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Leadership and conditional cooperation in public good games: What difference does the game make?

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Abstract

We investigate experimentally whether the extent of conditional cooperation in public good games depends on the marginal return to the public good and type of game. The marginal return is varied from 0.2 to 0.4 to 0.8. The 'standard' game, in which three players contribute before a follower, is compared with a leader-follower game, in which one player leads and three follow. We find no strong evidence that the marginal return or type of game makes a difference to the extent of conditional cooperation. We also find no evidence that the type of game makes a difference to unconditional contributions. The level of marginal return does, however, have a strong effect on unconditional contributions. Our results highlight the critical role that can be played by leaders in a public good game.

Keywords: Public good, conditional cooperation, reciprocity, leadership.

JEL Categories: C72, H41.

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1. Introduction

With a simple and elegant public good experiment Fischbacher, Gächter and Fehr (2001) demonstrated the prevalence of conditional cooperation. They found that around half of their subjects could be classified as conditional cooperators, in the sense that own contribution was an increasing function of the average contribution of others. This compared to around a third of subjects classified as free-riders. These basic findings have proved robust to different contexts and countries (Kocher et al. 2008, Hermann and Thoni 2009, Martinsson, Pham-Khanh and Villegas-Palacio 2013). They are also of wide applied interest; they can help us understand, for example, dynamic changes in public good contributions (e.g. Keser and van Winden 2000, Fischbacher and Gächter 2010). Open questions remain, however, about the extent and implications of conditional cooperation. In this paper we shall consider three inter-related issues that have not been previously considered in the literature. We introduce each issue in turn.

Issue 1: In the original Fischbacher et al. (2001) study the marginal return from contributing to the public good was 0.4. Subsequent studies have considered different values of the marginal return and individual heterogeneity in the return, but only within the narrow range of 0.3 to 0.6 (Fischbacher, Schudy and Teyssier 2012, Kamei 2012. This leaves open the crucial question of what happens for small or large values. We know that unconditional contributions in public good games vary with the marginal return (Isaac, Walker and Thomas 1984, Isaac and Walker 1988). It seems, therefore, plausible that the extent of conditional contribution may also vary.

In section three of the paper we shall work with the Fehr-Schmidt model of inequality aversion (Fehr and Schmidt 1999) and demonstrate two distinct reasons why the marginal return may influence conditional cooperation. First, there may be a critical value of the marginal return below which they are not conditionally cooperative and above which they are. For example, when the marginal return is 0.4 the person may contribute zero irrespective, but when the marginal return is 0.8 they may perfectly match the average contribution of others. Second, the extent to which a conditional cooperator matches the average contribution of others may be increasing in the marginal return. For example, a person might go from contributing 50 percent of the average when the marginal return is 0.4 to 100 percent when the return is 0.8.

In section five of the paper we report on an experiment where the marginal return was varied between the 0.2, 0.4 and 0.8. This allows us to explore whether conditional cooperation systematically depends on the marginal return. We find some evidence for both types of influence discussed above. But the extent of the variation is small. Our interpretation of the experimental results is, therefore, that the extent of conditional cooperation is relatively stable across different values of the marginal return. Subjects were either conditionally cooperative or were not. Which, relating back to our theoretical results, means subjects were either relatively strongly inequality averse or they were not inequality averse. There was only weak signs of anything in between.

Issue 2: The original Fischbacher et al. (2001) study considered a game in which three people make an unconditional contribution before a fourth person makes a contribution conditional on the average of the earlier three. In application it is also interesting to consider an alternative game in which one player leads by example (e.g. Güth et al. 2007, Rivas and Sutter 2011). That is, to consider a game where one person makes an unconditional contribution before three people (or some other number) make a contribution conditional on the leader contribution. There are important differences between these two types of game. For example, in section three we shall show that less conditional cooperation may be expected in a leader follower game. Such differences would be vital to take account of when applying results on conditional cooperation.

Our experiment design allows us to compare behaviour in a leader follower game with that in the original game use by Fischbacher et al. (2001). We find that the type of game makes no difference to behaviour. This is a reassuring result in terms of application because it suggests that conditional cooperation is not overly dependent on specific details of the strategic environment. It does, however, raise interesting questions about how subjects reason though such games. We shall argue that our results are consistent with a 'two player' reasoning process in which 'everyone else in the game' is collapsed into a unique player. In a two player context the leader follower game and the original game used by Fischbacher et al. (2001) become equivalent.

Issue 3: The relationship between the unconditional and conditional contribution remains relatively unexplored. This, however, can inform on the underlying motivations behind a positive contribution. To illustrate the issue, suppose that a person knows to expect conditional cooperation from others. As we shall show this may incentivize her to make a large unconditional contribution (Cartwright and Patel 2010). Hence a 'free-rider' may make a large leader contribution. At the opposite end of the scale a conditional cooperator may contribute zero in the position of leader. *If* others contribute, a conditional cooperator is willing to reciprocate. This does not tell us he will contribute in the position of leader or that he expects others to contribute.

