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# Are cooperators efficiency- or fair-minded? Evidence from a public goods experiment

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## Abstract

We use a two-person public goods experiment to distinguish between efficiency and fairness as possible motivations for cooperative behavior. Asymmetric marginal per capita returns allow only the high-productivity player to increase group payoffs when contributing positive amounts. Asymmetric contributions, however, yield unequal individual payoffs. To assess *a priori* cooperative preferences, we measure individual 'value-orientations' by means of the decomposed game technique. Overall, our results indicate that fairness (or inequality aversion) is more influential than efficiency in driving behavior.

*JEL Classification:* A13; C92; D63; H41

*Keywords:* Public goods experiments; Conditional cooperation; Fairness; Efficiency; Value orientations

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## 1 Introduction

In public goods experiments, a significant number of individuals contribute more than what would be implied by material self-interest (see, e.g., Ledyard, 1995; Ostrom, 2000). A plausible explanation for such behavior is the existence of conditional cooperators, i.e., individuals who are willing to contribute as long as others also contribute or are expected to do so (Fischbacher et al., 2001). Several experiments reveal that behavior is geared towards the average contribution of the other group members (see, e.g., Keser and van Winden, 2000; Brandts and Schram, 2001; Fischbacher et al., 2001; Fischbacher and Gächter, 2006; Chaudhuri and Paichayontvijit, 2006; Croson, 2007). On the other hand, contributing at least as much as the minimal contribution of the others is theorized by Sugden (1984) and tested by Levati and Neugebauer (2004). Fischbacher et al. (2001) view conditional cooperation as either a motivation in itself or a consequence of fairness preferences like inequality aversion or reciprocity.<sup>1</sup>

Efficiency (measured by the sum of individual payoffs) constitutes a competing explanation for non self-interested behavior. A handful of experimental studies investigate whether people act on efficiency motives. Some (such as Kritikos and Bolle, 2001; Andreoni and Miller, 2002; Charness and Rabin, 2002; Engelmann and Strobel, 2004) find that a substantial proportion of individuals in dictator-like games prefer efficiency over equality in payoffs.<sup>2</sup> Others suggest that efficiency becomes a much less important motive when it requires high monetary sacrifice (Güth et al., 2003; Okada and Riedl, 2005).

In this paper, we attempt to disentangle conditional cooperation from efficiency as motives for voluntary contributions. We focus on inequality aversion as the determinant of conditionally cooperative behavior, and create a sharp

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<sup>1</sup>These “non-standard motivations” have received considerable attention as explanations for cooperative behavior (see, among others, Sugden, 1984; Rabin, 1993; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Dufwenberg and Kirchsteiger, 2004; Falk and Fischbacher, 2006).

<sup>2</sup>Note, however, that in these studies preferences for efficiency (i.e., being willing to sacrifice a portion of own payoff to increase social welfare) do not always require to put oneself at a relative disadvantage. Actually, Andreoni and Miller (2002) refer to such preferences as “rational altruism”.

trade-off between preferences for equality and preferences for efficiency. In line with Bolton and Ockenfels (2006), who look at this issue in the context of a majority voting game, we examine the efficiency-equity trade-off from an empirical point of view. Thus, rather than inquiring about what is socially best, we explore what people prefer between efficiency and equality when each decision affects one's own pecuniary payoff.

The central feature of our design is the implementation of asymmetric marginal per capita returns to the public good so that only one player's contribution can increase social welfare, but at the expense of a less egalitarian income distribution.<sup>3</sup> Furthermore, we select the heterogeneous marginal returns to the public good so that their sum is less than the marginal benefits from free-riding. In this way, full-contribution by all group members is never more profitable than universal defection, and those who should rationally and efficiently free ride have no strategic incentives to contribute in order to induce a reciprocity-minded high-productivity fellow member to contribute.

In our setting, the players' decisions can, in principle, be driven by three main factors: one's own monetary payoff (i.e., opportunism), the group's total payoff (i.e., efficiency), and payoff equality among fellow members (i.e., fairness). If people care about efficiency, then every contribution vector minimizing absolute differences in payoffs is dominated by the uneven contribution vector where the most productive agent contributes fully and the others contribute zero. On the other hand, equal contribution decisions result in an egalitarian payoff distribution. Thus, people concerned about income inequalities would prefer to conditionally cooperate, irrespective of efficiency. Due to the absence of incentives for strategically-motivated other-regarding behavior, this asymmetric public goods game helps explore the relative impact of fairness and efficiency on voluntary contributions.

The game we use resembles the dictator dilemma game introduced by Ock-

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<sup>3</sup>For an empirical study of such a public good scenario, see the Japanese fishery case discussed in Gaspart and Seki (2003).

enfels (1999) and subsequently employed by, e.g., Andreoni and Miller (2002) and Güth et al. (2003).<sup>4</sup> Both our asymmetric public goods game and the dictator dilemma create a trade-off between efficiency and inequality aversion. Yet, while the dictator can increase social surplus (until a certain level) without putting herself at a relative disadvantage, this is not possible for the most productive individual in our game: if the latter cares about efficiency and contributes more than her fellow members, then she must *necessarily* accept a relatively unfavorable payoff.

To the best of our knowledge, mere preferences for efficiency (in isolation from other confounding factors) have not been explicitly addressed in public goods games, although there are some studies that examine the relative importance of different motives behind cooperation in voluntary contribution games. For instance, Bardsley and Sausgruber (2005) propose a novel experimental design to distinguish reciprocity from conformity<sup>5</sup> as determinants of conditional cooperation (which they call “crowding-in”). In their sequential public goods experiment, some subjects, before deciding, observe the behavior of their own group and of a “payoff-irrelevant group”. Conformity is detected if subjects’ contributions correlate positively with contributions in the payoff-irrelevant group. Their results suggest that conformity is behaviorally relevant, though less than reciprocity. Staffiero (2006) tests the relative performance of inequality aversion and reciprocity by using a two-person public goods game followed by a distribution game in which one member of the pair can either increase or decrease her partner’s payoff. His data support inequality aversion as the main force driving cooperation.

