Fair share and social efficiency: a mechanism in which peers can decide on the payoff division*

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Abstract

We show that for a well known class of voluntary contribution games, cooperation can be achieved under a simple mechanism in which each player's payoff is determined by a joint decision made by his peers after observing his effort. While the existing mechanisms used in the literature often rely on some costly punishment or on the notion of conditional cooperation, in the mechanism we propose each player can costlessly decide on some fraction of the other players payoff after observing their contributions. This mechanism is tested in a controlled laboratory, we find that more than 80% of the players use the proportional rule to reward others and that the players' contributions improve substantially and almost immediately with almost 90% of players contributing.

Keywords: externalities, mechanism design, voluntary contribution mechanism, experimental economics, distributive justice

JEL Classification: D62, H41, C79, C90, D63,

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1 Introduction

It is well known that the private optimal does not coincide with the social optimal for a wide class of economic problems, often referred to as social dilemmas. A rare positive result is due to Varian (1994) who shows that, in theory, for the case of two players, the problem can be solved by a mechanism that takes form of a two-stage game. However, Andreoni and Varian (1999) found that this mechanism did not perform well when tested in laboratory settings. In a seminal paper, Fehr and Gächter (2000) found when costly punishments are introduced full cooperation can be achieved in experiments after several rounds. Fehr and Gächter (2000) results not only remained very robust in many subsequent studies (for example, Gürerk et al. (2006), Sefton et al. (2007), Carpenter (2007), Nikiforakis and Normann (2008), Egas and Riedl (2008) but also led to some theoretical studies that incorporate behavioral considerations in utility functions (for example, see Fehr and Schmidt (1999), Bolton and Ockenfels (2000), Charness and Rabin (2002), Dufwenberg and Kirchsteiger (2004), Cox et al. (2007), Cox et al. (2008)). In this paper we show that a simple mechanism that does not depend explicitly on costly punishments can work well in laboratory settings in sustaining cooperation. Moreover, the mechanism performs well in theory within with an infinitesimally small behavioral parameter.

The idea behind our mechanism comes from John Kenneth Galbraith who described a profit-sharing scheme used by the National City Bank (now Citibank) in the US in the 1920s where each officer would sign a ballot giving an estimation towards each of the other eligible officers, himself/herself excluded. The average of these estimations would guide the Executive Committee in the final allocation of funds to the officers. Our mechanism uses the idea of the profit-sharing scheme described by Galbraith and it can be applied to many economic problems including games with positive externalities and principal-agents problems in which the principal needs to decide on the distribution of some common resource among the agents.[1] Another real life example in which our mechanism fits well is on the division of tasks in university level group assignments. While professors typically will not be able to know the individual student's input, they will only observe the final output. In such a situation, our mechanism can be described by a two stage game in which students choose how much effort to exert in the first stage and in the second stage after observing each other's effort, each student proposes a fraction of the total marks (sum of marks given to all students in the group) to be given to each of the remaining students in his group.

[1]An important assumption is that while the principal does not observe the agents effort levels, agents observe each other's effort. This is common in certain kind of workplace. For example, Freeman (2008) reports that 80% of employees observe their co-workers' effort levels in the factory production line.

Chaudhuri (2010), in a literature survey on laboratory experiments identified three main drivers of a cooperative outcome: 1) conditional cooperation, 2) costly punishments and 3) non-monetary punishments. While conditional cooperation theories and non-monetary mechanisms often depend on assumptions about the players' beliefs and non-standard theories, punitive mechanisms remain robust in many settings. However, it has been argued that from a welfare view point costly punishments might be inefficient as players need to destroy some of their own payoffs in order to punish others and that perverse "anti-social" punishment are often observed in experiments. Moreover, such mechanisms have also been criticized on the grounds of practicality as they cannot be implemented in many real life settings like organizations. The mechanism we propose is based on some endogenous payoff allocation in which players can freely decide on some fraction of the counter-players payoff. Players are free to punish to reward or even always allocate evenly to the remaining players while no costs are incurred by the players in the allocation exercise.

While we find that our mechanism performs well in laboratory settings, we also give some theoretical results to show that our mechanism implements effort in subgame perfect equilibrium. These relate to results by Varian (1994) who introduced a class of mechanisms where the unique subgame perfect Nash equilibrium coincides with the pareto-optimal outcome. One merit of his result relative to the literature on optimal tax design by Mirrlees (1971) is that it is a pure market result in which no third party intervention is needed to solve the externality problem.However, in Varian's mechanism players need to first decide on some side payments before playing the contribution game. One can argue that it is not very natural for players to discuss about side payments before playing the effort game especially when the number of players is large and therefore Varian's mechanism may not work in many real life settings. Our mechanism is a simpler mechanism that solves the same problem without requiring the players to make side payments before playing the game. Instead, we let the players propose a division of the pie among the remaining players at a second stage after observing the first stage history. Under some mild behavioral assumptions, our mechanism implements full cooperation in both SPNE and strong NE.

A more recent mechanism similar to that of Varian's is given by Masuda et al. (2014) who propose a simple mechanism of pre-play commitment. For the two-player case, their mechanism is a two stage game which they call the minimum approval mechanism (MAM). Under this mechanism a Pareto-efficient contribution level is guaranteed as it is a weakly dominant strategy for each player. However, implementing this mechanism demands an institution with strong regulations to enforce the announced contribution levels whereas our mechanism does not have this requirement. Our mechanism also distinguishes from mechanisms that require the intervention of a third party. For example, Falkinger (1996) proposed a mechanism in which a central planner chooses a single parameter to reward and penalize agents for deviations from the average contributions to the public good whereas Stoddard et al. (2014) designed an experiment that achieves cooperation in laboratory settings. However, while in their experiment, there is one additional player who acts as an allocator after observing group members' effort decisions, our mechanism can achieve the full cooperation result without relying on the central planner and an "external" allocator.

One important theoretical implication of Fehr and Gächter (2000)'s result is that standard theory cannot explain why players are willing to incur a cost to punish, but one has to assume certain fairness rules. Our results show that with some infinitesimally small behavioral parameter, cooperation can be achieved in subgame perfect equilibrium. While Cox et al. (2007) give a representation of preferences that capture some elements of altruism, in this paper we use the notion of distributive justice. This concept was first explored by sociologists (Homans (1958); Adams (1965)) and later adopted by behavioral economists (Gächter and Riedl (2005),Konow (2000)). Distributive justice is often defined by the principle by which a player's entitlement towards some group outcome should be proportional to his/her investment. Konow (2000) adds a cost component in the player's utility function to capture the cognitive dissonance suffered whenever the player himself does not abide by the distributive justice principle towards other players. In one of Konow (2000)'s experimental treatments, participants were divided into groups of two and were asked to fold envelopes as a task. A piece rate per envelope was paid to each group. A disinterested third party was then asked to divide each group's earnings between the group members. It was found that more than 90% of third parties used a division rule whereby each member was allocated a share that is proportional to the member's effort, i.e., the number of envelopes they fold. We explicitly incorporate Know's notion of fairness in our model.

The remainder of the paper is organized as follows. Section 2 presents our mechanism and its assumptions. Section 3 describes the experimental design and our hypotheses. Experimental results are discussed in section 4 and section 5 concludes.

2 Galbraith's Mechanism

2.1 Effort Game Setting

We consider a standard voluntary contribution (or effort) game, with $N = \{1, ..., n\}$ players, in which each player i has endowment of $\bar{e}$ unit of effort and chooses whether or not to contribute effort to some task. In particular, the player chooses some $e_i \in E = \{0, \bar{e}\}$. As usual, we let $e = (e_1, e_2, ...e_n) \in \mathbf{E} = \prod_{i=1}^{n} E_i$, $e_{-i} = (e_1, ..., e_{i-1}, e_{i+1}, ...e_n)$ and $e = (e_i, e_{-i})$. Players' actions determine a joint monetary outcome of $\Pi(e) : \mathbf{E} \to \mathbb{R}$ which must be allocated among the players. The transformation of effort to the monetary outcome is described by a production function in which inputs are perfect substitutes. More formally, we let $\Pi(e) = \beta \sum_i^n e_i$. If we let q_i be the share of total outcome $\Pi(e)$ that accrues to player i and we assume that $\Pi(e)$ will be fully allocated, that is, $\sum_{i=1}^n q_i = 1$, then player i's payoff function is given as follows:

$$\pi_i(q_i, e(e_i, e_{-i})) = (\bar{e} - e_i) + q_i \Pi(e) \tag{1}$$

We first consider an equal division sharing rule (i.e., standard voluntary contribution mechanism) in the following result.