The possibility of strategic leadership has been mentioned in the literature (e.g. Güth et al. 2007, Gächter et al. 2012, Arbak and Villeval 2013). To fully explore the possibility, however, it is necessary to have relatively extreme values of the marginal return and a leader follower game. In exploring issues 1 and 2 discussed above we are, therefore, naturally able to explore issue 3. Our experimental results show significant effects. In particular, we find that the unconditional contribution is far more sensitive to the marginal return and type of game than the conditional contribution. This feeds through into a large effect on aggregate outcomes. We find, though, little evidence of strategic behaviour. For example, with a high marginal return it was optimal for a leader to contribute his full endowment but free-riders did not exploit this opportunity. Our results are consistent with those of Gächter et al. (2012) who find that more cooperative followers contribute more as leaders. And, with those of Leipold et al. (2013) who find that cooperative individuals are better at predicting the types of others. The distinguishing aspect of our results is that we obtain them in a more extreme environment.

The rest of the paper proceeds as follows. In section 2 we introduce the linear public good game. In section 3 we work through a model of inequality aversion. In section 4 we describe our experimental design. In section 5 we present our experimental results. In section 6 we conclude.

2. Linear Public Good Game

We shall consider the standard linear public good game. There are n members of a group who are each endowed with E units of a private good. Independently of each other they must decide how much of their endowment to contribute towards a public good. Let $x_i \in [0, E]$ denote the contribution of member i and let $X = \sum_i x_i$ denote total contributions. Total contributions to the public good are multiplied by factor $M > 0$ and split evenly amongst group members. Let $m = M/n$ denote the *marginal return on the public good*. The final 'monetary' payoff of member i is given by

$$u_i(x_1, \dots, x_n) = E - x_i + mX.$$

We consider two variants of the linear public good game that differ in the timing of decisions.

In a *leader-follower game* the timing is as follows: Member 1 decides how much to contribute to the public good. Having observed the contribution of member 1, group members 2 to n simultaneously and independently of each other decide how much to contribute. The followers (members 2 to n) can, thus, make their contribution conditional on the contribution of the leader (member 1).

In a *follower-average game* the timing is as follows: Members 1 to $n - 1$ decide simultaneously of each other how much to contribute to the public good. Having observed the mean average contribution of members 1 to $n - 1$, group member n decides how much to contribute. The follower (member n) can, thus, make her contribution conditional on the average contribution of the leaders (members 1 to $n - 1$).

In both games the strategy set of leaders and followers are identical. Leaders make an *unconditional contribution* and so a strategy simply consists of a contribution from set $[0, E]$. In explaining the strategy set of a follower, let L denote the *average leader contribution*. This is given by the contribution of the leader (in a leader-follower game) or the average contribution of leaders (in a follower-average game). Followers make a *conditional contribution* and so a strategy consists of a function c mapping from $[0, E]$ to $[0, E]$. In interpretation $c(L)$ is the contribution the follower will make if the average leader contribution is L. In experiments the value of L is typically rounded to the nearest integer. A strategy can then by represented by a *contribution table* with the $E + 1$ possible values of average leader contribution in one column and the followers contribution in a second column.

3. Theory

If $M < n$ then each group member maximizes his own monetary payoff by contributing zero to the public good. This familiar logic provides a simple prediction: A player maximizing own monetary payoff will contribute zero to the public good if $m < 1$. We know from the extensive literature on public good games that this prediction is not the end of the story. This is primarily because a positive contribution generates a positive externality for other group members. Specifically, if $M > 1$ then it is socially efficient for a group member to contribute E. We get a second prediction: A player maximizing group monetary payoff will contribute E to the public good if $m > 1/n$ and contribute zero otherwise.

According to these predictions the size of the marginal return should only influence choice around the $m = 1/n$ and $m = 1$ critical values. Whether the game is a leader-follower or follower-average game should make no difference at all. (Neither should it matter whether the member is a leader or follower). In the following we shall briefly work through a model where the size of marginal return and type of game are predicted to make a difference. We consider in turn the role of followers and leaders.

3.1 Conditional cooperation

The existing evidence suggests that a large proportion of followers will behave in a conditionally cooperative way. A 'strong' version of conditional cooperation is to exactly match the average leader contribution by setting $c(L) = L$ for all L.[1] Such behaviour may arise for a variety of reasons such as reciprocity or imitation. We shall consider here the possibility of inequality aversion. Specifically, following the approach of Fehr and Schmidt (1999), suppose that the payoff of member i is given by

$$u_i^s(x_1, \dots, x_n) = E - x_i + mX - \alpha_i \frac{1}{n-1} \sum_{j \neq i} max\{0, x_i - x_j\}$$
$$- \beta_i \frac{1}{n-1} \sum_{j \neq i} max\{0, x_j - x_i\}$$

where $0 \leq \beta_i < \alpha_i < 1$ are individual specific parameters. The monetary payoff of member i is, therefore, augmented by a social payoff that depends on how much the member's contribution, and therefore payoff, differs from that of the other group members.[2]

Let us first consider a follower-average game where the average leader contribution is L. The follower cannot discern individual contributions, because she only knows the average, but we assume she believes all leaders chose L. Given this assumption

$$\frac{du_i^s}{dx_i} = -1 + m + \beta_i$$

for all $x_i < L$. She, therefore, maximizes her payoff by contributing L if $\beta_i + m > 1$, and by contributing zero otherwise. There are two observations we would highlight here:

(Ob1) There is predicted to be some value of the marginal return $m_i^* = 1 - \beta_i$ above which the member will match the average leader contribution. Because β_i can take any value between zero and one the critical value of the marginal return can also take any value between zero and one.

