups. You cannot identify who are in your group. Similarly, none of your group members knows whether you are in the group.

Step 2.

The computer determines “the order of receiving the fund" randomly. The order will be shown on your computer screen. Please check your order.

Example 1:

If you are the second receiver, the following information is shown on your computer screen:



Step 3.

Each round consists of four periods. Each period proceeds as follows.

First, you get 100 tokens at the beginning of each period. Your receiving order determines what to do in each of the four periods.

(a) In the period when you do not receive the fund:

You can choose either **"to give"** 100 tokens to the fund or **"not to give"**.

If you choose "GIVE", then all 100 tokens will be added to the fund, and you will lose 100 tokens. You cannot save anything and your payoff is 0 in this period.

If you choose "NOT GIVE", then you can save 100 tokens and your payoff in this period is 100.

(b) In the period when you receive the fund:

You can receive the fund given by your group members. You do not need to choose "GIVE" or "NOT GIVE". The amount of the fund depends on the number of other members who give 100 tokens in this period.

Your payoff in one round consisting of four periods is determined by both “the order of receiving the fund" and “the number of the other members who give 100 tokens to the fund" as follows:

		The number of members choosing "GIVE"			
		0	1	2	3
The order of receiving the fund	first period	100	320	539	759
	second period	100	269	438	607
	third period	100	230	360	490
	fourth period	100	200	300	400

More specifically, your payoff in one round is calculated as follows:

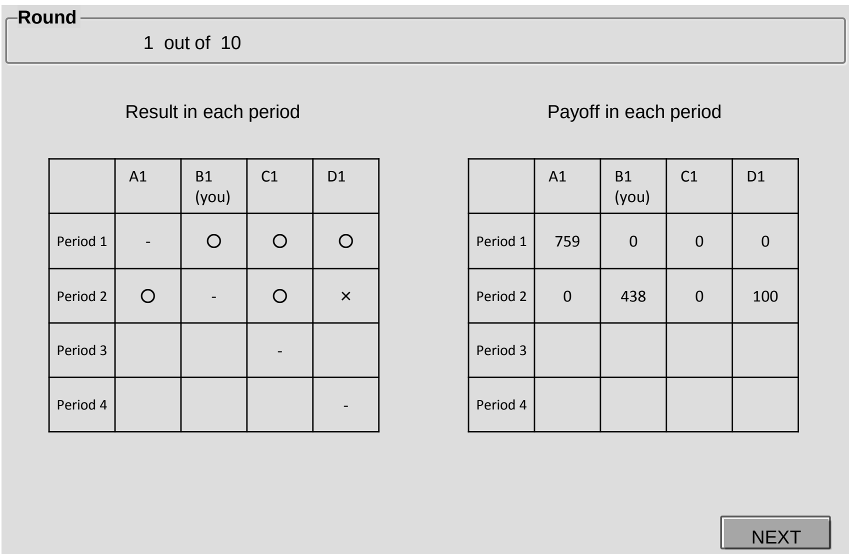
Your payoff =

(the number of members who have invested to the fund) * 100 * 1.3$^{(4\text{ - your receiving order})}$ +100

This means that the fund is multiplied by 1.3 in each period after you receive the fund. Therefore, the earlier you receive the fund or the more members give 100 tokens to your fund, the more payoff you can obtain. Meanwhile, "+ 100" in the second term of the right hand side means that you can automatically save 100 tokens which are given to you at the beginning of the period in which you receive the fund.

After all members finish making decisions in each period, two tables are displayed on your screen.

Example: Result and Payoff Tables after the second period.



The table on the left indicates **who gave 100 tokens and who did not**. The mark “○” means choosing "GIVE", the mark “x” means choosing " NOT GIVE", and "-" means you did not make any decision because you were the receiver in that period. The table on the right indicates **the payoffs of all members in each period**.

This process is repeated four times until every member has a chance to receive the fund. Then, one round is over.

Example:

Taking a specific example, we will show you how the experiment proceeds. Suppose that the order of receiving the fund is

A1 → B1 (you) → C1 → D1.

The first period:

You have 100 tokens.

Player A1 receives the fund in this period.