Proposition 1 (Equal Division Rule). *Assume $q_i = 1/n$ for all i, then $e_i = 1$ is a dominant strategy if and only if $\beta > n$.*

2.2 The Mechanism

Our mechanism is inspired by J.K. Galbraith's famous volume "The Great Crash of 1929", in which he outlined a profit-sharing scheme used by the National City Bank (now Citibank) in the US in the 1920s. The scheme as described by Galbraith is as follows: "After a deduction of eight precent, twenty percent of the profits of the bank...were paid into a management fund. This was divided twice a year between the principal officers by an arrangement which must have made for an interesting half-hour. Each officer first dropped in a hat an unsigned ballot suggesting the share of the fund that [the CEO] should have. Then each signed a ballot giving his estimate of the worth of each of the other eligible officers, himself excluded. The average of these estimates guided the Executive Committee of the bank in fixing the percentages of the fund each officer was to have."

We formally model this procedure in the following two stage game. In the first stage, each player will choose an effort e_i (contribution level) just as in the effort game described in the previous section. The second stage can be described as follows. Let a_{ij} denote the proportion of $\Pi(e)$ proposed by player i to player j such that$a_{ii} = 0$, $a_{ij} \in [0,1] \forall i \neq j$ and $\sum_{i=1}^{n} a_{ij}$=1. In other words, each player proposes a fraction of $\Pi(e)$ to be received by each of the other players. The final share q_i of $\Pi(e)$ that each player i receives is given by the following formula.

$$q_i = \frac{\sum_{i=1}^{n} a_{ji}}{n} \tag{2}$$

2.3 Equity Theory and Cognitive Dissonance

One interesting aspect of the second stage game described by the Galbraith's is that how players allocate do not affect their own payoff. Indeed, they may allocate in a random manner without any consequences to themselves. But what is "fair" distribution of the pie among a group of players when the size of the pie is determined by the sum of the individuals' effort? As pioneered by some sociologists (for example, Homans (1958), Adams (1965)), this is related to the concept of "equity". Distributive justice is obtained when the profits of each party are proportional to their investment. Recent experimental studies suggest that discretionary variables like the effort level (in our case) are used to justify a participant's entitlement of a share of the total outcome Konow (1996), Gächter and Riedl (2006), Stoddard et al. (2014)). Adams (1965) argues that when distributive justice is not achieved, people may either suffer from anger (feeling that they get less than what they deserve) or guilt (feeling that they get more than they deserve). Konow (2000) adds this element of emotion into player's utility function. In particular, whenever there is a difference between the actual share that the player allocate to others and the share that the player ought to allocate according to the proportional rule, the player will incur some psychological cost .[2]

In the same spirit of the Konow's approach, we consider Galbraith mechanism with a cost component that captures the idea of distributive injustice in the player's payoff function.

[2]In Konow (2000), people' adoption of distributive justice is modelled by some exogenous cost to reduce their cognitive dissonance. This method has also been used by Rabin (1994) and Oxoby (2003,2004). The "dissonance reduction" cost can be modelled endogenously in one's utility function in Benabou and Tirole (2011)'s model.

According to the equity theory, the fair proportion of player j 's share of the total outcome should be $q_i = \dfrac{e_i}{\sum_{i=1}^{n} e_i}$.

Under Galbraith's mechanism, perfect implementation of proportional rule cannot always be achieved. This is because the highest proportion one player can get is $(n-1)/n$. Suppose player i deserves more than $(n-1)/n$ under proportional rule, i.e., $q_i = e_i / \sum_{i=1}^{n} e_i > (n-1)/n$, then this cannot be implemented under Galbraith's mechanism. But we can still construct a fair allocation rule in the context of Gaibraith's mechanism that player i shall allocate to player j:

$$\eta_{ij} = \begin{cases} \frac{e_j}{\sum_{j \neq i} e_j} & if \quad \sum_{j \neq i} e_j \neq 0 \\ \frac{1}{n-1} & if \quad \sum_{j \neq i} e_j = 0 \end{cases}$$

We describe the cost of unfairness that player i incurs when he proposes an allocation a_{ij} that is not consistent with the above rule. More formally, let $d_{ij} = a_{ij} - \eta_{ij}$, we let function $f(d_{ij})$ be the cost that player i incurs if he is unfair to player j. We assume that $f$satisfies the following. (i) $f(0) = 0$, (ii) $f(d)$ is positive and is strictly increasing for all $d > 0$ and (iii) $f(d)$ is positive and strictly decreasing for all $d < 0$. An example of a simple function that satisfies (i)-(iii) is $f(d_{ij}) = \theta |d_{ij}|$, where θ >0. With this specification, in the second stage, the optimal allocation for player i will always be $a^*_{ij} = \eta_{ij}$.

2.4 Equilibrium with three players and Hypotheses

In this section, we will present the equilibrium situation with three players if they follow the fair allocation rule outlined in section 2.3.

Proposition 2 (Galbraith's Mechanism with fair allocation)**.** *Suppose player i's modified payoff function is given by $\pi_i(e, q_i) - \sum_{j \neq i} f(a_{ij} - \eta_{ij})$ and $\beta > 1.5$, then the strategy profile in which $e_i = \bar{e}$ for each i in the first stage and $a_{ij} = \eta_{ij}$ for all i, j in the second stage is the unique subgame perfect Nash equilibrium of Galbraith's Mechanism with three players. If $\beta < 1.5$, then multiple Nash equilibria exist in the game.*

Directly from Proposition 2, we develop the following hypotheses to be tested experimentally:

Hypothesis 1. *Under the Galbraith's mechanism, players use the proportional rule to allocate in the second stage.*

Hypothesis 2. *Under the Galbraith's mechanism, if $\beta > 1.5$, players contribute the full endowment to the public account.*

As is standard in this literature (for example,Andreoni and Varian (1999); Fehr and Gächter (2000); Falkinger et al. (2000); Bracht et al. (2008); Masuda et al. (2014)), we will compare our mechanism with the Voluntary Contribution Mechanism (VCM) which is the same contribution game with an equal division of payoffs for all possible effort combinations. Thus, in each set of experiments, subjects will play the standard VCM for the first 10 rounds followed by 10 rounds of GM. We will be particularly interested in changes in patterns of behavior as far as 1) and 2) are concerned. In the GM experiment, we will consider a high β (that is, some β greater than 1.5 – in fact, we will consider the case where $\beta = 1.8$) and a low (that is, some β less than 1.5 – in fact, we will consider the case where $\beta = 1.2$). Therefore, based on these values of β, in theory, we should observe that the VCM always fails to implement effort (as in Proposition 1) while GM succeeds if $\beta = 1.8$ and is inconclusive if $\beta = 1.2$. In later sections, we will show that results from our experiments corroborate the theory.

3 Experimental Design

Each participant only takes part in one of the three treatments (HighGM, LowGM or Control) listed in Table 1. Each treatment contains 20 rounds of decision making tasks that can be divided into two blocks of ten rounds. Participants will only be informed about the task in the second block once the first ten rounds are completed. In each round, the computer program randomly draws three participants to form a group. The group composition reshuffles every round in a nine-people matching group. In this way, we have ten independent matching groups for each experimental treatments (labelled as HighGM and LowGM) and four independent matching groups for control treatments (labelled as Control).