(Ob2) Given that the value of β_i is individual specific different group members will likely have a different critical value of the marginal return above which they will match the average leader contribution.

These two observations suggests that any increase in the marginal return can increase the likelihood the follower will match the average-leader contribution. The previously distinguished critical values of $m = 1/n$ and $m = 1$ loose their importance. Indeed, a member who is strongly averse to inequality, $\beta_i > 1 - 1/n$, will match the average leader

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[1] As we shall see in the results section followers typically contribute somewhat less than the average leader contribution (see also Fischbacher and Gächter 2010). So, this is a simplifying assumption.

[2] As an intermediate step we can write the standard formulation

$$u_i^s(x_1, \dots, x_n) = E - x_i + mX - \alpha_i \frac{1}{n-1} \sum_{j \neq i} max\{0, u_j - u_i\} - \beta_i \frac{1}{n-1} \sum_{j \neq i} max\{0, u_i - u_j\}$$

and then substitute in contributions for monetary payoff.

contribution even if the marginal return is below the level at which it is socially efficient to contribute to the public good. We shall discuss this possibility more fully in Section 5.

Let us next consider a leader-follower game where the leader contribution is L. In this case the follower cannot discern the contributions that other followers will make. We, therefore, consider two possibilities. The first possibility is that she focuses solely on the leader contribution, about which she is perfectly informed. Given this assumption

$$\frac{du_i^s}{dx_i} = -1 + m + \beta_i \frac{1}{n-1}.$$

for all $x_i < L$. She, therefore, maximizes her payoff by contributing L if $\beta_i > (1-m)(n-1)$, and by contributing zero otherwise. The important thing to note here is that:

(Ob3) the critical level of the marginal return above which a follower will match the leader contribution is higher in a leader-follower game than follower-average game. This is because the follower is comparing her payoff to only one player compared to $n-1$ players in the follower-average game. The incentive to reduce inequality is thus diminished.

The second possibility we shall consider is that a follower tries to predict what other followers will do. Specifically, suppose she believes that each follower will contribute $F > 0$ with probability p and will contribute zero with probability $1-p$. Given this assumption

$$\frac{du_i^s}{dx_i} = -1 + m + \beta_i \frac{1}{n-1} + (p\beta_i - \alpha_i(1-p))\frac{n-2}{n-1}$$

for all $x_i < F$. Again, we see that unless $p = 1$ the critical level of the marginal return above which a follower will make a positive contribution is higher than in the follower-average game. We get, however, the further possibility:

(Ob4) the follower will contribute $F < L$ and, therefore, not fully match the leader contribution. While we omit the details it is clear that the amount followers will contribute is increasing in the value of the marginal return. This difference can be crucial given that a failure to match the leader contribution has been linked to declining contributions in public good games (Fischbacher and Gachter 2010).

In summary, we have seen that the level of marginal return and the type of game can plausibly influence the likelihood a follower will behave in a conditionally cooperative way. We have also seen that it can influence the extent to which a conditionally cooperative follower matches the leader's contribution. The model we have used is highly stylized (and models of inequality aversion are not without critics) but we feel these basic findings are not particularly specific to the model used: There are good reasons why the extent of conditional cooperation could depend on the marginal return to the public good and the specifics of the game being played.

3.2 Leader contribution

We turn next to the contribution of a leader. We shall assume that a leader expects some amount of conditional cooperation. Specifically, she expects that if the average leader contribution is L then each follower will contribute L with probability p and will contribute zero with probability $1-p$. For now we ignore the possibility that followers choose some fraction of L.

In a leader-follower game the expected payoff of a leader who chooses L is

$$u_i^s = E - L + m(L + p(n-1)L) - (1-p)\alpha_i L.$$

Thus, the leader maximizes her payoff by contributing the full endowment E if

$$m > \frac{1 + (1-p)\alpha_i}{1 + p(n-1)}$$

and by contributing zero otherwise. This provides two further observations:

(Ob5) There exists a critical value of the public good marginal return such that the leader has an incentive to contribute towards the public good. She does so because she recognises her contribution may have a positive effect on the contributions of others.