To obtain information about the intrinsic social preferences of our subjects, prior to the public goods game, we measure individual “value orientation” (i.e., the weight an agent attaches to her own well-being in comparison to the

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<sup>4</sup>In dictator dilemma games, the recipient receives more than the dictator donates.

<sup>5</sup>Conformity implies that others’ behavior serves “as a guide to what is socially or morally appropriate” (Bardsley and Sausgruber, 2005, p. 665).

others' well-being) by means of the decomposed game technique (Griesinger and Livingston, 1973; Liebrand, 1984).<sup>6</sup>

The rest of the paper is organized as follows. Section 2 provides details about our asymmetric public goods game. Section 3 is devoted to the experimental design. Section 4 reports the results of our experimental study. Section 5 summarizes our central findings and concludes.

## 2 The asymmetric public goods game

Consider a group  $I$  of  $n$  ( $\geq 2$ ) individuals who interact for  $t = 1, \dots, T$  periods. In each period  $t$ , individual  $i \in I$  is endowed with income  $e$ , which can be either privately consumed or contributed to a group activity. Let  $c_{i,t}$  denote player  $i$ 's contribution in period  $t$ , with  $c_{i,t} \in \{0, 1, 2, \dots, e\}$ . For every contribution vector  $\mathbf{c}_t = (c_{1,t}, \dots, c_{n,t})$ , the monetary payoff of player  $i$  (for all  $i \in I$ ) depends linearly on choices as follows:

$$u_{i,t}(\mathbf{c}_t) = \beta(e - c_{i,t}) + \sum_{j=1}^n \alpha_j c_{j,t}. \quad (1)$$

Here,  $\beta$  is the marginal benefit of every token not contributed, and  $\alpha_j$  is  $j$ 's marginal benefit of every token contributed or, equivalently, the positive marginal externality generated by player  $j$ 's contribution on player  $i$ 's payoff. In line with standard linear public goods games, we assume  $\beta$  to be the same for all  $n$  players. But, contrary to the standard set-up, we suppose that  $\alpha_j$  varies with  $j$  due, for instance, to differences in productivity.<sup>7</sup> By imposing  $\alpha_i < \beta$  for all  $i \in I$ , the dominant strategy for a selfish, payoff-maximizing player is to contribute nothing. This is also the per-period level of contribution predicted

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<sup>6</sup>Because the decomposed game is an internally consistent measure (Liebrand and Van Run, 1985), it provides a reliable tool for assessing social value orientations. Parks (1994) illustrates the predictive abilities of social values in public goods games.

<sup>7</sup>Previous linear public goods experiments allowing for heterogeneity in the marginal per capita return include Brookshire et al. (1993), Fisher et al. (1995), Brandts and Schram (2001), and Goeree et al. (2002). An experiment investigating the effect of asymmetric preferences in a non-linear environment is provided by Chan et al. (1999).

by the unique subgame perfect equilibrium for the finitely repeated game.

Because our aim is to investigate how much agents value efficiency as opposed to conditional cooperation, we need a framework where the two motivations for contributing are mutually exclusive. To that end, we suppose that  $n\alpha_h > \beta$  holds for player  $h \in I$ , whereas  $n\alpha_l < \beta$  is true for all other players  $l \in I$ , with  $l \neq h$ . As a consequence, the social optimum (maximizing the group's payoff) requires the most productive player  $h$  to contribute all her endowment and all the least productive players  $l$  to contribute zero. The efficiency criterion excludes, therefore, conditionally cooperative behavior.

In a repeated-game context, strategic reasoning (Kreps et al., 1982) may lead low-productivity players  $l \in I$  to contribute positive amounts in order to induce a reciprocity-minded, high-productivity partner  $h \in I$  ( $h \neq l$ ) to contribute as well. To rule out strategic play, we simply impose  $\sum_{j=1}^n \alpha_j < \beta$ . This implies that, if all players contribute an additional token, they are worse off than by keeping the token for themselves. The underlying preferences for cooperation (if any) are therefore not confounded by strategic manipulation on the part of those who gain from the existence of reciprocators in the population.

A reason for responding to positive contributions with a positive own contribution is fairness. In line with Fehr and Schmidt (1999), we capture the notion of fairness by absolute differences in payoffs. In the game described above, it is easy to verify that all symmetric contribution vectors (with  $0 \leq c_{i,t} = c_{j,t} \leq e$  for all  $i, j \in I$ ) are sustainable as equilibria if players want to minimize differences in payoffs, and this is common knowledge. Suppose, for instance, that  $c_{h,t} = e$ . Then, the only contribution level allowing players  $l$  to reduce inequality in payoffs is  $c_{l,t} = e$  for all  $l \neq h$ . Thus, in our asymmetric public goods game, conditional cooperation can result from preferences for equality.

Since, on the one hand, the unevenly distributed efficiency gains are unacceptable to fair-minded (i.e., inequality averse) individuals and, on the other hand, an equal payoff distribution is not viable for efficiency-minded players, our



experiment allows for a direct comparison of fairness and efficiency as the two main forces driving voluntary contributions. In particular, if subjects are found to conditionally cooperate, this would speak in favor of fairness as opposed to efficiency. If, instead, the high- (low-) productivity players are observed to positively contribute (to free-ride), this would not only mean that people prefer efficiency over equality in payoffs, but also that equality in payoffs is not the main motivation leading to conditional cooperation.