In the first ten rounds, we will only consider the standard voluntary contribution mechanism discussed above for the case where $n = 3$. We use neutral terminology in the experiment and the contribution question formulated on the computer screen is "Tokens you want to add to the Group Fund:__."Players choose an integer from 0 to 10. The integer hence represents the contribution chosen by the participant. The production function is $\Pi(e_1, e_2, e_3) = \beta(e_1 + e_2 + e_3)$. Each player's payoff function is $\pi_i = 10 - e_i + \frac{1}{3}\Pi$. These ten

Table 1: Experiment Design

Sessions	Round1-10 Treatment	Round11-20 Treatment	β	Number of subjects
HighGM	VCM1.8	GM1.8	1.8	90
LowGM	VCM1.2	GM1.2	1.2	90
Control	VCM1.8	VCM1.8	1.8	36
Total				216

rounds are identical across all treatments except for different βs (i.e., 1.8 and 1.2). [3]

In round 11-20, there are two decision stages in each round of HighGM and LowGM treaments. The first stage decision is the same as in VCM, that is, each player voluntarily chooses an integer from 0 to 10. In the second stage, the computer screen displays each group members' contribution decisions in the first stage and the value of the group fund, i.e., $\Pi(e_1, e_2, e_3) = \beta(e_1 + e_2 + e_3)$. Each player's task is to divide $\frac{1}{3}$ of Π between the other two group members. For example, player 1 divides $\frac{1}{3}\Pi$ between player 2 and player 3. This occurs because in the Galbraith's mechanism sharing rule, the sum of the vector of all players proposed allocation will be divided by the total number of groups. In the control treatment, players simply repeat the same decision ask in round 1-10 for another ten rounds.[4]

All experimental sessions were conducted in the CeDEx laboratory in Feburary 2015 at the University of Nottingham, United Kingdom. The experiment was computerized using z-Tree (Fischbacher, 2007) and subjects were recruited with ORSEE (Greiner, 2004). In total, 216 university students from various fields of study took part in over 12 sessions, with 18 participants in each session. We ensure the recruited subjects had not participated in a similar experiment before. Upon arrival, participants were asked to randomly draw a number from a bag and they were seated according to that number. Participants were seated at a computer terminal in a cubicle and could not communicate with other participants. Participants received the relevant instructions at the beginning of each ten-round block, and the (same) experimenter then read the instructions aloud in front of laboratory in every

[3]We set $\beta = 1.2$ in the first ten rounds of LowGM treatment to minimize the variable changes during the experiment, so the treatment will be more comparable. As will be shown in section 4.1, the first ten rounds of all three treatments yields similar results.

[4]To make the procedure strictly comparable between the control and the experimental treatments, participants in the control treatment would receive a copy of instructions detailing the same information as in round 1-10. In this way, the time break between the first ten and the second ten rounds are similar for the control and the experimental treatments.

session.

Before the beginning of each ten-round block, participants were required to answer several computerized quiz questions regarding the payoff function and the procedure details. The experiment only started when all participants had provided the correct answers to the quiz. Questions were taken privately if any difficulties arose in understanding the instructions. At the end of a session, subjects were paid in private the amount they earned. The conversion rate is 30 experimental points = 1 pound. The quiz, 20 rounds of decision- making, and the questionnaire lasted for approximately one hour; participants earned on average GBP8.34.[5]

4 Experimental Results

The experiment is motivated by two questions: 1) how much do players contribute and 2) how do players allocate under the Galbraith's mechanism. We shall proceed with the analysis of the experimental results in the following way. Section 4.1 looks at the difference of the contribution decisions across treatments. Section 4.2 analyzes the participants' allocation decisions, and Section 4.3 studies how do allocation choices affect the players' contribution decisions.

4.1 Contributions

Figure 1 displays the time-path of the average contributions over all 20 iterations for each treatment. The first ten rounds are where standard voluntary contribution mechanism is used. We observe a decline in the level of contribution over time. Participants start with an average contribution level of 3.4 and end up with 0.4 in round 10. This finding is consistent with results from other studies. For example, Fehr and Gächter (2000) found only 1% of cooperative moves after 10 rounds of random matching with four players.

Since all participants face the same dilemma in round 1-10 (despite different β value), a priori one should not expect significant differences in contribution across these different treatments. Indeed, we find no significant difference in the contribution levels from round 6 to 10 among all three treatments (the Kruskal-Wallis test fails to reject the null hypothesis

[5]At the time of the experiment, the exchange rates were as follow: 1 GBP = 1.55 USD and 1.40 Euro.

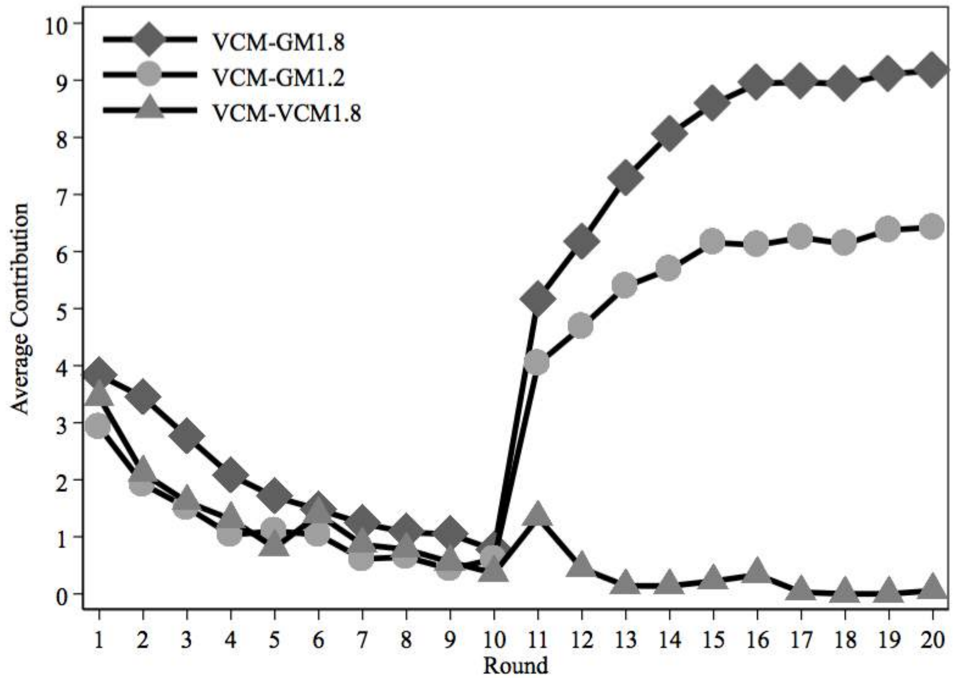


Figure 1: Time-path of the average contribution by treatment

of equal average contribution of the three treatments for each round, the smallest $p = 0.237$).

Given this history of declining average contribution and almost zero contribution in round 10, at the beginning of round 11, we introduce Galbraith's mechanism in both the GM1.8 and the GM1.2 treatments. This introduction triggers a dramatic increase in contribution level in round 11: about two fifth of the players increase their contribution (43.3% in the GM1.8 and 42.2% in the GM1.2) and the average contribution level is 5.17 in the GM1.8 and 4.03 in the GM1.2. On the contrary, in the control treatment, only a quarter of players increase their contributions and the average contribution level is 1.33.

In the GM1.8 treatment, the average contribution is 8.0 and the final round contribution reaches an average of 9.16. Eight out of ten independent groups in the GM1.8 treatment achieves full contribution in later rounds. The GM1.2 treatment achieves a mild but also clear increase in the average contribution level as shown in Figure 1. The average is 6.3 and the average last round contribution is 6.42. The difference between the GM1.8 and the GM1.2 treatment is significant as Mann-Whitney test rejects the null hypothesis of equal average contribution at 0.1% level for round-by-round comparison for round 11-20 between these two treatments. On the other hand, both the GM1.8 and the GM1.2 treatments differ

Table 2: Summary of the contribution decisions for round 11-20

	GM1.8		GM1.2		VCM1.8	
Round	Mean	S.D.	Mean	S.D.	Mean	S.D
11	5.2	3.6	4.0	3.4	1.3	3.0
12	6.2	3.2	4.7	3.1	0.4	1.2
13	7.3	3.0	5.4	3.5	0.1	0.5
14	8.1	2.7	5.7	3.5	0.1	0.7
15	8.6	2.3	6.2	3.4	0.2	1.0
16	8.9	2.1	6.1	3.4	0.3	1.7
17	9.0	2.5	6.2	3.4	0.0	0.2
18	8.9	2.4	6.1	3.5	0.0	0.0
19	9.1	2.2	6.4	3.5	0.0	0.0
20	9.2	2.2	6.4	3.6	0.1	0.3

significantly from the control treatment (i.e., VCM mechanism in rounds 11-20). In fact, almost all groups in the control treatment has zero contribution in later rounds.