(Ob6) The more inequality averse is the leader, the higher is α_i, the higher is the marginal return below which she has an incentive to contribute zero. It may seem surprising that a more inequality averse leader will contribute zero. This follows naturally, however, from the inequality that a positive leader contribution can cause. The consequence can be a potential 'mismatch' between conditional and unconditional contribution. For example, someone who is not inequality averse, $\alpha_i = 0$, may make a positive contribution as a leader but not as follower. Conversely, someone is highly inequality averse may make a positive contribution as follower but not as leader.

Consider finally a follower-average game. In this case we need to specify what a leader expects the other $n-2$ leaders will do. In keeping with the previous assumptions we assume she expects each other leader will contribute E with probability p and will contribute zero with probability $1-p$. If, therefore, she contributes x_i the expected contribution of a conditionally cooperative follower is

$$F = \frac{x_i + pE(n-2)}{n-1}.$$

This implies the following trade-off

$$\frac{du_i^s}{dx_i} = -1 + m\left(1 + \frac{p}{n-1}\right) - (1-p)\alpha_i - p\alpha_i \frac{n-2}{(n-1)^2}$$

when $x_i < L$. We again obtain a critical value of the marginal return above which the leader has an incentive to contribute. We make, though, our final observation:

(Ob7) The critical value above which a leader has an incentive to contribute is higher in a follower-average game than leader-follower game. This primarily reflects the diminished influence of the leader. In a leader-follower game the leader has the chance to influence $n-1$ followers. In a follower-average game she can only influence one follower.

In summary, we have seen that the level of public good marginal return and the type of game can plausibly influence the likelihood a leader will make a positive contribution. We have also seen that a leader solely motivated by monetary gain has more incentive to contribute than a leader who is inequality averse. Again, we feel these basic findings are not overly dependent on the specific model used. There are good reasons why the contributions of a leader could depend on the marginal return to the public good and the specifics of the game being played.

4. Experimental design

We use the benchmark game of Fischbacher et al. (2001) as our starting point. This benchmark is a follower-average game where $n = 4, E = 20$ and $m = 0.4$. This benchmark game is compared with games where the marginal return is $m = 0.2$ or 0.8 and/or the game is a leader-follower game. This allows us to evaluate the consequences of the marginal return and the type of game.

To help explain the experimental design in more detail consider Table 1. As you can see each experimental session consisted of three distinct parts. In the first part of session 3 subjects played the benchmark game. In the second part of the session subjects played a follower-average game with the higher marginal return of $m = 0.8$, and in part 3 they played a follower-average game with the lower marginal return of $m = 0.2$. In all parts subjects were asked to choose an unconditional contribution and fill in a contribution table. This allows us to elicit the full strategy (Fischbacher et al. 2001, Fischbacher, Gächter and Quercia 2012). Session 4 differed from session 3 in the type of game. Sessions 1 and 2 differed in the sequence with which different marginal returns were used. This design allows a between subject comparison on the influence of the type of game and a within and between subject comparison on the influence of the marginal return.

Table 1: Experimental design

Session	Type of game	Part 1	Part 2	Part 3	Subjects
3	Follower-average	$m = 0.4$	$m = 0.8$	$m = 0.2$	31
4	Leader-follower	$m = 0.4$	$m = 0.8$	$m = 0.2$	25
1	Leader-follower	$m = 0.2$	$m = 0.4$	$m = 0.8$	19
2	Leader-follower	$m = 0.8$	$m = 0.2$	$m = 0.4$	21

Two points should be clarified as regards any possible order effect from a subject playing three games in sequence. First, subjects were only informed on the outcomes of each game at the end of the experiment; the outcome from one part could not, therefore, have influenced choice in subsequent parts. Second, subjects were not given the instructions for a part until the previous part had finished (they were given general guidance that the experiment would consist of three parts); choice in one part could not, therefore, have been influenced by the parts to follow. These two effects combined should diminish any order effects. We will, however, control for order in the analysis. We shall also pay attention to part 1, where order effects are not an issue.

In motivating the experimental design we highlight that the marginal return is compared across a deliberately large range. This will allow us to explore all the seven observations made in section 3. For instance, the marginal return of $m = 0.8$ is above the critical value at which the leader has an incentive to contribute in a leader-follower game (for reasonable estimates of p). The marginal return of $m = 0.2$ is such that the leader can have no incentive to contribute (whatever her estimate of p). We can, therefore, explore observations 5 and 6. Similarly, the marginal return of $m = 0.2$ allows us to see whether followers are conditionally cooperative even though it is socially inefficient to contribute to the public good. This allows us to fully explore observations 1 and 2.

A total of 96 subjects took part in the experiment recruited from across the University of Kent. The experiment took place in a computer lab using the software z-tree (Fischbacher 2007). The instructions were kept as close as possible to those used in previous studies and the language was deliberately neutral [full instructions are available in the appendix]. Each session took around 30 minutes and the average payment was £8.64.

5. Experimental results

We begin by noting that the results in the benchmark game (specific details shortly) were entirely in-keeping with those observed in previous studies. We shall, therefore, focus on the effect of the marginal return and type of game. We consider in turn the conditional and unconditional contribution.

