Economics Letters 71 (2001) 397–404

economics letters

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Are people conditionally cooperative? Evidence from a public goods experiment

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Received 19 July 2000; accepted 21 December 2000

Abstract

We study the importance of conditional cooperation in a one-shot public goods game by using a variant of the strategy-method. We find that a third of the subjects can be classified as free riders, whereas 50% are conditional cooperators.

Keywords: Voluntary contributions; Conditional cooperation; Free riding; Strategy-method; Experiments

JEL classification: H41; C91

1. Introduction

In public goods experiments one observes that people cooperate much more than predicted by standard economic theory assuming rational and selfish individuals. However, observed cooperation is heterogeneous and declining over time. One possible explanation, which is investigated in this paper, is the assumption that there are '*conditional cooperators*', i.e. people who are willing to contribute more to a public good the more others contribute. Conditional cooperation can be considered as a motivation in its own or be a consequence of some fairness preferences like 'altruism', 'warm-glow', 'inequity aversion' or 'reciprocity'. In the recent literature, such 'non-standard' motivations have received a lot of attention as explanations for the observed contribution behavior in public goods-type situations.[1] In this paper, we report the results of an experiment that *directly* elicits subjects'

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[1]See, for example, Sugden (1984), Andreoni (1995), Palfrey and Prisbrey (1997), Anderson et al. (1998), Croson (1998), Sonnemans et al. (1999), Keser and van Winden (2000) and Brandts and Schram (2001).

0165-1765/01/$ – see front matter
PII: S0165-1765(01)00394-9

willingness for conditional cooperation.[2] Our examination of the importance of conditional cooperation is based on a novel experimental design described in detail in Section 2. The central feature of our design is that we apply a variant of the so-called 'strategy method' (Selten, 1967) to elicit subjects' preferences. Put differently, the subjects' main task in the experiment is to indicate *for each average contribution level of other group members* how much they want to contribute to the public good.

In Section 3 we present the main results of our investigation. According to our data, roughly 50% of the subjects show conditional behavior such that the own contribution increases in the other group members' average contribution. A third of the subjects can be characterized as free riders. The conditional contribution patterns of about 14% are 'hump-shaped'.

Given the observed pattern of conditional cooperation, the often observed decay of cooperation in a repeated public goods game can be explained as a reaction to the other players' contributions. In the concluding section we discuss this in more detail.

2. Experimental design and procedures

The decision situation in which the experiment was embedded is a standard linear public goods game (see Ledyard (1995)). Each of four individuals decides how to spend 20 tokens. A subject can either keep these tokens for herself or invest them into a so-called 'project'. The pecuniary payoff function that was explained to the subjects was the following:

$$\pi_i = 20 - g_i + 0.4\sum_{j=1}^{4} g_j. \tag{1}$$

For simplicity, the size of the project, i.e. the public good, is just given by the sum of all contributions g_j to it. The marginal payoff of a contribution to the public good is 0.4 tokens. Hence, under standard assumptions the prediction is complete free riding by all subjects.

The above public good problem was explained to the subjects in the instructions[3]. After subjects had read the instructions they had to answer 10 control questions that tested their understanding of this public goods problem. All subjects successfully solved all 10 control questions. This indicates that the subjects understood the mechanics and the implications of the above payoff function.

After all participants had finished the control questions the subjects were introduced to the actual decision situation. Specifically, subjects were asked to make two types of contribution decisions. The first type of contribution decision was called '*unconditional contribution*' and the second type of decision was called '*contribution table*'. Subjects had to make both types of decisions without knowing the others' decisions. To ensure thoughtful decisions, we gave subjects plenty of time to make their decisions (i.e. we did not impose a time limit).

The 'unconditional contribution' was just a *single* decision about how many of the 20 tokens to

[2]The above-mentioned papers by Croson (1998), Sonnemans et al. (1999), Keser and van Winden (2000) and Brandts and Schram (2001) also investigate 'conditional cooperation'. However, in contrast to our experiment the approaches in these papers are much more indirect. The evidence on conditional cooperation found in these papers is inferred from particular data patterns.