### 3 The experiment

The computerized experiment was performed at the experimental laboratory of the Max Planck Institute in Jena using the z-Tree software (Fischbacher, 2007). A total of five sessions were conducted, involving 118 undergraduate students at the University of Jena (one session with 22 participants and each of the other four sessions with 24). Each session consisted of two different experiments. Individual value orientations were assessed in the first experiment. The asymmetric linear public goods game, described in Section 2, was played repeatedly in the second experiment. The instructions distributed at the beginning informed participants that they would take part in two separate experiments, and explained the rules of the first experiment only.<sup>8</sup> In both experiments amounts were denoted by ECU (Experimental Currency Unit), where 10 ECU = €1. The average payoff, earned in about  $1\frac{1}{2}$  hour, was €16.78 (including a show-up fee of €2.50).

#### 3.1 Design of the preference elicitation experiment

In the first experiment, the decomposed game technique (Liebrand, 1984; Offerman et al., 1996; Park, 2000; Brosig, 2002) was used to assess an individual's value orientations. Participants played 24 decomposed games. In each game,

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<sup>8</sup>A translation of the German instructions for both experiments can be found in Appendix A.

they were asked to choose between two options. Each option assigned a certain amount of money to the decision-maker, the own payoff  $x$ , and a certain amount to another participant, the other payoff  $y$ . These two options were two adjacent vectors of 24 equally spaced vectors on the circle  $x^2 + y^2 = 15^2$  (i.e., centered at the origin  $(0, 0)$  and with a radius of 15 monetary units). For example, participants were asked to choose between Option A =  $(13.00, 7.50)$  and Option B =  $(14.50, 3.90)$ , where the former allocated 13.00 ECU to oneself and 7.50 ECU to the other, and the latter allocated 14.50 ECU to oneself and 3.90 ECU to the other. The 24 decision problems we used are listed in Appendix B and are identical to the problems in Park's (2000) decomposed game experiment.

Subjects did not know the identity of the person whom they were paired with, but they knew that this partner would remain the same throughout the 24 choices. To avoid strategic considerations, the subjects did not receive any feedback on the other's decisions. They were told that after all 24 decision problems, the computer program would randomly form pairs and calculate total earnings for each participant. Since the payoffs attained in the decomposed game experiment might affect behavior in the public goods game, information on the first experiment's earnings was disclosed only at the end of each session.

Adding up the 24 chosen vectors yields an estimate of the importance given to the own payoff and to the other's payoff, i.e., of the agent's preferred motivational vector. Using a standard classification procedure developed for this technique, individuals with an observed motivational vector lying between  $-112.5^\circ$  and  $-67.5^\circ$  are classified as "aggressive" (i.e., minimization of other's payoff); with a vector between  $-67.5^\circ$  and  $-22.5^\circ$  as "competitive" (i.e., maximization of the difference between own and other's payoff); with a vector between  $-22.5^\circ$  and  $22.5^\circ$  as "individualistic" (i.e., maximization of own payoff); with a vector between  $22.5^\circ$  and  $67.5^\circ$  as "cooperative" (i.e., maximization of the sum of own and other's payoff); and with a vector between  $67.5^\circ$  and  $112.5^\circ$  as "altruistic" (i.e., maximization of other's payoff). The length of the motivational vector

serves as an index for a subject's consistency, i.e., it indicates whether the alternatives selected by the subject are the closest to her motivational vector. If the subject makes 24 consistent choices, the vector length is 30. If she chooses randomly, the vector length is zero. Thus, the vector length as a percentage of 30 (the maximal value) provides a measure of a subject's consistency.<sup>9</sup>

### 3.2 Design of the public goods experiment

In the public goods experiment, groups of size two interacted for 12 periods in a partner design (i.e., pair composition never changed). Each member of the pair was either a high-productivity player or a low-productivity player in all periods, yielding a total of 59 independent observations per  $\alpha$ -value. We set  $n = 2$  in order to keep things simple: groups of minimal size permit a straightforward test of our research question, avoiding controversial issues such as which relevant reference contribution of the group (the minimal, the average or the maximal) drives a conditional cooperator's behavior, and which reference group (the entire group or one's own peers only) is used by inequality averse individuals to assess their optimal distribution of payoffs.<sup>10</sup> The pecuniary payoff function explained to the subjects was Equation (1) with  $e = 10$  ECU,  $\beta = 1$ ,  $\alpha_h = 0.7$  and  $\alpha_l = 0.2$ .<sup>11</sup>

We made sure that the rules were understood by means of a control questionnaire that subjects had to answer in order for the public goods experiment to start. Since contributions were restricted to integer values, we could provide subjects with a table showing their payoffs depending on their own contribution and the contribution of their partner. Furthermore, to familiarize participants with the game and its incentives, we ran six practice periods without inter-

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<sup>9</sup>See Brosig (2002) for a more detailed description of the decomposed game technique.

<sup>10</sup>While these issues are theoretically relevant, keep in mind that our goal is to disentangle motives for (conditional) cooperation. Groups of size two suffice for our purpose and allow to make clear predictions.

<sup>11</sup>Notice that  $\alpha_h + \alpha_l = 0.9 < \beta = 1$ , so that  $u_i(e, e) = 9 < u_i(0, 0) = 10$ . Consequently, the least productive player  $l$  has no incentive to strategically contribute in order to induce the most productive player  $h$  to do the same.

action: the computer program randomly determined the other's decision, and participants received no payment for these training periods.