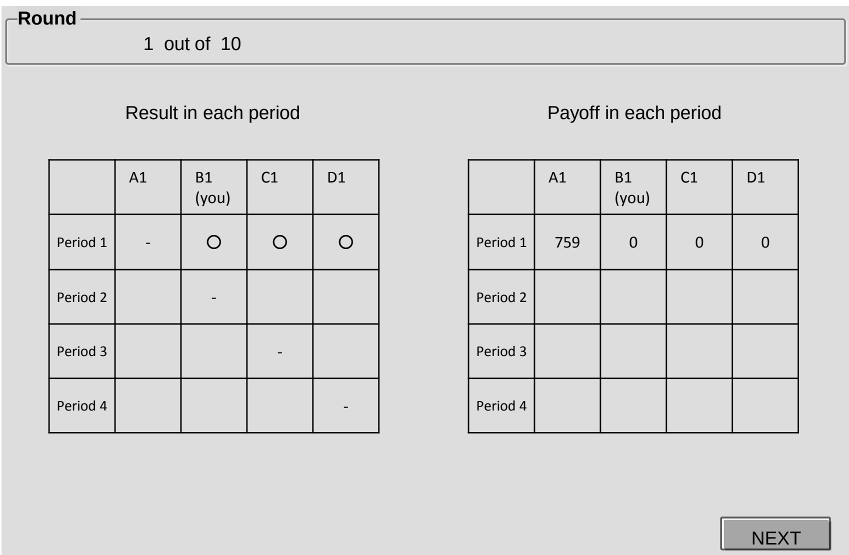
You can choose either "GIVE" or "NOT GIVE".

Suppose that you choose "GIVE".

Your payoff in this period is **<u>0</u>**.

Also, suppose that C1 and D1 choose "GIVE".

Then the choice and payoff of each member will be displayed on your screen as follows:



Round

1 out of 10

Result in each period

	A1	B1 (you)	C1	D1
Period 1	-	○	○	○
Period 2		-		
Period 3			-	
Period 4				-

Payoff in each period

	A1	B1 (you)	C1	D1
Period 1	759	0	0	0
Period 2				
Period 3				
Period 4				

NEXT

A1 receives 300 tokens and A1's payoff will be **<u>759</u> at the end of** the fourth period:

$$300 * 1.3^{(4-1)} + 100 \fallingdotseq 759.$$

The second period:

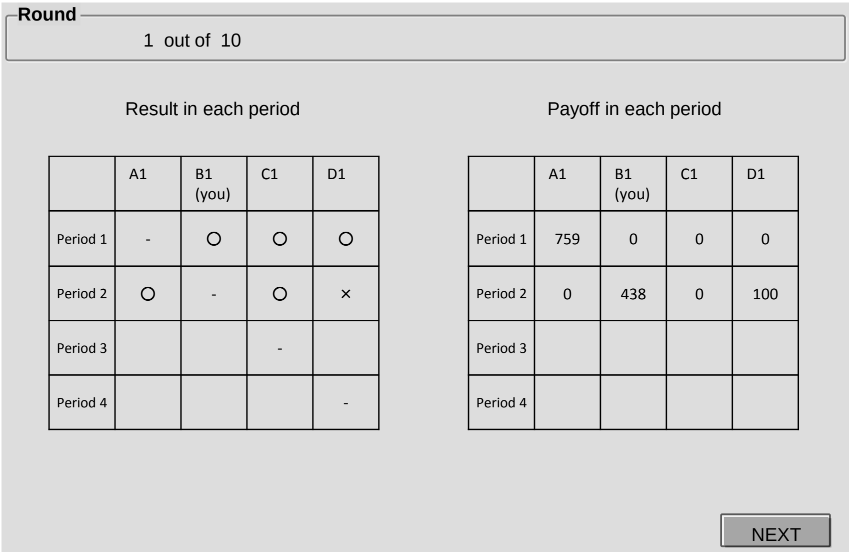
You have 100 tokens again.

In this period, you can receive the fund and you do not need to choose anything.

The payoff is determined by the choices of the other members.

Suppose that A1 and C1 choose "Give", and D1 chooses "Not Give".

Then the current and past choices and payoffs of each member will be displayed on your screen as follows:


Round

1 out of 10

Result in each period

	A1	B1 (you)	C1	D1
Period 1	-	○	○	○
Period 2	○	-	○	×
Period 3			-	
Period 4				-

Payoff in each period

	A1	B1 (you)	C1	D1
Period 1	759	0	0	0
Period 2	0	438	0	100
Period 3				
Period 4				

NEXT

You receive 200 tokens and your payoff will be **<u>438</u> at the end of** the fourth period:

$$200 * 1.3^{(4-2)} + 100 = 438.$$

The third period:

You have 100 tokens again.

C1 receives the fund. You can choose either "GIVE" or "NOT GIVE".

Suppose that you choose "NOT GIVE".

Your payoff in this period is **100**.

Suppose that A1 and D1 choose "NOT GIVE".