[3]Instructions are available upon request.

invest into the 'project', i.e. into the public good. After subjects had made their unconditional contribution decision, a new screen appeared where they now had to fill out a 'contribution table', i.e. we applied a variant of the 'strategy method' (Selten, 1967). Subjects were told that they have to indicate for *each* of the 21 possible average contribution levels of the other group members (rounded to integers) how much they are willing to contribute to the public good. Whereas the unconditional contribution decision just asked for the 'usual' type of decision, the contribution table elicits a contribution *schedule* (i.e. a vector of contributions).

To give subjects a monetary incentive to take both types of decisions seriously and to ensure that potentially all decisions can become contributions to a public good, we employed the following procedure. Subjects were told that, after they have made *both* types of decisions, a random mechanism will determine which of the two decisions will become relevant for the determination of actual payoffs.[4] In each group, for *one* randomly chosen subject the contribution table became this subject's relevant decision. For the other three group members their unconditional contribution was their relevant contribution decision. For each subject, the probability that the contribution schedule will be the payoff-relevant decision was 1/4. This procedure ensures that both, all entries in the contribution table, as well as the unconditional contributions, are potentially payoff relevant for *all* subjects.[5]

Our experiment can be considered as the following extensive form game played with the strategy-method: firstly, nature chooses three players who simultaneously have to make their contribution decisions. The fourth player learns the (rounded) average contribution of the other players and then decides how much to contribute. All players learn whether they are the fourth player or not. If they are not chosen to be the fourth player, they do not learn *who* is chosen. For rational and selfish players, we get the following prediction: for the fourth player it is optimal to contribute zero — independent of the contributions of the other players. Hence, with the strategy method rational and selfish players should have only '0' entries in their contribution schedules. Assuming common knowledge of rationality and selfishness, also the players who have to make simultaneous contribution decisions will contribute zero to the public good.[6]

Contrary to many other experiments, this one was only played *once*, i.e. there were no repetitions

[4]The random mechanism worked as follows. In each group, each group member was given a 'member number' between 1 and 4. At the very beginning of the experiment, when subjects were randomly allocated to the computers, one participant was randomly selected to employ the random mechanism at this stage of the experiment. Subjects were told that this participant will — *after* all decisions have been made — throw a 4-sided die to determine for which group member 1 to 4 the contribution table is the relevant decision.

[5]An example illustrates the point. Assume that the four group members make an unconditional contribution of 4, 6, 8 and 10 tokens, respectively. Assume that the random mechanism determines that for the fourth subject, whose unconditional contribution is 10 tokens, the contribution table becomes the payoff-relevant decision, while for the other three group members their unconditional contributions are payoff-relevant. The average of their unconditional contributions is, therefore, 6 tokens. Assume the contribution table of the fourth subject says that she will contribute 5 tokens in case the others contribute 6 tokens, then her contribution to the public good was taken to be 5 tokens. In this example the sum of all contributions is, therefore, 23 tokens. Individual payoffs can now be calculated according to payoff function (1). To render this method for the calculation of payoffs transparent, the instructions contained several examples like this.

[6]If we lift the assumption of *common knowledge* of rationality, the latter prediction does not necessarily hold anymore. If players assume that a 'fourth player' is a 'conditional cooperator' who displays a pattern of increasing contributions in her schedule then it may be optimal to make 'non-zero' *unconditional* contributions. However, for the prediction of the *conditional* contribution, only rationality and selfishness is assumed. In this paper, we are mainly interested in the contribution schedule and not in the unconditional contribution.

and this was known to the subjects. The reason for this is that we are interested in eliciting *preferences* and therefore did not want to complicate matters by 'intertemporal' considerations of strategy choices. For example, if a subject chooses a contribution table that is increasing in the average contribution of others, this cannot be due to reputation formation or any kind of repeated game consideration. Instead, it can be taken as an unambiguous measure of the subject's willingness to be conditionally cooperative.

The experiments were conducted in the computerized experimental lab of the University of Zurich. We used the experimental software 'z-Tree' developed by Fischbacher (1999). Subjects were first and second-semester undergraduates from various fields (except economics). We conducted two experimental sessions in which 44 subjects participated. These subjects formed a total of 11 groups of four subjects. Since all subjects played only once, all 44 decisions are independent observations. To give subjects an incentive to take the experiment seriously we chose a relatively high stake level. On average subjects earned 27.6 Swiss Francs (about $21).