5.1 Follower behaviour

For each of the three games that a subject played they are classified as one of four behavioural types: a conditional-cooperator, free-rider, hump-shaped contributor, or other. Subjects are classified following the approach of Fischbacher et al. (2001). A conditional co-operator has a Spearman rank correlation coefficient between own and average leader contribution significant at the one percent level. A free-rider contributes zero irrespective of average leader contribution. A hump-shaped contributor has positive Spearman rank correlation coefficient for low levels of average leader contribution and a negative coefficient for high levels of average leader contribution. We reiterate that a subject is classified for each of the three games they play. The same subject could, therefore, be classified as a conditional-cooperator in one game, free-rider in another, and so on. We shall return to this point below.

5.1.1 Proportion of behaviour types

Table 2 summarizes the proportion of subjects of each behavioural type for the six different games considered. It provides data for all parts and for part 1 of each session only. Recall our basic theoretical hypotheses were that the proportion of conditional cooperators would be weakly increasing in the value of the marginal return (Ob1 and 2) and weakly higher in the follower-average game (Ob3).

In interpreting the proportions in Table 2 we begin by focussing on the data for part 1 of a session. The differences between the follower-average game and leader follower game, for a marginal return of 0.4, are not statistically significant ($p = 0.9$, proportion test). Neither are those between a marginal return of 0.4 and 0.8 in the leader-follower game ($p = 0.7$). The proportion of conditional co-operators when the marginal return is 0.2 is significantly lower than that in the other three games ($p = 0.03$ and 0.06 for a one and two sided test respectively). It is still noteworthy, however, that conditional cooperation comfortably remains the modal behavioural type.

The picture remains similar if we look across all three parts of each session. The differences between the follower-average game and leader follower game, for a fixed marginal return, are not statistically significant ($p > 0.1$). Neither are the differences between a marginal return of 0.4 and 0.8 ($p = 0.3$ in the leader-follower game and 1.00 in the follower-average game). In the leader-follower game the difference between a marginal return of 0.2 and 0.4 is marginally significant ($p = 0.08$) but that between a return of 0.2 and 0.8 is not ($p = 0.48$). In the follower-average game the difference between a marginal return of 0.2 and that of 0.4 or 0.8 is significant (p = 0.02 in both cases). Again, however, we note that the proportion of conditional cooperators is still relatively high with a marginal return of 0.2.

Given that contributing to the public good is socially inefficient when the marginal return is 0.2 is may seem counter-intuitive to observe conditional cooperation. So let us briefly comment on this (and also remind that the issue was partially covered in Section 3). The first thing we would remind is that it is not in a follower's material interests to contribute to the public good unless the marginal return is above one. A positive contribution must, therefore, reflect a desire to reduce inequality, to reciprocate, to conform, or similar. This means that whether or not it is socially efficient to contribute is essentially irrelevant.[3] In particular, *if* the three leaders in a follower-average game make a positive contribution then they have benefited the follower: for every unit they contributed she gets 0.2. It is perfectly reasonable she would want to 'return the favour' and contribute herself.[4] This can help explain why conditional cooperation remains the most common behaviour type for a marginal return of 0.2. Whether or not leaders make a positive contribution for such a low marginal return is a question we shall address below.

Table 2: Proportion of subjects of each behavioural type for the six different games.

	Leader-follower game			Follower-average game		
All parts	$m = 0.2$	$m = 0.4$	$m = 0.8$	$m = 0.2$	$m = 0.4$	$m = 0.8$
Conditional cooperator	47.69	63.08	53.85	41.94	70.97	70.97
Free-rider	30.77	15.38	18.46	41.94	6.45	9.68
Hump-shaped	3.08	3.08	6.15	0.00	3.23	3.23
Other	18.46	18.46	21.54	16.13	19.35	16.13
Part 1						
Conditional cooperator	47.37	72.00	66.67		70.97	
Free-rider	21.05	12.00	0.00		6.45	
Hump-shaped	5.26	4.00	4.76		3.23	
Other	26.32	12.00	28.57		19.35	

Table 3 provides the results of two probit regressions in which the dependent variable is whether or not a subject was classified as a conditional cooperator. The results presented in first column use data from part 1 of a session and those presented in the second column use the data from all parts. For part 1 we see a marginally lower probability of conditional cooperation when the marginal return is 0.2. Interestingly, however, this difference does not show up in the data for all parts. Instead we see evidence of an order effect with conditional cooperation decreasing in parts 2 and 3 of a session.[5] Surprisingly, we see a negative coefficient for a marginal return of 0.8 in the leader follower game; this, though, may also be

[3] The marginal return on the public good reflects the 'price' of reducing inequality or reciprocating. So, a decrease in the marginal return may influence the decision to reciprocate. But, there is no 'discontinuity' around the marginal return, m = 0.25 in our case, at which contributing becomes socially efficient. This is captured in the analysis of section 3.

[4] It is also reasonable she would have preferred the leaders to contribute zero in order to avoid a costly round of 'gift giving'!