Result 1. *While round 1-10 display similar patterns of failure to promote contribution across all three treatments when the standard voluntary contribution mechanism is used (the average contribution is almost zero in round 10) , round 11-20 show different patterns of contribution across the three treatments (we observe 80% cooperation in the GM1.8 treatment and 57% contribution in the GM1.2 treatment).*

What causes these sharp differences across three treatments? Will pure imitations of strategies from those who earn higher payoffs explain the pattern? Note that by design, in the VCM treatment, those who contribute more will necessarily result in a lower payoff compared to those of the free-riders'. Under Galbraith's mechanism, however, one's profit depends on other player's allocation decisions in the second stage of the game. In the GM1.8 treatment, players who contribute more than a median player in round 11 results in significantly higher profit (mean = 15.3) as compared to players who contribute less than a median player (mean = 12.3) (Mann-Whitney test, $z = -4.18, p < 0.001$, two-sided). However, the profit gap between high contributors and low contributors is smaller and not significantly different in the GM1.2 treatment especially in the early two rounds (Mann-Whitney test, $z = -0.77, p = 0.44$, two-sided).

To better understand the dynamics of the changes in contribution decisions and the reasons behind payoff differences, we proceed in the next section to study players' allocation decisions.

4.2 Allocation Decisions

For each round in the second sequence of the experiment, participants need to decide on how to allocate between the other two group members. The allocation must sum up to one third of the group fund, that is, $\tilde{a}_{ij} + \tilde{a}_{ik} \equiv \frac{\Pi}{3}$.[6] In the following analysis, we only consider each player i's allocation to player j, $\tilde{a}_{ij}$, because the allocation to each k is automatically determined by $\tilde{a}_{ij} \equiv \frac{\Pi}{3} - \tilde{a}_{ij}$. Repeated entries are hence eliminated: if $\tilde{a}_{12}, \tilde{a}_{23}, \tilde{a}_{31}$ are counted, $\tilde{a}_{13}, \tilde{a}_{21}, \tilde{a}_{32}$ will not be counted.

Following to the discussion in section 2.3, proportional rule predicts an allocation to be entirely depend a player's entitlement. The results from the experiment confirm this prediction. We observe the mean fractional allocations, $\frac{\tilde{a}_{ij}}{\tilde{a}_{ij}+\tilde{a}_{ik}}$, are not significantly different from player's entitlement, $\frac{e_j}{e_j+e_k}$. (t-test, $p = 0.66$ in GM1.8 and $p = 0.98$ in GM1.2, two sided). The following least-squares (OLS) regressions clustered on independent groups present additional support for the theory. The regression equation is:

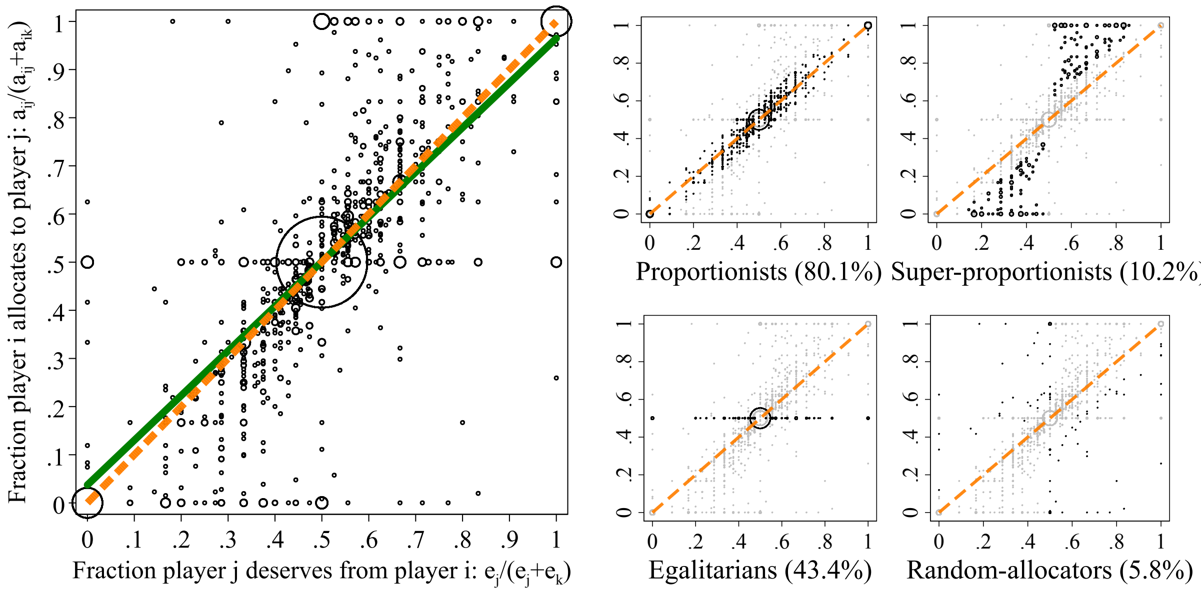
$$\frac{\tilde{a}_{ij}}{\tilde{a}_{ij} + \tilde{a}_{ik}} = \beta_0 + \beta_1 \frac{e_j}{e_j + e_k} + \varepsilon_i \tag{3}$$

where ε_i is an error term. Proportional rule predicts that the intercept of this equation equals 0 and that the slope equals 1. OLS estimates of these parameters are consistent with the hypothesis: the intercept of 0.044 (for GM1.8) and 0.034 (for GM1.2) are not significantly different from 0 but the slope of 0.917(for GM1.8) and 0.933(for GM1.2) are. Moreover, using an F-test, the slope turns out not to be significantly different from 1 ($F_{GM1.8} = 1.53, p_{GM1.8} = 0.25; F_{GM1.2} = 1.43, p_{GM1.2} = 0.26$, two-sided).

A useful way to represent the allocation choices is to plot allocation decisions according to the regression equation. Figure 2 includes all allocation decisions of both the GM1.8 and the GM1.2 treatments.[7] The horizontal axis indicates the fraction player j deserves from player i if proportional rule is implemented, that is, $\frac{e_j}{e_j+e_k}$. The vertical axis shows the actual fraction i allocates to player j, that is, $\frac{\tilde{a}_{ij}}{\tilde{a}_{ij}+\tilde{a}_{ik}}$. All observations on the 45 degree line (dashed

[6] In section 2, a_{ij} is defined as the proportion player i allocates to player j, and $a_{ij} + a_{ik} = 1$. To calculate player's final profit, this proportion will be normalized by dividing the group number and multiply the joint profit, i.e., $\pi_i = 10 - e_i + \frac{\sum a_{ji}}{n}\Pi$. In the experiment, for the ease of explanation, the quantity each player is entitled to allocate is directly given as $\frac{\Pi}{3}$, therefore, $\tilde{a}_{ij} = \frac{\Pi}{3} a_{ij}$.

[7] Players are randomly matched and they are informed that they will never be in the same group again with the other two group members. Therefore, each round can be seen as an independent observation with no direct consequences of later rounds.



(a) Allocation Choices

(b) Four types of allocators

Figure 2: Allocation decisions in Galbraith's Mechanism

on Figure 2) depicts the set of players who allocate exactly as the proportional rule dictates. A linear fitted line of $\widehat{\frac{\tilde{a}_{ij}}{\tilde{a}_{ij}+\tilde{a}_{ik}}} = \widehat{\beta}_0 \frac{e_j}{e_j+e_k}$ is depicted as a solid line inFigure 2. That this fitted line almost coincides with the 45-degree line confirmed the result that majority observations are proportional allocations.

Except for those dots gathered close on 45-degree line, a closer visual investigation in Figure 2 shows some other interesting patterns of allocation choices. For example, if player j deserves less than 0.5, most dots are gathered below 45-degree line. On the other hand, if player j is entitled more than 0.5, those dots are clustered above 45 degree line. In the mean time, we also observe substantial amount of dots lie horizontally on $\frac{\tilde{a}_{ij}}{\tilde{a}_{ij}+\tilde{a}_{ik}} = 0.5$. We therefore categorize allocators into four different types as shown in Figure 2.