3. Results

Our main interest concerns subjects' contribution decisions in the 'contribution table', i.e. their elicited willingness to contribute given the average contribution level of others. Fig. 1 contains our main result.

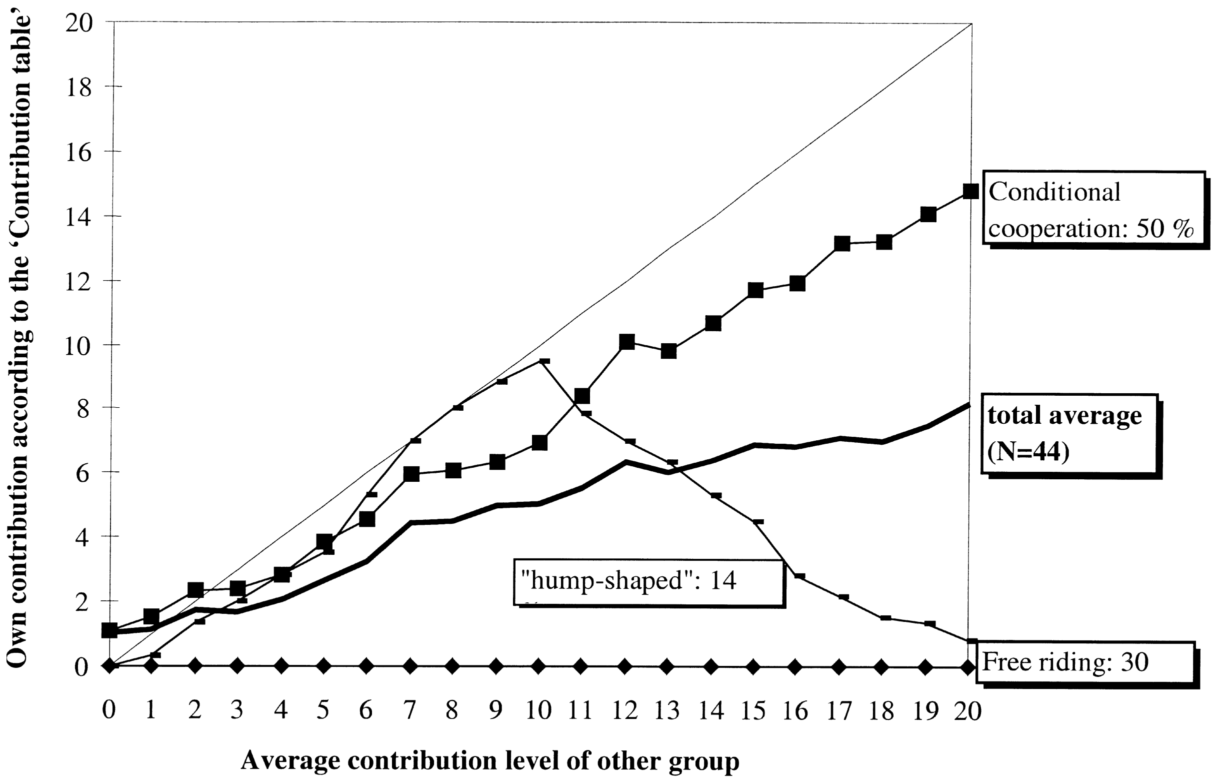


Fig. 1. Average own contribution level for each average contribution level of other members (diagonal = perfect conditional).

Although it was common knowledge that this game will be played only once, the average contribution vector is not characterized by complete free riding. The mean contribution (the bold line in Fig. 1) is clearly increasing in the average contribution of other group members. Thus, on average, subjects display conditional cooperation.