Given our parameters values, we can easily derive a set of theoretical predictions under the assumption that the other player's preferences are commonly known. If both players care for efficiency, then  $c_{h,t} = e$  and  $c_{l,t} = 0$ . If the high-productivity player  $h$  cares for efficiency and the low-productivity player  $l$  is inequality averse, the resulting contribution vector is  $\mathbf{c}_t = (0, 0)$ : player  $l$ 's inequality aversion induces the efficiency-minded player  $h$  to contribute zero because any other contribution would result in lower aggregate payoffs. The same prediction, that is  $\mathbf{c}_t = (0, 0)$ , holds in case of inequality averse player  $h$  and efficiency-minded player  $l$ , but inverting players' position in the derivation of the final outcome. Finally, if both players are inequality averse, all symmetric contribution vectors (with  $0 \leq c_{h,t} = c_{l,t} \leq e$ ) are possible solutions to the game, with  $c_{h,t} = c_{l,t} = 0$  being Pareto-dominant.

## 4 Results

In reporting our results we proceed as follows. First, we classify subjects according to their decision profile in the decomposed game experiment and analyze the contributions of the identified types. Then, we examine cooperation levels of low- and high-productivity players.<sup>12</sup> Finally, we try to identify patterns of conditional cooperation by investigating the relationship between changes (if any) in individual contribution behavior and deviation from the partner's contribution in the previous period.

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<sup>12</sup>All statistical tests in this part of the analysis rely on averages over periods and players for each pair as independent unit of observation.

#### 4.1 Classification by the decomposed game technique

In the decomposed game, all 118 subjects can be classified according to their behavioral types (i.e., no subject is found to choose randomly).<sup>13</sup> According to the classification scheme used, only one subject (0.85 percent) can be labeled altruistic: in the following public goods experiment, she is a low-productivity player. Fifty-four subjects (45.8 percent) are classified as cooperative: 26 are then low-productivity players and the remaining 28 are high-productivity players. Sixty-two subjects (52.5 percent) are classified as individualistic: 32 are low-productivity players and 30 high-productivity players. One subject (0.85 percent) is labeled competitive: she is then assigned to be a high-productivity subject. Aggressive types are not present in the sample under investigation. This distribution is in line with that detected in previous studies (Offerman et al., 1996; Park, 2000; Brosig, 2002).

Table 1 reports descriptive statistics on the contributions of the subjects with different value orientations. Cooperation levels are in general very low and the median contribution equals zero across all social value orientations. If compared to the standard results in public goods experiments showing that individuals, interacting finitely often, start out by contributing substantial amounts, the low contributions in our asymmetric game provide immediate support for the hypothesis that *pure* efficiency motives uncontaminated by other possible concerns are not the main force driving cooperation.

Insert Table 1 about here

Individualists contribute, on average, slightly more than cooperators, but the difference is not significant ( $p = 0.126$ ; two-sided Wilcoxon rank sum test). A lack of significant difference is detected even when we distinguish the two preference types according to their  $\alpha$ -value ( $p = 0.205$  for high-productivity coop-

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<sup>13</sup>Following Offerman et al. (1996, p. 827), random players are those subjects whose consistency measures are below 33%. The overall index of consistency in the experiment is about 93%.

erators vs. high-productivity individualists, and  $p = 0.362$  for low-productivity cooperators vs. low-productivity individualists; two-sided Wilcoxon rank sum test), and when we compare players with the same value orientation but different  $\alpha$ -values ( $p = 0.729$  for cooperators with  $\alpha_h = 0.7$  vs. cooperators with  $\alpha_l = 0.2$ ;  $p = 0.388$  for individualists with  $\alpha_h = 0.7$  vs. individualists with  $\alpha_l = 0.2$ ). Thus, although a considerable number of subjects are classified as cooperative in the decomposed games (meaning that they tend to maximize the joint payoff), such cooperators are not willing to bear alone the social cost of efficiency when being the high-productivity member of the pair.

### 4.2 Cooperation levels by $\alpha$ -value

We now turn our attention to the contributions of high- and low-productivity players (disregarding the above classification into types). High-productivity players contribute, on average, more than low-productivity players (0.78 vs. 0.56). However, a two-sided Wilcoxon signed rank test comparing the 59 average (independent) contributions in case of  $\alpha = 0.7$  with the corresponding 59 contributions in case of  $\alpha = 0.2$  does not allow rejecting the null hypothesis of equality ( $p = 0.159$ ).

Figure 1 displays the time paths of the average contributions of the high- and low-productivity players.

Insert Figure 1 about here

The first and the last periods are particularly interesting for our research question: the first period shows how subjects behave before receiving any feedback information about their partner; the last period shows how subjects decide when they have information about their partner's preferences. Wilcoxon signed rank tests (two-sided) indicate that there is no significant difference in contributions of high- and low-productivity players, neither in  $t = 1$  ( $p = 0.273$ ) nor in  $t = 12$  ( $p = 0.217$ ). However, comparing contributions by subjects with the

same  $\alpha$ -value in the first and the last period, the null hypothesis of equality cannot be rejected for participants with  $\alpha_h = 0.7$  ( $p = 0.668$ ), but it can be weakly rejected for participants with  $\alpha_l = 0.2$  ( $p = 0.053$ ). Figure 1 makes it clear that while low-productivity players' contributions tend to decline over periods, the same does not hold for high-productivity players. Hence, albeit players with  $\alpha_h = 0.7$  do not seem to be inclined to put themselves at a relative disadvantage (even if that would be efficiency enhancing), they can somewhat sustain their (low) levels of average contributions better than players with  $\alpha_l = 0.2$ .

### 4.3 Is there any conditional cooperation?

The analysis carried out so far suggests that people are more concerned with reducing differences in payoffs than with increasing social welfare. A key feature of our asymmetric public goods game is that conditionally cooperative behavior can be explained by preferences for equality but not by preferences for efficiency. Thus, to strengthen the previous findings we control for the potential amount of conditional cooperation in the public goods game.