The current and past choices and payoffs of each member will be displayed on your screen as follows:

Round

1 out of 10

Result in each period

	A1	B1 (you)	C1	D1
Period 1	-	○	○	○
Period 2	○	-	○	×
Period 3	×	×	-	×
Period 4				-

Payoff in each period

	A1	B1 (you)	C1	D1
Period 1	759	0	0	0
Period 2	0	438	0	100
Period 3	100	100	100	100
Period 4				

NEXT

C1 receives 0 token and his payoff will be **100 at the end of** the fourth period:

$$0 * 1.3^{(4-3)} + 100 = 100.$$

The fourth period:

You have 100 tokens again.

D1 receives the fund. You can choose either "GIVE" or "NOT GIVE".

Suppose that you choose "GIVE".

Your payoff in this period is **<u>0</u>**.

Suppose that A1 and C1 decide to choose "GIVE".

The current and past choices and payoffs of each member will be displayed on your screen as follows:

Round

1 out of 10

Result in each period

	A1	B1 (you)	C1	D1
Period 1	-	○	○	○
Period 2	○	-	○	×
Period 3	×	×	-	×
Period 4	○	○	○	-

Payoff in each period

	A1	B1 (you)	C1	D1
Period 1	759	0	0	0
Period 2	0	438	0	100
Period 3	100	100	100	100
Period 4	0	0	0	400

Your payoff 538

NEXT

D1 receives 300 units and his payoff is **<u>400</u> at the end of** the fourth period:

$$300 * 1.3^{(4-4)} + 100 = 400.$$

This is the end of one round. The payoff of each participant in this round is the sum of his/her payoffs over four periods as the following table illustrates:

	A1	B1(You)	C1	D1
Period 1	759	0	0	0
Period 2	0	438	0	100
Period 3	100	100	100	100
Period 4	0	0	0	400
Sum	859	538	100	600

Step 4.
Go back to Step 1. In the next round, the 20 subjects are randomly made into five new groups. The same procedure will be repeated. As group members are randomly chosen, some members of your group in the second round may have belonged to your group in the first round or they may not.

This procedure will be repeated **10 times**. The experiment consists of 10 rounds, each of which consisting of four periods.

After choosing either "GIVE" or "NOT GIVE", please write down the reasons why you make the decision in your record sheet.

Earnings

We will explain how to calculate your earnings that we will pay.

Your earnings = (the sum of your payoffs over 10 rounds) × 0.75 (JPY).

Any decimal places are rounded up.

This is the end of instruction. Please raise your hand if you have any questions.

Let us start the experiment. You will take 3 minutes to read the instruction to make you understand the rules of the experiment completely.

Please raise your hand silently if you have any questions. Experimenters will come to you. However, do not communicate with other subjects. Thank you.

Appendix B: Subgame Perfect Equilibrium of the Game with Treatment B

We demonstrate here that the subgame-perfect equilibrium for a four-person four-period Rosca game is that at each period, every player takes the strategy “ to pay no contribution regardless of the history before the period.”

Proof. Without loss of generality, assume that player *i* receives contributions from the other three players in period *i*. That is,

Player 1 receives money from players 2, 3, and 4 in period 1;

Player 2 receives money from players 1, 3, and 4 in period 2;

Player 3 receives money from players 1, 2, and 4 in period 3; and

Player 4 receives money from players 1, 2, and 3 in period 4.We solve the subgame-perfect equilibrium for this game by backward induction.

Period 4: Suppose that the players make their decisions in period 4. Period 4 is the final stage, and so players 1, 2, and 3 have no incentive to pay money because they just lose payoffs if they contribute. Hence, player 4 receives nothing.

Period 3: Suppose that the players make their decisions in period 3. Players 1 and 2 have no incentive to pay money because they lose payoffs by contributing in period 3, and they do not receive any penalties in period 4 even if they do not contribute in period 3. Player 4 has no incentive to pay money either because they obtain nothing in this game regardless of their contributions in period 3. Hence, player 3 receives nothing.

Period 2: Suppose that the players make their decisions in period 2. Player 1 has no incentive to pay money because they lose the payoff by contributing in period 2, and they do not receive any penalties in periods 3 or 4 even if they do not contribute in period 2. Players 3 and 4 have no incentive to pay either because they obtain nothing in this game regardless of their contributions in period 2. Hence, player 2 receives nothing.

Period 1: Suppose that the players make their decisions in period 1. Players 2, 3, and 4 have no incentive to pay because they obtain nothing in this game regardless of their contributions in period 1. Hence, player 1 receives nothing.

Thus, the subgame-perfect equilibrium is that every player takes the action of paying nothing in each period when they are to contribute to another player. Q.E.D.

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