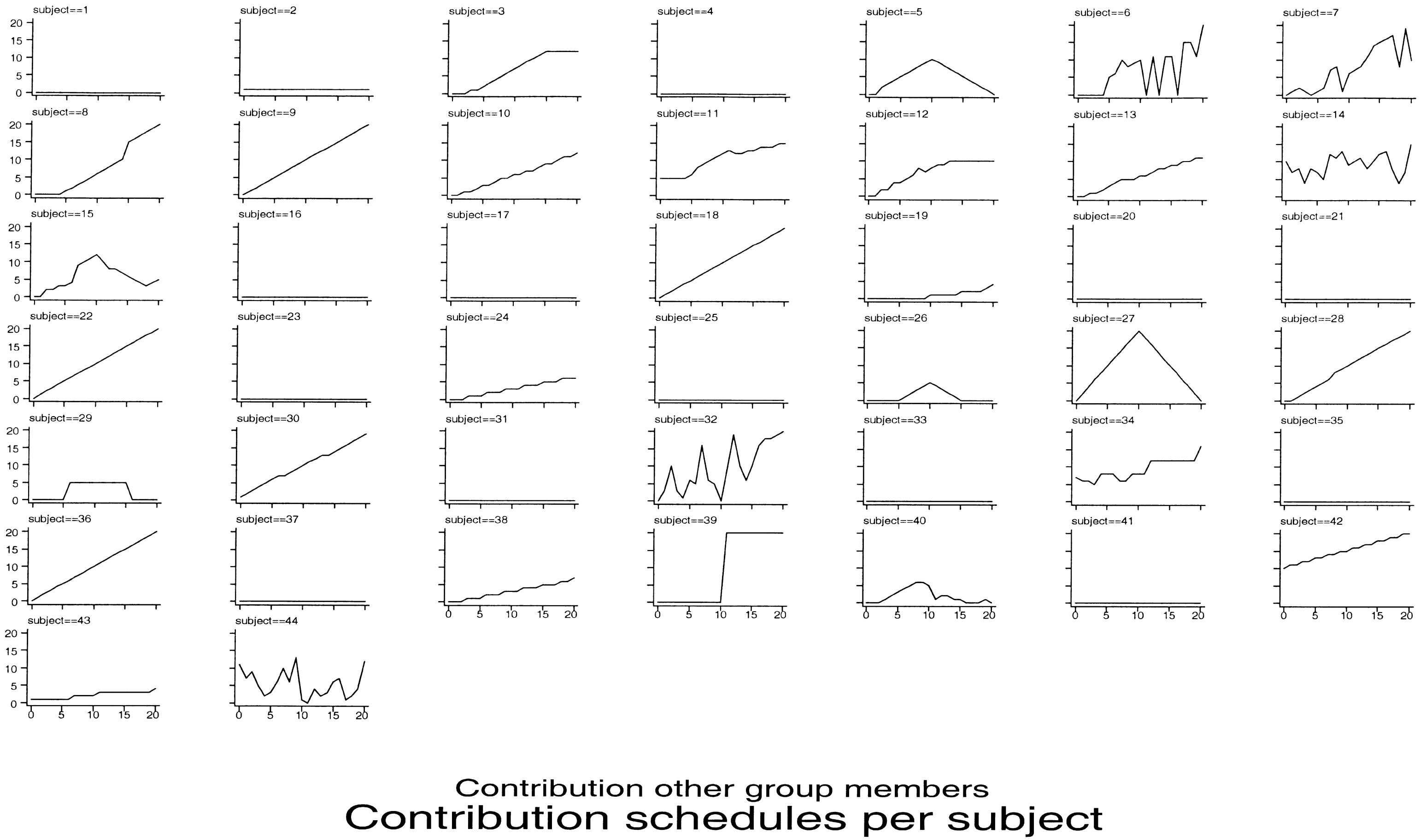
However, an inspection of the data at the individual level shows that subjects are *heterogenous*. Fig. 2 contains the individual schedules of all 44 subjects. Basically, subjects' contribution decisions fall into three distinct categories.