Extreme proportionists are those who allocate exactly based on others' merit, i.e., $\frac{\tilde{a}_{ij}}{\tilde{a}_{ij}+\tilde{a}_{ik}} = \frac{e_j}{e_j+e_k}$. Due to the experimental design, $\frac{e_j}{e_j+e_k}$ may not always be a fraction of ten. We therefore relax the equality condition and use the following condition instead. Define player i as a Proportionists when $\mid \frac{a_{ij}}{a_{ij}+a_{ik}} - \frac{e_j}{e_j+e_k} \mid \leq 0.1$ (see the category highlighted as Proportionists in Figure 2). In around 80.1% of instances, players adopt the proportional rule in the allocation stage.[8] The proportional rule also remains the most popular rule in any round of the second sequence.

Egalitarians are those who desire an equal division regardless of other concerns. Under the Galbraith's mechanism, those are the players who equally allocate half of $\frac{1}{3}\Pi$ to the other two. In our experimental settings, the exact egalitarian rule is always feasible since $\frac{1}{3}\Pi$ is a multiplier of 0.2. To be comparable with the definition of proportionists, we define player i as an egalitarian when $\mid \frac{a_{ij}}{a_{ij}+a_{ik}} - \frac{1}{2} \mid \leq 0.025$ (see the category highlighted as Egalitarians in Figure 2). Note that proportionists and egalitarians are not mutually exclusive. For example, if the other two counter-players contribute the same amount, both the proportionist and the egalitarian rules will predict $\frac{a_{ij}}{a_{ij}+a_{ik}} = 0.5$. This is not a rare case as about 40% of instances fall under this category.

There is an interesting type of players that we call "super-proportionists". If player j contributes less than player k, player i, under the "super-proportionists" category, rewards player j with no more than what he/she deserves under the extreme proportional rule. The other player, player k may consequently be over-compensated. On the other hand, when an equal contribution is observed, an equal division is implemented. Therefore, super-proportionists tend to "punish" players who contribute less than the others and over-compensate players who contribute more than the others (see the category highlighted as super-proportionist in Figure 2). Note that the possibility allowed by the Galbraith's mechanism to "punish" other players is different from the "punishment mechanism" in Fehr and Gächter (2000). Under Fehr and Gächter's setting, players can choose to incur a cost to destroy part of the other players' payoff. One critique of such a mechanism is that efficiency is wasted by punishing others. Note that in our results, there are still 5.8% of observations that cannot be captured by any of the three above types (see the last panel of Figure 2).

A reader may be interested in what factors can help to explain players' allocation decisions. In this paper, we hypothesize that a player's allocation decision $a_{ij,r}$ in time r can be explained by the following variables in the regression equation:

$$\tilde{a}_{ij,r} = \alpha_1 Contribution_{i,r} + \alpha_2 OtherContribution_{i,r} + \alpha_3 \tilde{\eta}_{ij} + \alpha_4 GM1.8_I + \alpha_5 Round_i + \varepsilon_i \quad (4)$$

[8] Overall, 48.6% of the instance fall exactly on the 45 degree line, i.e., they are extreme proportionists. When considering the case where the reminder of $\frac{e_j}{e_j+e_k} \times \frac{\Pi}{3}$ divided by 0.1 is 0, 78.7% of the instance fall under extreme proportional allocation rule.

	Logit Regression: Dependent Variables			
	(1)	(2)	(3)	(4)
	Proportional	Random	Super-proportional	Egalitarian
$Contribution_i$	0.110***	-0.138***	0.098**	-0.573***
	(3.49)	(-3.72)	(2.30)	(-5.80)
$Others'Contribution_i$	0.046	0.077	-0.056	0.027
	(0.97)	(0.97)	(-1.13)	(0.50)
Entitlement:η_{ij}	-0.300	1.049	-0.169	0.110
	(-1.44)	(1.23)	(-1.12)	(0.25)
$GM18_i$	-0.012	0.437	-0.293	0.544
	(-0.06)	(1.18)	(-1.27)	(1.33)
$Round_i$	0.033	0.017	0.026	-0.047
	(1.27)	(0.29)	(0.60)	(-0.78)
$Constant$	0.049	-3.451***	-2.082***	-0.296
	(0.15)	(-3.07)	(-3.63)	(-0.31)
N	1800	1800	1088	1088

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Determinants of allocation decisions

In this model, $\tilde{a}_{ij,r}$ is a binary variable taking the value of 1 if player i is using a certain allocation rule to allocate to player j in round r, and zero otherwise. We use the allocation rules defined in Figure 2 to classify $\tilde{a}_{ij,r}$. That is, in model (1)-(4), $\tilde{a}_{ij,r}$ indicates whether or not player i is using proportional rule, random rule, super-proportional rule and egalitarian rule to allocate respectively. $Contribution_i$ is player i's own contribution in round r. The variable $OtherContribution_{i,r}$ is the sum of other two group members contribution in round r. η_{ij} is the proportion player j entitled from player i, which equals $e_j/(e_j + e_k)$. In other words, $\tilde{\eta}_{ij}$ is player j's entitled allocation from player i if proportional rule is implemented. $GM1.8_i$ is an experimental treatment dummy variable, taking the value of one if player i belongs to treatment GM1.8 and zero if she belongs to treatment GM1.2. $Round_i$ represents the round variable and is included to capture the time trend. Last, $\varepsilon_{i,r}$ is assumed to have zero mean and be independently distributed from the explanatory variables. The estimation method is Logit with robust standard error clustered on matching groups as the independent units of observation. Table 3 presents the estimated parameters for the model. The estimated coefficients of $Contribute_i$ are significantly different from zero for all four allocation rules. This suggests a strong correlation between one's contribution and allocation decision in the same round. For instance, the positive coefficient estimates of $Contribution_i$ in model (1) shows that the more one player contribute, the more likely he would adopt proportional rule to allocate. In contrast, the coefficient estimate of $Contribution_i$ in model (2) is negative; it suggests that the more one player contributes, the less likely she would use a random rule to allocate. In terms of model (3) and (4), we eliminate the cases where players observe the equal contributions from the other two group members.[9] The results indicate the more a player contribute, the more likely he uses super-proportional rule to allocate, and the less likely he uses egalitarian rule to allocate. Indeed, the average contribution of egalitarian allocators is less than 2 (out of 10), which are the lowest among four categories.

The marginal effects of the other explanatory variables are not significantly different from zero. It means, first of all, the other group members' total contribution in that round does not affect the allocator's allocation rules, given other things equal. Secondly, other player's entitlement does not affect allocator's rule either. Furthermore, allocators' decisions do not differ significantly across time and treatment.

4.3 How do the allocation choices affect contribution decisions?

Section 4.2 analyses the rules players use to allocate $\Pi/3$. The objective of this section is to look at the relation between the contribution at time t and the allocation choices at time $t-1$. In order to do that we need to develop a measure of fairness in $t-1$. This measure can be constructed in a similar manner as the measure developed in the previous section on how player j treats player i. In particular, this measure will compare the share that player i actually receives to the share that she deserves using the proportional rule.

Figure 3 reports the result on how players are treated in the allocation stages in all rounds. The horizontal axis q_i^f represents the fair share player i should get under Galbraith's mechanism.[10] The vertical axis is the fraction that player i actually gets, i.e., $q_i = \frac{a_{ji}+a_{ki}}{3}$. Observations on the 45-degree line indicate that player i is treated using proportional rule by the other two group members. In a similar fashion as in section 4.2, the six panels in figure

[9] In our definitions, a player can use "super-proportional" rule to allocate only if inequality of contributions arises between the other two group members. In terms of egalitarian rule, about 40% of the observations coincide with the proportional rule in which the other two group members contribute the same amount. We hence eliminate those observations of equal contributions among group members in this regression.