Following Keser and van Winden (2000), we detect patterns of conditional cooperation by investigating whether and how individuals change their contribution between two consecutive periods in response to the difference between their own and their partner's contribution in the previous period. Figure 2 depicts the changes in one's own contribution ( $c_{i,t} - c_{i,t-1}$ ) as function of the deviations from the partner's contribution in the previous period ( $c_{i,t-1} - c_{-i,t-1}$ ), separately for high-productivity players and low-productivity players.<sup>14</sup> Table 2 summarizes the data by showing how often subject  $i$  reacts with an increase (column  $c_{i,t} > c_{i,t-1}$ ), a decrease (column  $c_{i,t} < c_{i,t-1}$ ) or no change (column  $c_{i,t} = c_{i,t-1}$ ) in her contribution having observed that her own contribution was above (situation 1), below (situation 2) or equal to (situation 3) the contribution of her partner in the previous period.

<sup>14</sup>We added some white noise to the plots in order to improve the visual presentation of overlapping data points.

Insert Figure 2 and Table 2 about here

Due to the large number of subjects contributing zero, more than half of the observations do not exhibit any change from one period to the next (almost 70 percent for both values of  $\alpha$ ). However, when a change does occur, it is in the direction of the other's contribution in the previous period: whatever their  $\alpha$ -value, subjects tend to decrease (increase) their contribution if it was above (below) that of their partner. It seems, therefore, that fellow members try to align their contribution, as suggested by conditionally cooperative behavior.

To complement this descriptive analysis and to corroborate the importance of conditional cooperation, Table 3 reports the results of a linear regression with the change in subject  $i$ 's contribution from one period to the next, i.e.,  $c_{i,t} - c_{i,t-1}$ , as dependent variable.<sup>15</sup> Regressors are the most recent deviation from the partner's contribution (i.e.,  $Dev_{t-1} = c_{i,t-1} - c_{-i,t-1}$ ), *Period* (which takes values 2 to 12), and the dummies  $\alpha$  and *Type*. The dichotomous variable  $\alpha$  equals 0 for low-productivity players and 1 for high-productivity players. *Type* refers to the classification in the decomposed games and takes value 0 for cooperators and 1 for individualists. The specification of the model includes the interaction of  $\alpha$  with  $Dev_{t-1}$ , which allows us to assess whether different values of  $\alpha$  affect how subjects react to observed deviations from their partner's contribution.

Insert Table 3 about here

The most recent deviation from the other's contribution affects negatively and significantly the change in contributions, confirming that conditional cooperation is important. The coefficient of  $\alpha$  is positive and significant, meaning that players with  $\alpha_h = 0.7$  show a more pronounced change in consecutive contributions than players with  $\alpha_l = 0.2$ . However, the estimated interaction

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<sup>15</sup>We employ a robust estimation of the variance to control for potential heteroscedasticity. Furthermore, the fact that the dependent variable is taken in differences provides a control for potential correlation of the errors at the individual and group level.



term reveals that the difference in productivity does not induce a different reaction to observed deviations. Individualists do not vary their contribution to a greater extent than cooperators. Finally, *Period* has a small but significant impact on the dynamics of period-to-period contributions. To sum up, the regression analysis provides further support for the hypothesis that participants in our experiment prefer to conditionally cooperate, thereby disliking inequality in payoffs.

## 5 Conclusions

Conditional cooperation is regarded as a plausible explanation for voluntary contributions in public goods settings often without considering the underlying preferences. Efficiency concerns, in terms of total payoffs or social surplus, may interact with the propensity of people to conditionally cooperate. In this paper we have provided a test of the relevance of *pure* efficiency motives in explaining voluntary contributions by creating a sharp trade-off between preferences for conditional cooperation and preferences for efficiency.

In our experimental public goods game, only one player's contribution can increase social surplus, but disadvantaging herself, and conditionally cooperative behavior can be observed only if people are concerned with income inequalities. A decomposed game experiment, prior to the public goods game, helped us to obtain an independent measure of the weight an individual attaches to her own welfare as compared to another person's welfare (or the individual's value orientation).

Both the contributions of the subjects with different value orientations and an independent analysis of conditional cooperation in the public goods experiment suggest that efficiency concerns are dominated by fairness concerns. Agents identified as cooperators in the decomposed games dislike putting themselves at a disadvantage when they are the high-productivity fellow member in

the following public goods game. This indicates that, although agents value maximizing joint payoffs, they are not willing to contribute positive amounts if they themselves do not gain from efficiency.

Due to the absence of ‘pure’ efficiency motives, contributions remain negligible throughout the experiment. This finding stands against the vast evidence on people’s cooperative behavior and, in our setting, is justified by the fact that zero-contribution is the Pareto-dominant solution if both members of a pair are fair-minded, i.e., inequality averse. The relevance of inequality aversion is supported by the good performance of conditional cooperation in our asymmetric public goods game: subjects – irrespective of their productivity – tend to decrease (increase) their contribution if it was above (below) that of their partner.

To sum up, our analysis suggests that ‘pure’ efficiency concerns (uncontaminated by other factors) do not play any role in explaining voluntary cooperation. Rather, behavior seems to be driven by conditional motives and, in particular, by egalitarian tendencies. This is in line with the findings of, e.g., Güth et al. (2003), Okada and Riedl (2005), and Staffiero (2006). Yet, it stands against the results of Kritikos and Bolle (2001), Andreoni and Miller (2002), Charness and Rabin (2002), and Engelmann and Strobel (2004), who, however, look at the issue in allocation games where increasing the others’ payoff does not always necessarily require to put oneself at a relative disadvantage.

When seen in the broad perspective of on-going studies on this issue, our results provide clarifications on the forces driving behavior in social dilemma situations, but at the same time call for further explorations. For instance, it would be interesting to see whether increasing the group size, and thus the social surplus created by the high-productivity player, changes the behavior of the latter: as her contributions would, in this case, substantially raise the group’s total payoff, the most productive group member may be less averse to stay “behind” her fellow members. Although our conclusions must be limited,

because we analyze data from only one experiment, they are suggestive of the necessity to moderate the (behavioral) tension between efficiency and equality when wanting to raise funds for public goods.