[5] An order effect was also noted by Fischbacher, Schudy and Teyssier (2012).

picking up an order effect. There does not appear any strong evidence that the marginal return or type of game matter.

As a final piece of evidence regarding conditional cooperation we can exploit the fact that each subject is observed playing a game for three different values of the marginal return. In total 34 of the 96 subjects were conditional cooperators in all three games. 16 subjects were conditional cooperators for a marginal return of 0.4 and 0.8 but not for a return of 0.2.[6] These are the most common and second most common patterns of behaviour. To put these numbers in perspective suppose that subjects were to independently decide in each part whether or not to be conditional cooperators. Then we would not expect 33 subjects to be conditional cooperators in all three games ($p < 0.001$). But, we could expect that 16 subjects would only be conditional cooperators for a return of 0.4 and 0.8 ($p = 0.26$). Thus, as intuition would suggest, someone who is conditionally cooperative for one level of marginal return is likely to be conditionally cooperative for another level. There is, though, no evidence the size of marginal return matters.

Table 3: Results of two probit regressions with conditional cooperator as dependent variable, using the data from part 1 or the full sample

	Part 1	All parts
Constant	0.552** (0.238)	1.068** (0.476)
0.2 return	-0.649* (0.392)	-0.839 (0.602)
0.8 return	-0.152 (0.389)	0.507 (0.474)
Leader-follower game	0.030 (0.359)	-0.095 (0.560)
0.2 return * Leader-follower game		0.139 (0.638)
0.8 return * Leader-follower game		-0.905* (0.519)
Part 2		-0.507* (0.303)
Part 3		-0.613* (0.338)
Number of observations	96	288

Note: Cluster robust standard errors in parentheses; *, **, *** denote significance at 10%, 5% and 1% respectively.

The basic picture seems to be that the marginal return and type of game make little difference to the proportions of behavioural types. There is some evidence of less conditional cooperation for a marginal return of 0.2, but conditional cooperation still remains relatively common. In order to reconcile this with the analysis of section 3 and our hypotheses we essentially need inequality aversion to be at one extreme or the other. Specifically, a subject with a high level of inequality aversion β_i will reciprocate for any marginal return of 0.2 or above. This is consistent with the modal behaviour of our subjects. By contrast, a subject with a low level of inequality aversion will not reciprocate even if the marginal return is 0.8. Potentially, we also observe subjects with an intermediate level of inequality aversion, who

[6] Of the remaining subjects: 24 were a conditional cooperator for at least one game while 17 were not a conditional cooperator in any game.

reciprocate when the marginal return is 0.4 but not 0.2, but the evidence if far from compelling.

5.1.2 Matching average leader contribution

To say that a person behaves as a conditional cooperator merely means her contribution is increasing in the average leader contribution. We now question to what extent subjects matched the average leader contribution. More precisely, for each subject and each game we regress own contribution on average leader contribution.[7] The resulting regression coefficient we call the *cooperation factor*. If the cooperation factor is one the subject matched one for one the average leader contribution. If the cooperation factor is 0.5 then the subject contributed, on average, half the average leader contribution. Recall (Ob4) our basic hypothesis is that the cooperation factor will be weakly increasing in the marginal return to the public good and weakly lower in a leader-follower game.

Table 4 summarizes the average cooperation factor of conditional cooperators for the six games, distinguishing between the results for part 1 of a session and all parts. None of the differences in part 1 are statistically significant. Looking over all parts differences do appear. Specifically, in the follower-average game the average cooperation factor for a marginal return of 0.2 is significantly lower than for a marginal return of 0.4 and 0.8 (p = 0.005 and 0.002 respectively). Also, the cooperation factor in a leader-follower game is significantly lower than in the follower-average game when the marginal return is 0.4 and 0.8 (p = 0.033 and 0.081 respectively). These differences are consistent with our basic hypothesis, but we need to rule out possible order effects.

Table 4: Average cooperation factor of conditional cooperators for the six games.

	Leader-follower game			Follower-average game		
	$m = 0.2$	$m = 0.4$	$m = 0.8$	$m = 0.2$	$m = 0.4$	$m = 0.8$
All parts	0.619	0.633	0.695	0.509	0.798	0.834
Part 1	0.773	0.642	0.731	-	0.798	-

Table 5 provides the results of four Tobit regressions in which the dependent variable is cooperation factor. For completeness we provide the results of regressions where all subjects are included and those where only conditional cooperators are included. Over the entire sample the cooperation factor is significantly lower with a marginal return of 0.2. Our primary interest, however, is in the cooperation factor of conditional cooperators. We see that the cooperation factor is lower with a marginal return of 0.2, higher with a marginal return is 0.8, and lower in a leader-follower game, but none of these differences are significantly.