[10] That is,

$$q_i^f = \begin{cases} \left(\frac{e_i}{e_i+e_k} + \frac{e_i}{e_i+e_j}\right)/3 & if \quad e_i \neq 0 \\ 1/6 & if \quad e_i = 0, \max\{e_j, e_k\} \neq 0, \min\{e_j, e_k\} = 0 \\ 1/3 & if \quad \sum e_i = 0 \end{cases}$$

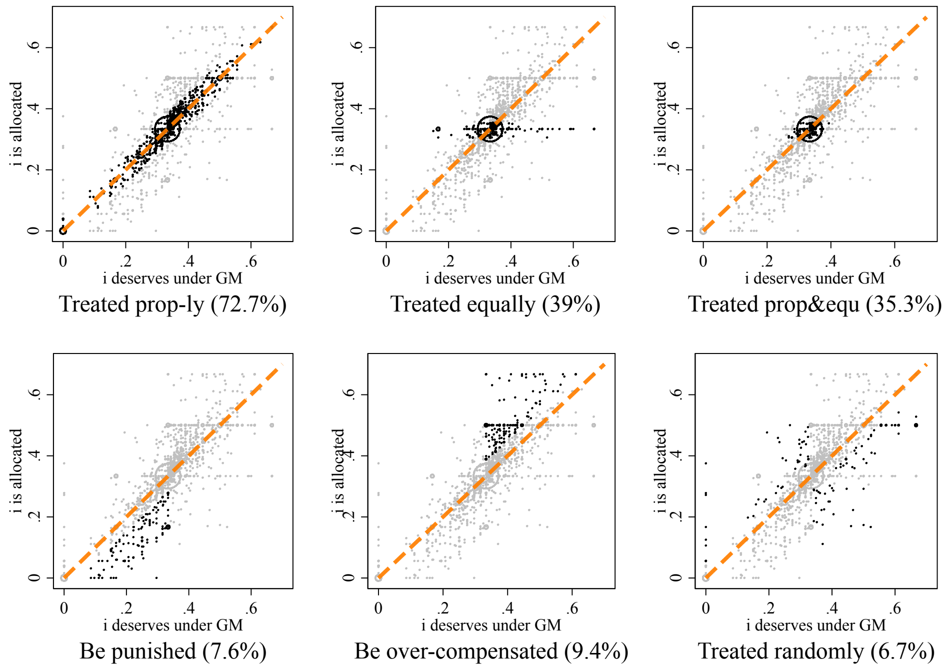


Figure 3: How players have been treated in the allocation stage

3 classify how players are treated in each round[11] . Most players are treated proportionally under most circumstances (72.7%); this corresponds to the fact that in around 80% of the incidences, players use the proportional rule to allocate.In around 39% incidences, players are treated by egalitarian rules. However, in only less than 4% of the observations players are treated by egalitarian rules when their contribution is significantly different from their counter-part. There are around 17% of the incidence players are either being punished from contributing less than their counterparts, or being over-compensated from contributing more than their counterparts. The remaining 6.7% of the players are treated by random rules.

We hypothesize that players' decisions to increase or decrease their contribution in the subsequent rounds may be affected by how they were treated in the previous rounds. For example, if players were treated fairly (proportionally) in the previous rounds, they are more likely to increase their contribution. Players's contribution decisions may also be

[11] We define how players are treated in the allocation stage using the following criteria to be consistent with the allocation rule proposed in section 4.2. Player i is treated by proportional rule if $|\frac{a_{ji}+a_{ki}}{3} - \frac{e_i}{e_i+e_k} - \frac{e_i}{e_i+e_j}| \leq 5\%$. We say player i is treated by egalitarian rule if $|\frac{a_{ji}+a_{ki}}{3} - \frac{1}{3}| \leq 2.5\%$. When $\frac{e_i}{e_i+e_k} + \frac{e_i}{e_i+e_j} < \frac{1}{3}$ and $\frac{e_i}{e_i+e_k} + \frac{e_i}{e_i+e_j} - \frac{a_{ji}+a_{ki}}{3} > 5\%$, we say player i is being punished. When $\frac{e_i}{e_i+e_k} + \frac{e_i}{e_i+e_j} > \frac{1}{3}$ and $\frac{a_{ji}+a_{ki}}{3} - \frac{e_i}{e_i+e_k} - \frac{e_i}{e_i+e_j} > 5\%$, we say player i is being over-compensated. If player i's received allocations cannot be justified by the rules outlined above, we say player i is treated by random rules.

affected by their believes about other group member'ss contribution. For instance, if a player believes the other players are going to contribute high in the subsequent round, they may also wish to match this high contribution in the next round. This behavioural regulation of condtional cooperation has been well documented in Fischbacher et al. (2001). We did not elicit player's believe in the experiment, instead, in our model, we use the other two group members's contribution from the previous round to serve as a proxy. Specifically, our behavioural model of the change in contribution for player i in round r, $\Delta e_{i,r}$ is given by:

$$\Delta e_{i,r} = \gamma_0 + \mathbf{B_{i,r-1}}\theta + \gamma_1 OtherContribution_{i,r-1} + \gamma_2 GM1.8_I + \gamma_3 Round_i + \varepsilon_i$$

In this model, $\mathbf{B_{i,r-1}}$ is a set of dummy variables indicating how the player is treated in allocation stage from the previous round. To be precise, it includes five variables: $B^{PROP}_{i,r-1}$=1 means player i is treated by proportional rule in round r; the notation $B^{EGA}_{i,r-1}$, $B^{PUNISH}_{i,r-1}$, $B^{OVERCOMP}_{i,r-1}$, $B^{RANDOM}_{i,r-1}$ are equivalent dummy variables in the case of the player being treated by egalitarian rule, being punished, being over-compensated, or being treated by random rules respectively in the previous round. The variable $OtherContribution_{i,r-1}$ represents the average contribution of the other two group members in player i'ss group in round $r-1$. GM1.8 is a dummy variable that takes a value of 1 if player i belongs to treatment GM1.8 and zero if GM1.2. *Round_i* captures the time trend. Last, $\varepsilon_{i,r}$ is an unobservable variable that is assumed to have mean zero and is uncorrelated with other explanatory variables. The estimation method is OLS with robust standard errors clustered on matching groups as the independent units of observation. Table 4 presents the estimated parameters for the model. Figure 4 shows the classification of how players are treated in the previous round and their average change of the contribution level in the current round.

The result from model 1, which includes only variable $B^{PROP}_{i,r-1}$, shows that when a player is treated by proportional rule in the last round, she is likely to increase her contribution. However, the magnitude of the estimation is small. It may be caused by the fact that around 85% of the participants are treated using the proportional rule in the experiment. Model 2 includes the dummy variables $B^{EGA}_{i,r-1}$, $B^{PUNISH}_{i,r-1}$, $B^{OVERCOMP}_{i,r-1}$, $B^{RANDOM}_{i,r-1}$as well as other controlling variables. The variable $B^{PROP}_{i,r-1}$ is removed to avoid multicollinearity. The positive estimated coefficient of $B^{PUNISH}_{i,r-1}$, which is significantly different from zero (two-sided $p = 0.03$), indicates a strong positive impact on contribution for players who are punished in the previous round. Reflecting the estimate on Figure 5, holding other things constant, being punished increases one'ss contribution by 0.62 on average. On the other hand, being treated by random rules have large negative impacts on contributions. The estimated coefficient of$B^{RANDOM}_{i,r-1}$ is negative and significantly different from zero (two-sided

	Dep. Variable: One-round Change in Contribution				
Model	(1)	(2)	(3a)	(3b)	(3c)
Round used	12-20	12-20	12	12-15	16-20
$B-prop_{t-1}$	0.301*				
	(1.79)				
$B-ega_{t-1}$		-0.438	-0.133	-0.421	-0.369
		(-0.98)	(-0.12)	(-0.68)	(-1.15)
$B-punish_{t-1}$		0.617**	4.068***	1.662***	0.0623
		(2.28)	(14.80)	(3.76)	(0.16)
$B-overcomp_{t-1}$		-0.215	1.249***	-0.420	-0.0760
		(-1.55)	(3.87)	(-1.39)	(-1.09)
$B-random_{t-1}$		-0.832***	-0.474	-0.878***	-0.548
		(-4.25)	(-0.74)	(-2.94)	(-1.72)
$Others'Contribution_{t-1}$		0.103***	0.456***	0.250***	0.0188
		(4.99)	(4.55)	(6.33)	(1.06)
$GM1.8$		-0.0797	-0.138	-0.146	-0.00412
		(-0.74)	(-0.39)	(-0.70)	(-0.05)
Round		-0.161***		-0.363***	-0.0111
		(-5.10)		(-4.07)	(-0.32)
Constant	0.0961	2.295***	-1.208**	4.234***	0.165
	(0.59)	(5.04)	(-2.77)	(3.71)	(0.25)
N	1620	1620	180	720	900