- Conditional cooperation. The contribution schedules of 22 subjects (i.e. 50%) fall into this category. Sixteen of them are both increasing and (weakly) monotonic. Four of these 16 subjects are perfectly conditionally cooperative, i.e. their contribution table is exactly on the diagonal. In other words, these subjects always want to exactly match the contributions of others. Five contribution schedules show an increasing trend but display sometimes (slight) negative deviations from the trend. These are strategies that are not monotonic in a strict sense but they all have a highly significant (at the 1% level) and positive Spearman rank correlation coefficient (between own and others' contribution). It is also noteworthy that only 11.9% of all entries of the conditionally cooperative subjects' contribution schedules are strictly above the diagonal. In other words, the bulk of all conditionally cooperative contribution decisions lies at or below the diagonal. Most subjects who are conditionally cooperative deviate from the diagonal in the selfish direction. The observed average behavior in this category can thus be briefly described as 'conditional cooperation with a self-serving bias'.
- Free riding. Thirteen subjects (i.e. about 30%) can be classified as purely selfish or as insufficiently motivated by altruism or warm glow. They all submitted a contribution schedule that contained '0' in all 21 entries.
- 'Hump-shaped' contributions. Six subjects (or 14%) display such a contribution behavior. As can be seen from the figure, they are — on average — close to perfect conditional cooperation for contribution levels of up to 10 tokens of the other group members. Beyond this level they steadily *reduce* their contributions.
- 'Other patterns'. One subject was willing to contribute one token for all contributions of other group members. The contribution vectors of two subjects do not show a readily interpretable pattern — except, perhaps, randomness.[7]

Remember that in our design we also asked subjects to make an 'unconditional contribution', primarily to render the contribution schedules payoff-relevant. We find that the total average over all 44 unconditional decisions is 6.7 tokens which corresponds to 33.5% of the endowment.[8]

[7]For clarity, they are not separately included in Fig. 1. They are, however, present in the total average over all subjects.

[8]A breakdown of the 'unconditional contribution' made by the types summarized in Fig. 1 shows that the unconditional contributions are largely consistent with the observations of Fig. 1. Specifically, the mean (with standard deviations in parentheses) of the unconditional contributions of the different types of subjects are as follows. 'Conditional cooperators': 8.4 (6.3); 'free riders': 2.0 (5.3); 'contributors with 'hump-shaped' schedules': 9.0 (5.9), and 'other patterns': 12.7 (5.0).



Note: Subjects were classified as follows: *Free-riders:* Subjects no. 1, 4, 16, 17, 20, 21, 23, 25, 31, 33, 35, 37, 41;
Conditional Cooperators (Spearman's $\rho > 0$ at p-value < 0.001): Subjects no. 3, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19, 22, 24, 28, 30, 32, 34, 36, 38, 39, 42, 43;
"Hump-Shaped": Subjects no. 5, 15, 26, 27, 29, 40;
Other patterns: Subjects no. 2 (unconditional cooperation of 1 token), 14, 44 (random patterns).

Fig. 2. The contribution schedules of all subjects.

4. Concluding discussion: the decline of cooperation

Our results allow for a new, tentative, interpretation why we observe declining contributions in almost all public goods experiments. The key is given in Fig. 1. Firstly, a non-negligible fraction of subjects free rides regardless of others' contribution. Secondly, even those who are conditionally cooperative display a bias in the self-serving direction in that they contribute less than the others do on average.[9] Under the assumption that the elicited preferences are stable (i.e. the assumption that these schedules do not change with experience)[10] contributions in repeated interactions are expected to 'spiral downwards' over time. Since subjects react on average conditionally cooperatively on other subjects' contributions (but with bias in the selfish direction), positive but deteriorating contributions to the public good are observed. The speed of convergence depends on the actual composition of the group. Positive *and stable* contributions to the public good are very unlikely. Put differently, despite a majority of conditional cooperators, free riding will be pervasive under conditions of anonymous interactions.

Acknowledgements

This paper is part of the EU-TMR Research Network ENDEAR (FMRX-CT98-0238). Support from the Swiss National Science Foundation under the project no. 1214-051000.97 and from the MacArthur Foundation Network on Economic Environments and the Evolution of Individual Preferences and Social Norms is also gratefully acknowledged. We thank Armin Falk, Claudia Keser, Axel Ockenfels, Arthur Schram and seminar participants at the University of Amsterdam, the GEW workshop in Meissen and the European Economic Association Meeting in Santiago de Compostela for their helpful comments.

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[9] Ockenfels (1999), in a comparable design, gets results similar to ours.

[10] To test this stability, we asked the subjects in a post-experimental questionnaire again to fill out a hypothetical 'contribution table'. It turned out that the results are almost identical to the schedules submitted in the actual experiment.

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