### **Acknowledgements**

We are indebted to Luis G. González and Frank P. Maier-Rigaud who provided us with valuable help on previous versions of the manuscript. We are also grateful to Werner Güth, Andreas Ortmann, Birendra Kumar Rai and participants at the GEW Conference in Prague for helpful comments.

## Appendix A: Experimental instructions

### General Instructions

Thank you very much for being here. You will receive €2.50 for having shown up on time. Today you will participate in two different experiments. The instructions for experiment I follow on this page. The instructions for experiment II will be distributed to you at the end of the first experiment. Please read the instructions – which are identical for all participants – carefully. During the experiment you are not allowed to talk to other participants. If you do not follow this rule, you will be excluded from the experiment and you will not receive any payment. Whenever you have a question, please raise your hand. An experimenter will then come to you and answer your question privately.

During both experiments, amounts will be denoted by ECU (Experimental Currency Unit). ECU are converted to euros at the following exchange rate: 1 ECU = €0.10. This means that 10 ECU = €1. The show-up fee of €2.50 and any additional amount of money that you will earn during the experiment will be paid out to you in cash at the end of today's session, i.e., after experiment II.

### Instructions for Experiment I

In this experiment, you must make a series of 24 choices involving money. For each of the 24 decision problems, you will have to choose between Option *A* and Option *B*. Each option specifies two different amounts of money:

- The amount under the label “Self” is the sum that you will either receive (in case of a positive amount) or pay (in case of a negative amount) yourself.
- The amount under the label “Other” is the sum that the participant with whom you are randomly paired will receive or pay.

Note that the person with whom you are paired does not change for all 24 decisions. You will never know the identity or the choices of the person with whom you are paired. Nor will the person with whom you are paired know your identity or your choices.

As you make choices, both you and the other participant will earn ECU. In each decision problem, you receive or pay the ECU that you assign to yourself plus the ECU that “the other” assigns to you.

### EXAMPLE

Suppose that you and the participant with whom you are paired must choose between

the following options:

Option A		Option B	
Self	Other	Self	Other
3.90	14.50	7.50	13.00

If you choose Option A, you will receive 3.90 ECU and the other will receive 14.50 ECU. If you choose Option B, you will receive 7.50 ECU and the other will receive 13.00 ECU. Suppose that both you and the other have chosen Option A. This means that you have assigned 3.90 ECU to yourself and the other has assigned 14.50 ECU to you. Thus, you would receive:  $3.90 + 14.50 = 18.40$  ECU. Likewise, the participant with whom you are paired has assigned 3.90 ECU to him/herself and you have assigned 14.50 ECU to him/her. Therefore, (s)he would receive:  $3.90 + 14.50 = 18.40$  ECU.

After all participants have made their 24 decisions, the computer program will randomly pair you with another participant. Your final earnings are determined by adding the amounts that you assign to yourself and the amounts that “the other” assigns to you in the 24 decisions. You will receive information about your earnings in this experiment at the end of today session, i.e. after completing experiment II.

*Please remain seated quietly until the experiment starts. If you have any questions, please raise your hand now.*

**Instructions for Experiment II**

Please take your time to read the instructions for experiment II at your own pace. If you have any questions while reading them, please raise your hand and one of the experimenters will come to your place.

Experiment II consists of 12 separate periods, in which you will interact with another participant. The two of you form a pair that will remain the same in all 12 periods. The identity of the participant in your pair will not be revealed to you at any time.

In each pair, there will be one “Red” person and one “Blue” person. You will learn your color at the beginning of the experiment. Colors are determined by chance and do not change; i.e., you will keep your color for the entire experiment.

At the beginning of each period, each participant receives 10 ECU. In the following, we shall refer to this amount as *your endowment*. Your task (as well as the task of the other member of your pair) is to decide how much of your endowment you want to contribute to a project. Your contribution decision must be an integer number

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between 0 and 10 ECU. Whatever you do not contribute, you keep for yourself (“ECU you keep”).

In every period, your earnings consist of two parts:

- (1) the “ECU you keep”; i.e.: your endowment *minus* your contribution;
- (2) the “income from the project”.

$\text{Your period-earnings} = \text{ECU you keep} + \text{Income from the project}$
--

The income from the project is determined as follows:

$\text{Income from the project} =$	$0.7 \times \text{Contribution of “Red”}$ $+$ $0.2 \times \text{Contribution of “Blue”}$
------------------------------------	--

- Each ECU that you keep yields money for you alone. That is, the other member of your pair does not receive anything for the ECU that you do not contribute.
- Each ECU that you contribute to the project increases “income from the project” by 0.7 ECU if you are Red or by 0.2 ECU if you are Blue. Since “income from the project” is the same for both members of a pair, each ECU that you contribute to the project raises your period-earnings as well as the period-earnings of your fellow member by 0.7 ECU if you are Red or by 0.2 ECU if you are Blue. The same holds for the contributions of the other member of your pair: Each ECU that (s)he contributes to the project, increases “income from the project” (and therefore your earnings) by 0.7 ECU if (s)he is Red or by 0.2 ECU if (s)he is Blue.

### EXAMPLE

[Blanks 1 and 2 in the example were filled out by randomly drawing two number slips from a bag with 11 slips, numbered 0–10.]