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Determinants of Contribution Change

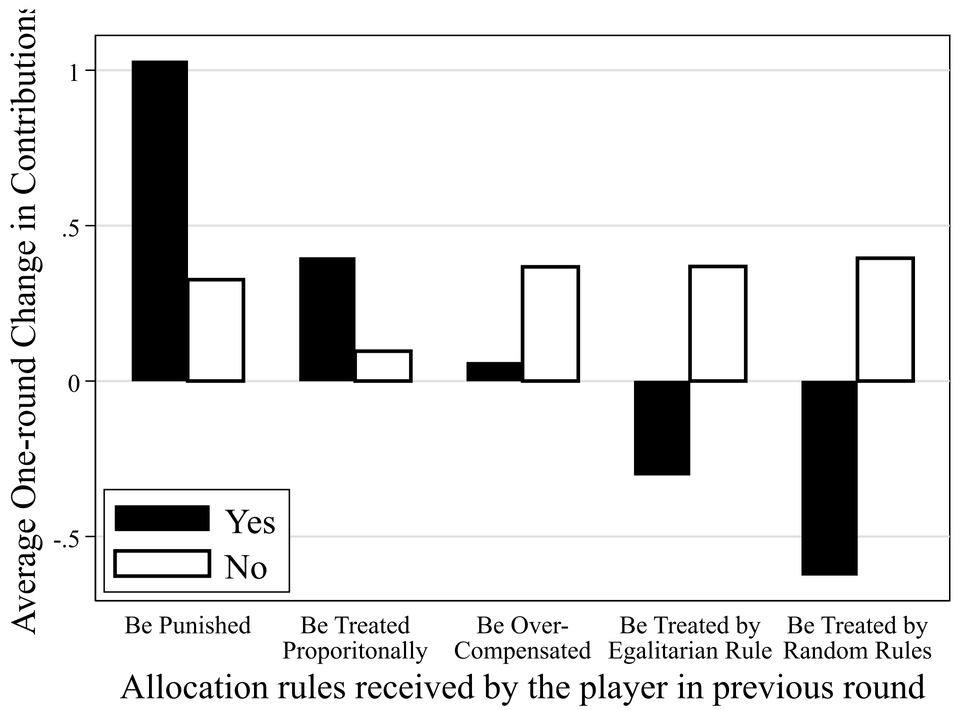


Figure 4: The Determinants of Contribution Change

$p < 0.001$). Compare to those who have not been treated by random rules, the victims tend to decrease contribution by 0.83 on average. When players are treated by egalitarian rules or being over-compensated, they seem to decrease their contribution, but the effect is not significantly different from zero. Model 3a,3b,3c are the same as Model 2, but show estimations from different rounds of the experiment. In particular, Model 4a only looks at round 12. Note that round 12 is the first round in which a player'ss contribution may be affected by the allocation decision. The estimated coefficients of both $B^{PUNISH}_{i,r-1}$ and $B^{OVERCOMP}_{i,r-1}$are large and significantly different from zero (two-sided $p^{PUNISH} < 0.001$ and $p^{OVERCOMP} = 0.001$). This suggests that, keeping other things equal, being punished or being over-compensated in round 11 on average increase players's contribution by 4.07 and 1.25 respectively in round 12. Model 3b only includes the data from round 12-15, while model 3c only uses data from round 16-20. Chow-test rejects the hypothesis that the coefficients are the same for model 3b and 3c. This is because that the contribution level has been stabilized in the second half of the mechanism. The variation of $\Delta e_{i,r}$ is small in round 16-20 compared to the first half of the mechanism.

5 Conclusion

We study a mechanism for a class of public good games studied by Fehr and Gächter (2000), Andreoni and Varian (1999) as well as many others. Our mechanism does not rely on any costly punishments and can be very naturally implemented in many real life settings. Our mechanism takes the form of a two stage game in which players make contributions in the first stage and propose an allocation to each of the remaining players in the second stage. With the behavioural assumption that each player value fairness based merit, we find that the players uniquely allocate according to the proportional rule in the second stage which in turn induces the maximal contribution in the first stage. Our laboratory experimental results support our theory. Indeed, we observe that 90% of cooperation (players play the pareto optimal outcome) among the participants in the experiment, which is significantly higher than other previous studies using different mechanisms. In view of both of our experimental results, we believe that our mechanism improves on many of the existing results and is applicable to many real world situations.

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Appendix A. Proofs

Proof of Proposition 1. First observe that $e_i = \bar{e}$ is a dominant strategy if and only if $\pi_i(e(\bar{e}, e_{-i}), \frac{1}{n}) > \pi_i(e(e_i, e_{-i}), \frac{1}{n}) \forall e_{-i}$. Using the payoff function, this can be rewritten as $0 + \frac{1}{n}\beta(1 + \sum_{j \neq i} e_j) > 1 + \frac{1}{n}\beta(\sum_{j \neq i} e_j)$ for all $\sum_{j \neq i} e_j$, which is true if and only if $\frac{1}{n} > \frac{1}{\beta}$. Finally taking summation on both sides we get $1 > \frac{n}{\beta}$.

Proof of Proposition 2. Suppose each player allocates according to the fair allocation rules outlined in section 2.3, each player will receive a fraction of $q_i = \frac{\sum_{j \neq i} a^*_{ji}}{n}$ from the $\Pi(e)$. Their payoff can be written as follows:

$$\pi_i = \begin{cases} \bar{e} - e_i + \frac{\beta \sum_{i=1}^{3} e_i}{3}\left(\frac{e_i}{e_i + e_j} + \frac{e_i}{e_i + e_k}\right) & if \quad e_i \neq 0 \qquad (1) \\ \bar{e} + \frac{\beta e_k}{6} & if \quad e_i = 0 \quad and \quad \sum_{i=1}^{3} e_i = e_k \qquad (2) \\ 10 & if \quad e_i = 0 \quad and \quad \sum_{i=1}^{3} e_i > e_k \qquad (3) \\ 10 & if \quad \sum_{i=1}^{3} e_i = 0 \qquad (4) \end{cases}$$

We first check at the case where $\beta > 1.5$ and check the payoff function one by one:

(1) Suppose $e_i \neq 0$. Taking the first order derivative of the payoff function with regard to e_i, we have $\frac{\partial \pi_i}{\partial e_i} > 0$ if $\beta > 1.5$. This means $\pi_i(\bar{e}, e_{-i}) > \pi(e_i, e_{-i})$ where $e_i \neq 0$ and $e_i \neq \bar{e}$.

(2) Suppose $\sum_{i=1}^{3} e_i = e_k$. If $\beta > 1.5$, we have $\pi_i(e_i, e_{-i}) > \pi_i(0, e_{-i})$, where $e_i \neq 0$.

(3) Suppose $\sum_{i=1}^{3} e_i > e_k$. If $\beta > 1.5$, we have $\pi_i(e_i, e_{-i}) > \pi_i(0, e_{-i})$, where $e_i \neq 0$.

(4) Suppose $e_k + e_j = 0$. If $\beta > 1.5$, we have $\pi_i(e_i, e_{-i}) > \pi_i(0, e_{-i})$, where $e_i \neq 0$.

To summarize, in all four cases, player i's best response in the contribution stage is $e_i^* = \bar{e}$ when $\beta > 1.5$. This is true for all three players, we conclude that $e^* = (\bar{e}, \bar{e}, \bar{e})$ is the dominant strategy equilibrium in the contribution stage.