One could argue that we see more systematic differences in terms of cooperation factor that we did the proportion of behaviour types. Overall, though, the basic picture again seems to be that the marginal return and type of game does not make much difference. Even for the low marginal return of 0.2 we have seen that conditional cooperation is the modal type of behaviour and that the cooperation factor of conditional co-operators is above 0.5. We shall

[7] There are 21 data points for each subject given that the average leader contribution is anything between 0 and 20. We also include a constant term in the regression.

discuss the interpretation and implications of this in more detail after looking at leader behaviour.

5.2 Leader behaviour

We turn now to the unconditional contribution. Table 6 details the average unconditional contribution for each game, also distinguishing across behaviour type. Recall our three basic hypotheses: the leader contribution will be weakly increasing in the marginal return (Ob5), it will be weakly higher in a leader-follower game (Ob7), and it will be weakly lower the more inequality averse the subject (Ob6). We shall focus for now on the first two of these hypotheses. The data in Table 6 is consistent with the first hypothesis but appears inconsistent with the second.

Table 5: The results of Tobit regressions with cooperation factor as the dependent variable.

	Part 1		Entire sample	
Cooperation factor	All subjects	Conditional cooperators	All subjects	Conditional cooperators
Constant	0.643***	0.904***	0.606***	0.938***
	(0.149)	(0.110)	(0.155)	(0.104)
0.2 return	-0.221	0.210	-0.483**	-0.180
	(0.278)	(0.194)	(0.192)	(0.116)
0.8 return	0.062	0.097	0.175	0.160
	(0.237)	(0.163)	(0.186)	(0.107)
Leader-follower game	-0.235	-0.197	-0.140	-0.149
	(0.219)	(0.148)	(0.198)	(0.130)
0.2 return * leader-follower			0.241	0.167
			(0.217)	(0.134)
0.8 return * leader-follower			-0.250	-0.074
			(0.212)	(0.121)
Part 2			-0.241**	-0.132*
			(0.109)	(0.067)
Part 3			-0.229**	-0.090
			(0.109)	(0.069)
Number of observations	96	63	288	164
F-test	1.00	0.73	35.95***	20.30***
Pseudo R^2	0.017	0.024		

Note: Cluster robust standard errors in parentheses; *, **, *** denote significance at 10%, 5% and 1% respectively.

In looking at the data in more detail let us start by focussing on part 1. The unconditional contribution in the leader-follower game when the marginal return is 0.8 is significantly higher than that when the marginal return is 0.2 or 0.4 (p = 0.03, 0.02 respectively). There is, though, no significant difference between the average contribution in the follower-average game compared to the leader-follower game (p =0.42). The story is similar if we look at the data from all parts. In the leader follower game the leader contribution with a marginal return of 0.8 is significantly higher than that with a return of 0.4 (p = 0.05), and the leader contribution with a marginal return of 0.4 is significantly higher than that with a return of 0.2 (p = 0.26).[8] Similarly, in the follower-average game the unconditional contribution with a marginal return of 0.8 is marginally higher than that with a return of 0.4 (p = 0.01), and the contribution with a marginal return of 0.4 is significantly higher than that with a return of 0.2 (p = 0.03). The differences between the leader-follower and follower-average game are, however, insignificant.

Table 6: Average un-conditional contribution overall and by type for the six different games.

	Leader-follower game			Follower-average game		
All parts	$m = 0.2$	$m = 0.4$	$m = 0.8$	$m = 0.2$	$m = 0.4$	$m = 0.8$
Overall average	3.85	6.34	8.49	2.84	7.23	9.97
Conditional cooperator	5.13	6.90	9.31	3.54	6.68	11.18
Free-rider	0.35	2.60	3.25	2.15	2.50	1.00
Hump-shaped	7.50	7.50	8.75	n/a	10.00	8.00
Other	5.75	7.33	10.86	2.80	10.33	10.40
Part 1						
Overall average	4.58	4.64	9.05		7.23	
Conditional cooperator	5.22	5.22	9.00		6.68	
Free-rider	1.50	0.00	n/a		2.50	
Hump-shaped	5.00	3.00	5.00		10.00	
Other	5.80	6.33	9.83		10.33	

Table 7 reports the results of two Tobit regressions in which the dependent variable is unconditional contribution. Consistent with the earlier results we see a strong effect due to the marginal return but only weak evidence of any effect due to the type of game.

Finally, we turn our attention to differences in unconditional cooperation across behaviour type. Recall (Ob6) that those who are least inequality averse may have most incentive to make a large leader contribution. The intuition being that a large leader contribution will lead to higher contributions but also increased inequality. To make this idea more concrete we can work out what the optimal unconditional contribution would have been for someone who purely wants to maximize own payoff.[9] The optimum was zero in all games except a leader-follower game with a marginal return of 0.8. In this game the optimal leader contribution was the full endowment of 20. A ‘selfish’ individual has, therefore, the incentive to make a large leader contribution.

[8] The difference between a marginal return of 0.2 and 0.8 is highly significant (p < 0.001) for both the leader-follower and follower-average game.

[9] That is, we look at expected payoff for all possible values of unconditional contribution given the actual conditional contributions that our subjects chose.