Suppose that you are Red and you contribute [blank 1: .....] ECU to the project. The other member of your pair (Blue) contributes [blank 2: .....] ECU to the project. Both you and the other member of your pair receive an “income from the project” of  $0.7 \times [\text{blank 1: .....}] + 0.2 \times [\text{blank 2: .....}] = [\text{blank 3: .....}]$ . The ECU you keep are:  $10 - [\text{blank 1: .....}] = [\text{blank 4: .....}]$ . Therefore your period-earnings are:  $[\text{blank 4: .....}] + [\text{blank 3: .....}] = [\text{blank 5: .....}]$ . The ECU that the other

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member of your pair keeps are:  $10 - [\textit{blank 2: .....}] = [\textit{blank 6: .....}]$ . Therefore his (her) period-earnings are:  $[\textit{blank 6: .....}] + [\textit{blank 3: .....}] = [\textit{blank 7: .....}]$ .

Attached to these instructions, you can find a payoff table that will help you in making your decisions. The rows of each table represent the number of ECU Red decides to contribute, the columns represent the number of ECU Blue decides to contribute, and its entries show the amount of ECU each member of the pair earns given Red's and Blue's contribution decision. If you are Red, your earnings are written in red. If you are Blue, your earnings are written in blue.

### *The information you receive at the end of each period*

At the end of each period, you will receive information about the number of ECU contributed by the other member of your pair as well as about your period-earnings.

### *Your final earnings*

Your final earnings will be calculated by adding up your period-earnings in each of the 12 periods. The resulting sum will be converted to euros and paid out to you in cash, together with your earnings in Experiment I and the show-up fee of €2.50.

Before the experiment starts, you will have to answer some control questions. Once everybody has answered all questions correctly, six practice periods will be played. During these six periods, you will not be matched with a person in this room, but with the computer that will randomly determine the other's decision. You will get no payment for these practice periods.

*Please remain seated quietly until the experiment starts. If you have any questions, please raise your hand now.*

## Appendix B: Decision problems in the decomposed game experiment

The following 24 dichotomous choices were presented to the subjects:

	Option <i>A</i>		Option <i>B</i>	
	<b>Self</b>	<b>Other</b>	<b>Self</b>	<b>Other</b>
1.	0.00	15.00	3.90	14.50
2.	3.90	14.50	7.50	13.00
3.	7.50	13.00	10.60	10.60
4.	10.60	10.60	13.00	7.50
5.	13.00	7.50	14.50	3.90
6.	14.50	3.90	15.00	0.00
7.	15.00	0.00	14.50	-3.90
8.	14.50	-3.90	13.00	-7.50
9.	13.00	-7.50	10.60	-10.60
10.	10.60	-10.60	7.50	-13.00
11.	7.50	-13.00	3.90	-14.50
12.	3.90	-14.50	0.00	-15.00
13.	0.00	-15.00	-3.90	-14.50
14.	-3.90	-14.50	-7.50	-13.00
15.	-7.50	-13.00	-10.60	-10.60
16.	-10.60	-10.60	-13.00	-7.50
17.	-13.00	-7.50	-14.50	-3.90
18.	-14.50	-3.90	-15.00	0.00
19.	-15.00	0.00	-14.50	3.90
20.	-14.50	3.90	-13.00	7.50
21.	-13.00	7.50	-10.60	10.60
22.	-10.60	10.60	-7.50	13.00
23.	-7.50	13.00	-3.90	14.50
24.	-3.90	14.50	0.00	15.00



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Table 1: Descriptive statistics on contributions by preference types

Value Orientation	$N^a$	Mean	Median	Std. dev.
Altruistic	12	0.417	0.000	1.443
Cooperative	648	0.480	0.000	1.453
Individualistic	744	0.860	0.000	1.802
Competitive	12	0.000	0.000	0.000
Aggressive	0	–	–	–
All	1416	0.675	0.000	1.651

<sup>a</sup>  $N$  denotes the number of observations.

Table 2: Number of times in which a subject reacts by increasing, decreasing or not changing her contribution given the situation observed in the previous period

<i>High-productivity players</i>			
Situation	$c_{i,t} > c_{i,t-1}$	$c_{i,t} < c_{i,t-1}$	$c_{i,t} = c_{i,t-1}$
1) $c_{i,t-1} > c_{-i,t-1}$	22	97	14
2) $c_{i,t-1} < c_{-i,t-1}$	37	6	67
3) $c_{i,t-1} = c_{-i,t-1}$	31	5	370
<i>Low-productivity players</i>			
Situation	$c_{i,t} > c_{i,t-1}$	$c_{i,t} < c_{i,t-1}$	$c_{i,t} = c_{i,t-1}$
1) $c_{i,t-1} > c_{-i,t-1}$	9	94	7
2) $c_{i,t-1} < c_{-i,t-1}$	41	9	83
3) $c_{i,t-1} = c_{-i,t-1}$	31	6	369

Table 3: OLS regression on changes in subject  $i$ 's contribution from one period to the next, i.e.,  $c_{i,t} - c_{i,t-1}$

Independent variables	Coefficient	Std. Error
Constant	-0.661**	0.221
$Dev_{t-1}$	-0.379***	0.052
$\alpha$	0.263**	0.089
$Type$	0.100	0.090
$Period$	0.030*	0.014
$\alpha \times Dev_{t-1}$	-0.105	0.082
Observations	1276	
Prob. $> \chi^2$	0.000	
$R^2$	0.270	

Note: Significance levels: \*\*\*  $\leq 0.001$ , \*\*  $\leq 0.01$ , \*  $\leq 0.05$ .