Next, we consider the case where $\beta < 1.5$. There are at least two Nash equilibria. We first prove that $e = (0, 0, 0)$ is a Nash equilibrium. Suppose $e_j = e_k = 0$, $e_i = 0$ is the best response strategy if and only if $\pi_i(0, 0, 0) > \pi_i(\tilde{e}_i, 0, 0)$ where $\tilde{e}_i \neq 0$. Using the payoff function, this can be rewritten as $10 > 10 - e_i + \frac{2}{3} \times e_i \times \beta$, which is true if and only if $\beta < 1.5$. Since players i, j, k are symmetric, the above proof is also true for player j and k. Therefore $e = (0, 0, 0)$ is a Nash equilibrium. We then prove that $e = (\bar{e}, \bar{e}, \bar{e})$ is a Nash equilibrium. Suppose $e_j = e_k = \bar{e}$, $e_i = \bar{e}$ is the best response strategy if and only if $\pi_i(\bar{e}, \bar{e}, \bar{e}) > \pi_i(\tilde{e}_i, \bar{e}, \bar{e})$ where $\tilde{e}_i \neq \bar{e}$. The first order derivative of $\frac{\partial \pi_i(\tilde{e}_i, \bar{e}, \bar{e})}{\partial \tilde{e}_i} > 0$. This is true for all three players, therefore $e = (\bar{e}, \bar{e}, \bar{e})$ is a Nash equilibrium.

Appendix B. Experimental Instructions

We present the experimental instructions for the VCM1.8-GM1.8 treatment. Instructions for other treatments are similar and can be requested from the authors. Each treatment has two parts. Part 2 instruction is distributed only after the completion of Part 1 decisions.

Part 1

Welcome!

You are taking part in a decision making experiment. Now that the experiment has begun, we ask that you do not talk. The instructions are simple. If you follow them carefully and make good decisions, you can earn a considerable amount of money. If you have questions after we finish reading the instructions, please raise your hand and one of the experimenters will approach you and answer your questions in private.

This experiment consists of two sequences of decision rounds. Each sequence contains ten decision rounds. In each round, you will be in a group with two other people, but you will not know which of the other two people in this room are in your group. The people in your group will change from round to round, and in particular you will never be matched with the same set of two other participants twice during the whole experiment.

The decisions made by you and the other people in your group will determine your earnings in that round. Your earnings in this experiment are expressed in EXPERIMENTAL CURRENCY UNITS, which we will refer to as ECUs. At the end of the experiment you will be paid in cash using a conversion rate of **£1 of every 30 ECUs** of earnings from the experiment. Under no circumstance will we expose your identity. In other words, your decisions and earnings will remain anonymous with us.

This set of instructions details Sequence 1. An additional set of instructions detailing sequence 2 will be provided after sequence 1 is completed.

SEQUENCE 1 (Decision round 1-10)

Sequence 1 consists of ten decision rounds. At the beginning of each round, you will be randomly allocated a participant identification letter, either A, B, or C. (Thus, your identification letter may change from round to round).

Decision Task in Each Round

Each individual begins EACH ROUND with an endowment of 10 tokens in their Individual Fund. **Tokens in Individual Fund worth 1 ECU each.**

Each three-person group begins with a Group Fund of 0 ECUs each round. Each person will decide independently and privately whether or not to contribute any of his/her tokens from his/her own Individual Fund into the Group Fund. **Tokens in Group Fund worth 1.8 ECU each.**

In other words, each token that a person adds to the Group Fund reduces the value of his/her Individual Fund by 1 ECU. Each token added to the Group Fund by a group member increases the value of the Group Fund by 1.8 ECUs.

Each person can contribute up to a maximum of 10 tokens to the Group Fund. Decisions must be made in whole tokens. That is, each person can add 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 tokens to the Group Fund (see screenshot 1).

Three examples illustrate how the tokens moved to the Group Fund relate to the value of your Individual and Group Funds.

- If you add 0 tokens to the Group Fund, it means you add 0 ($0 \times 1.8 = 0$) ECUs to the Group Fund and 10 ECUs remain in your Individual Fund.
- If you add 5 tokens to the Group Fund, it means you add 9 ($5 \times 1.8 = 9$) ECUs to the Group Fund and 5 ECUs remain in your Individual Fund.
- If you add 10 tokens to the Group Fund, it means you add 18 ($5 \times 1.8 = 18$) ECUs to the Group Fund and 0 ECUs remain in your Individual Fund.

Feedback and Earnings

After all participants have made their decisions for the round, the computer will tabulate the results.

$$\textbf{ECUs in Group Fund} = \textbf{1.8} \times \textbf{(Sum of tokens in the Group Fund).}$$

ECUs in the Group Fund will be divided equally among all individuals in the group. That is, each group member will receive one-third of ECUs in the Group Fund. Your earning in one round equals ECUs in your Individual Fund plus one-third of ECUs in the Group Fund.

$$\textbf{Your Earnings} = \textbf{ECUs in Individual Fund} + \tfrac{1}{3}\ \textbf{ECUs in Group Fund}$$

At the end of each round, you will receive information on your Group Fund earnings and your total earnings for that round. You will also be informed of all group members' contribution to the Group Fund and their earnings in ECUs

Total Earnings for the experiment will be the sum of the earnings in all rounds of the experiment.

This completes the instructions for Sequence 1.

Before we begin the experiment, to make sure that every participant understands the instructions, please answer several review questions on your screen.

SEQUENCE 2 (Decision round 11-20)

Sequence 2 consists of ten decision rounds. In each round, you will be in a group with two other people, but you will not know which of the other two people in this room are in your group. The people in your group will change from round to round, and in particular you will never be matched with the same set of two other participants twice during the whole experiment.

At the beginning of each round, you will be randomly allocated a participant identification letter, either A, B, or C. (Thus, your identification letter may change from round to round).

Decision Task in Each Round

Each individual begins EACH ROUND with an endowment of 10 tokens in their Individual Fund. **Tokens in Individual Fund worth 1 ECU each.**

Each decision round will have two phases.

Phase 1: Decision Choice

Decision choice will be the same as in Sequence 1. Each three-person group begins with a Group Fund of 0 ECUs each round. Each person will decide independently and privately whether or not to contribute any of his/her tokens from his/her own Individual Fund into the Group Fund. **Tokens in Group Fund worth 1.8 ECU each.**

In other words, each token that a person adds to the Group Fund reduces the value of his/her Individual Fund by 1 ECU. Each token added to the Group Fund by a group member increases the value of the Group Fund by 1.8 ECUs.

Each person can contribute up to a maximum of 10 tokens to the Group Fund. Decisions must be made in whole tokens. That is, each person can add 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, or 10 tokens to the Group Fund.

Phase 2: Allocation Choice

After all individuals have made their decisions in Phase 1, you will be informed of the other two group members' contribution to the Group Fund, the total number of tokens and ECUs in the Group Fund.

ECUs in Group Fund = 1.8 $\times$ (Sum of tokens in the Group Fund)

You decide how to allocate ONE-THIRD of the ECUs in the Group Fund between the other two group members.In other words, the sum of your allocation between the other two group members will be one-third of ECUs in the Group Fund. Each person can only divide one-third of ECUs in the Group Fund for the other two group members, their own share of the Group Fund will be determined by the allocation decisions of the other two group members. Specifically,

- Person A will divide one-third of ECUs in the Group Fund between Person B and Person C.
- Person B will divide one-third of ECUs in the Group Fund between Person A and Person C.
- Person C will divide one-third of ECUs in the Group Fund between Person A and Person B.

You may change your choice as often as you like. But once you click Submit, the decision will be final. Click the calculator button on the lower-right corner if you need the assistance of calculation.

Feedback and Earnings

After all individuals have made their decisions for the round, the computer will tabulate the results. A person's share of the Group Fund will be determined at the end of phase 2. ***His/her earnings from Group Fund*** *will be the sum of ECUs that the other two group members allocate towards him/her.*

Your earnings in a round will equal ECUs in your Individual Fund plus ECUs the other two group members allocated to you (i.e., your share of ECUs in the Group Fund).

Your Earnings=ECUs in Individual Fund + Your share of ECUs in Group Fund

At the end of each round, you will receive information on your Group Fund earnings and your total earnings for that round. You will also be informed of all group members' contribution to the Group Fund, their allocation decisions in phase 2 and their earnings in ECUs for that round.

Total Earnings for the experiment will be the sum of the earnings in all rounds of the experiment.

This completes the instructions.

Before we resume the experiment, to make sure that every participant understands the instructions, please answer several review questions on your screen.