Table 7: The results of Tobit regressions with unconditional contribution as the dependent variable.

Unconditional Contribution	Part 1	All parts	All parts
Constant	6.368***	3.470*	4.166**
	(1.936)	(1.949)	(2.029)
Conditional Cooperator	0.626	3.657**	3.610**
	(1.829)	(1.705)	(1.703)
0.2 return	0.815	-4.871***	-7.715***
	(2.354)	(1.336)	(2.632)
0.8 return	6.808**	3.132***	2.833
	(3.051)	(0.924)	(1.854)
Leader-follower game	-4.408*	-0.504	-1.804
	(2.413)	(1.784)	(2.253)
0.2 return * leader-follower			3.750
			(2.958)
0.8 return * leader-follower			0.427
			(2.161)
Part 2		-0.695	0.778
		(1.055)	(1.272)
Part 3		-0.420	0.446
		(1.259)	(1.499)
Number of observations	96	288	288
LR chi2 test/F test	1.94	6.74***	5.06***
Pseudo R^2	0.017	0.027	0.028

Note: Cluster robust standard errors in parentheses; *, **, *** denote significance at 10%, 5% and 1% respectively.

The data in Table 6 shows no evidence of subjects taking advantage of this possibility. Across the board the unconditional contribution of conditional cooperators is higher than that of free-riders. In Table 7 we see, looking at the data from all parts, that conditional cooperators make a significantly higher unconditional contribution. This evidence is inconsistent with Ob6. It is, however, consistent with the previous literature. For example, Gächter et al. (2012) find that more cooperative followers make a larger leader contribution. This partly reflected a false consensus effect where cooperative leaders were more optimistic about followers. Likewise, Leipold et al. (2013) find that cooperative types are better at predicting what others will do. Note, however, that we are the first to consider a setting where the selfish interest is to contribute and so we reaffirm prior results in a quite extreme setting.

6. Conclusion

Our starting point for this paper was the seminal contribution of Fischbacher et al. (2001) on conditional cooperation. We wished to explore three related issues: (i) Whether the extent of conditional cooperation depends on the marginal return to the public good. (ii) Whether we observe different behaviour in a leader-follower game as compared to the follower-average game considered by Fischbacher et al. (2001). (iii) The connection between an individual's conditional and unconditional contribution.

We find that the marginal return to the public good makes a significant difference to the unconditional contribution: The contribution of leaders is increasing in the value of the marginal return. By contrast, we find little evidence that the marginal return makes a significant difference to the conditional contribution: The proportion of conditional cooperators and the cooperation factor is relatively stable across different values of the marginal return. In interpreting these findings note that differences in unconditional contribution, coupled with no difference in conditional cooperation, equates to a significant overall difference in contributions. With a low level of marginal return leaders give little and so followers give little. With a high level of marginal return leaders give more and so followers give more.

Once we note the critical role played by leaders it becomes easier to postulate why follower behaviour is more stable than leader behaviour. It seems as if followers essentially devolve responsibility to leaders. A conditional cooperator will reciprocate the contribution of the leader without taking too much account of the strategic incentives to contribute. This can be consistent with inequality aversion or reciprocity but equally may suggest conformity or imitation. The crucial point is that because the contributions of leaders does take some account of strategic incentives it is not unreasonable for followers to devolve responsibility in this way. They will not, for example, end up contributing much when the marginal return is below the level for which contributing is socially efficient.

In terms of the comparison between a leader-follower game and follower-average game we found no significant effect on behaviour. From a theoretical perspective this is a surprising result because the two games are quite different. In a leader-follower game, for example, the un-conditional contribution is more critical than in a follower-average game because the contributions of three, and not one, player are conditioned on it. This clearly may change the incentive to contribute. One explanation for why we observe no difference is that both games are seen as a 'two player game' in which all other players are collapsed into one representative player. With only two players the leader-follower and follower-average games become identical. Such a lack of sensitivity to the number of players has been noted in other contexts such as the minimum effort game (Weber et al. 2001). Whatever the cause, it will be useful in application if behaviour in a leader-follower game mirrors that in a follower-average game.

We have already noted the critical role played by leaders. If the behaviour of followers is not sensitive to the marginal return or details of the game then leaders effectively determine the outcome. Arguably, however, the literature has more to say about followers than leaders. It is only in recent years that attention has begun to focus more on the leader (Güth et al. 2007, Cartwright and Patel 2010, Rivas and Sutter 2011, Gächter et al. 2012, Arbak and Villeval 2013) and many questions remain unanswered. One issue we were able to explore a little in this paper is whether a 'strategic' leader can take advantage of conditional cooperation. Specifically, in a leader-follower game with a marginal return of 0.8 we found that it was the interests of a 'selfish' leader to contribute the full endowment towards the public good. As far as we are aware we provide the first public good experiment where such a possibility has arisen. We did not, however, find any evidence of 'free-riders' changing behaviour to take advantage of the different incentives. This is an issue we hope to explore in more detail in future work.

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