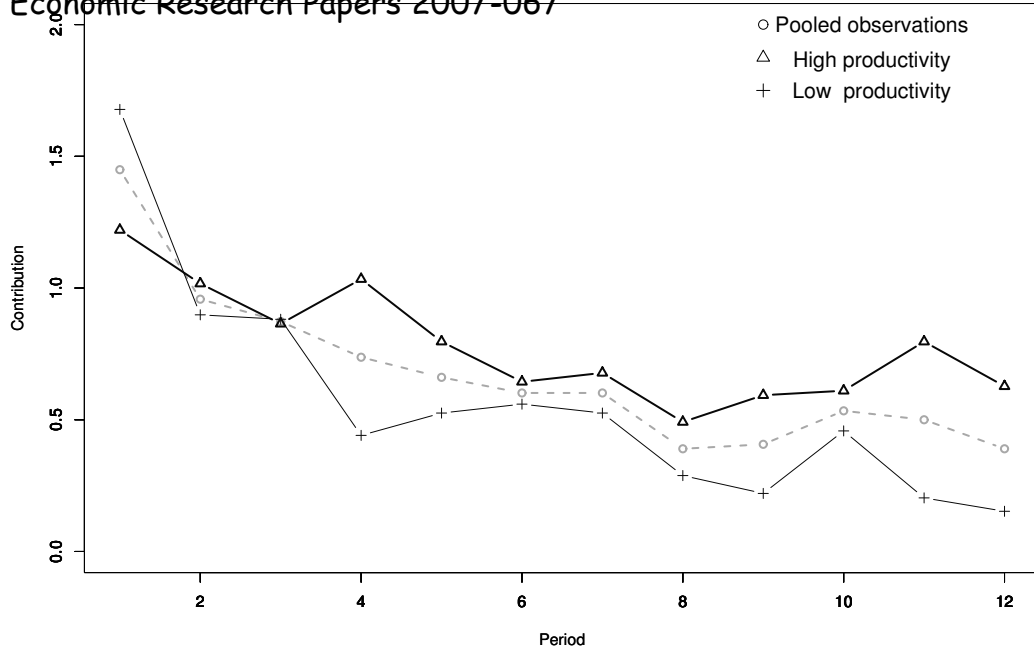
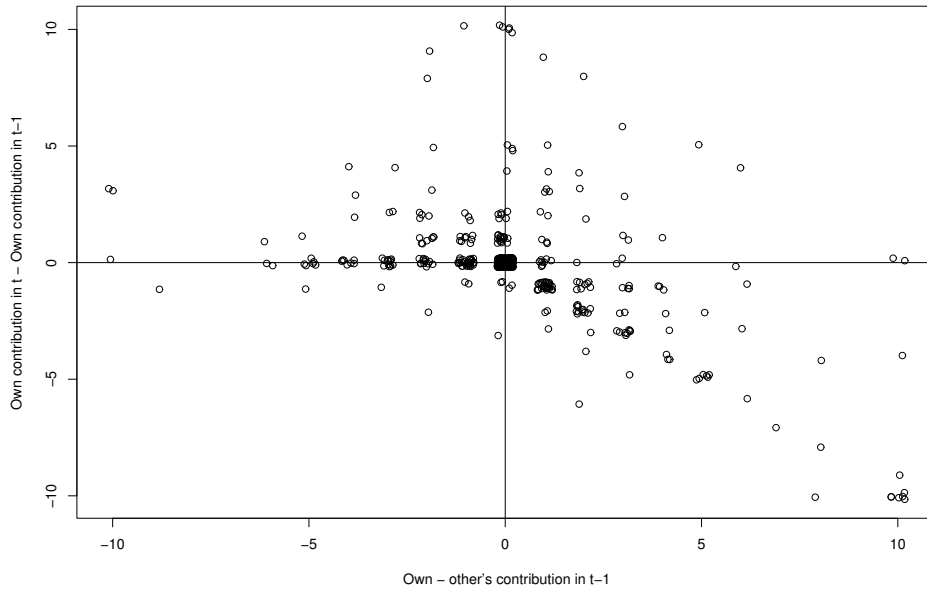


Figure 1: Time paths of average contributions separately for high- and low-productivity players as well as over all players.



2.a High-productivity players ( $\alpha_h = 0.7$ )



2.b Low-productivity players ( $\alpha_l = 0.2$ )

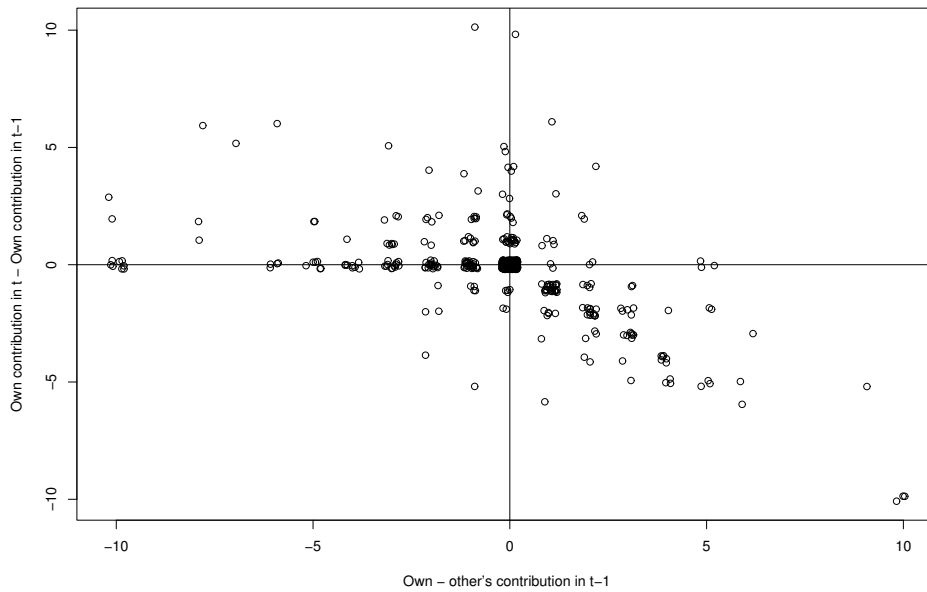


Figure 2: Changes in one's own contribution vs. previous deviations from the partner's contributions.