

Voluntary Contributions to a Dynamic Public Good: Experimental

Evidence

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Abstract

Previous experimental studies indicate that voluntary contributions to a public good decline over time to near zero. We explore whether a similar decline of contribution rates occurs when the return to contributions is a function of contributions in previous periods. We find that, at least in one such environment, average contributions decline to low levels in only a minority of groups.

1. Introduction

Individual incentives exist to free ride on the provision of a public good when the good is supplied with voluntary contributions. Experimental evidence has largely confirmed such free riding as a behavioral principle. This result emerges primarily from the extensive and careful investigation of behavior in a game called the Voluntary Contributions Mechanism (VCM). In the VCM game, each member of a group of potential beneficiaries of the public good receives an initial endowment of money. They then decide simultaneously on a portion of their endowment to contribute to a group account. A contribution to the group account increases the total earnings of the group, benefiting each group member equally, while it reduces the earnings of the contributor. Thus, contributing to the group account constitutes a voluntary provision of a public good. Individuals' average contributions, while initially positive, decrease to low levels with repeated opportunities to contribute (Isaac et al., 1985; Isaac and Walker, 1988a; Andreoni, 1988; Ledyard, 1995), unless an additional instrument to promote cooperation, such as communication (Isaac and Walker, 1988b) or punishment (Fehr and Gaechter, 2000) is in place.

The marginal per-capita return (MPCR) is the benefit each individual receives from each unit of money that any group member contributes, and can thus be interpreted as a return on expenditure on a public good. In all of the previous studies of which we are aware, the MPCR is independent of the history of prior expenditures on the public good. However, such dependence is a feature of many situations of interest in the field. For example, if individuals have failed to

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maintain the cleanliness of a lake in the past, the cost of converting it into a recreational facility of a given quality is higher than if the lake had been well maintained. Similarly, a public park that is a popular destination because it has been well maintained in the past yields benefits to a greater number of users, and thus higher welfare for a fixed monetary expenditure, than a park that has been undermaintained. National defense readiness is less costly to maintain when large investments have been made in its provision in the past; investment in military equipment yields a higher return when the personnel operating it have been better trained previously. In this paper, we refer to public goods with the property that the value of the marginal product of current expenditure depends on past expenditures as “dynamic public goods”.

We report here the results of an experiment that investigates the effectiveness of a system of voluntary provision of a dynamic public good. The principal issue we consider is the extent to which the free-rider problem, so evident in the studies described in the first paragraph, leads to underprovision of a dynamic public good. In the experiment, the production technology for the public good has the property that the MPCR is a simple increasing function of prior total group contributions. If the total contribution in period t was greater than 50% of total group endowment, the MPCR increases by .1 for period $t+1$. If period t contributions fail to reach the 50% threshold, the MPCR decreases by .1 for $t+1$. If period t contributions equal exactly 50% of endowment, the MPCR remains the same for $t+1$.

It is plausible to hypothesize that the free rider problem might not be severe for dynamic public goods. Because the value of the public good is a function not only of current contributions, but of previous contributions as well, an “investment” motive exists to contribute to dynamic public goods, and this motive might encourage high contributions. Furthermore, because higher contributions are generally associated with higher MPCR (Isaac and Walker, 1988a), it is possible that high contributions in early periods could create positive feedback that raises the MPCR and, in turn, contributions in later periods. Nevertheless, the logical argument leading to an outcome of free-riding and zero public good provision is highly compelling. Because of a restriction that the $MPCR < 1$ at all times, and the fact that the number of periods is finite and common knowledge, the only subgame perfect equilibrium of the game is for all players to contribute zero in each period. Thus, it is also reasonable to hypothesize that contribution levels would converge to close to zero, as in the case of non-dynamic public goods.

2. The Experiment

The experiment was conducted in ten sessions at Emory University, located in Atlanta, Georgia, USA. At the beginning of each session, eight participants were separated into two

groups of four on a random basis. Each session followed a “partner matching” protocol, in which group membership remained fixed for the entire session. Each session consisted of 10 periods of play of the voluntary contributions mechanism. At the beginning of each period, each subject was endowed with 10 tokens, where each token was to be converted to US\$.1 at the end of the session. Communication between subjects was strictly prohibited at all times.

During each period, subjects simultaneously chose the number of tokens from their endowment to keep for themselves, contributing the remainder to a group account. In each period, each individual earned \$.1 for every token he did not contribute and $\$MPCR/10$ for each token any member of their group contributed. There were two treatments, HM (High MPCR) and LM (Low MPCR). In HM, the MPCR in period 1 equaled .4. In LM, the MPCR in period 1 was .1. Ten independent groups participated under the conditions of each treatment. In both treatments, however, the MPCR in periods 2 and greater depended upon the level of contributions in the previous periods. If the total contribution of the group equaled more than 20 tokens (50% of the group’s total endowment) in period t , the MPCR would increase by .1 for period $t+1$. If the total group contribution equaled less than 20 tokens, the MPCR would decrease by .1, and if the total number of tokens contributed equaled exactly 20, then the MPCR would remain the same. The MPCR could not exceed .9 or drop below 0.

3. Results

Figures 1 and 2 display the total contribution levels for each of the ten groups as a percentage of the total endowment in treatments HM and LM, respectively, over the ten periods that comprised each session. Each time series represents the activity of one particular group. The bold line indicates the average over all groups comprising the treatment. The data indicate that contributions do not consistently exhibit the decline found in previous studies in either treatment. Rather, there is heterogeneity among groups. In both treatments, contributions of a considerable minority (30 – 40%) of groups increase over time to close to the maximum possible level. For another 30 - 40% of groups, contributions decrease to zero. For the rest of the groups, contributions decline over time but do not reach levels close to zero. Therefore, the strong tendency for contribution rates to decline observed in previous studies does not carry over to the dynamic public good environment that we study here.¹

¹ The willingness to contribute in the early periods in LM is noteworthy because the MPCR in these periods is less than .25, and thus each token contributed yields less than one token in overall earnings to the four players in the current period. This means that short-term group gains from not contributing are foregone to achieve higher total payoffs over the 10-period horizon.

[Figures 1 and 2: About Here]

Contributions are high enough to allow the MPCR to exhibit an overall increase over the ten round horizon for a majority of groups. Figures 3 and 4 illustrate the MPCR in each period for each group in treatments HM and LM, respectively. The bold lines in the figures represent the average MPCR in each round for all groups in the treatment.

[Figures 3 and 4: About Here]

Figure 3 shows that under HM, seven of the ten groups made sufficiently high contributions to increase MPCR by .1 each period and to reach the maximum level of .9 in either period 9 or 10. The MPCR for the three remaining three groups declined to a low level: zero in two of the sessions, and .1 by period 10 in the remaining session. Figure 4 indicates that five of the ten groups in LM converged to an MPCR of at least .8 by period 9, while 4 groups converged to zero.

Contributions and final MPCR are not significantly different between the two treatments, suggesting that the properties of the provision patterns for dynamic public goods after several periods are fairly independent of the initial conditions. Contributions average 22.2 and 19.4 tokens in the HM and LM treatments, respectively, over the complete 10-period horizon. They average 21.1 and 16.8 in the last five periods for HM and LM, respectively, and 21.0 and 16.7 in period 9. We conduct Wilcoxon rank sum tests for treatment differences, using each group's activity as a unit of observation, yielding 10 observations in each treatment. These tests indicate that we cannot reject the null hypothesis at the 10-percent level that the median group contributions in the two treatments are equal in period 9, over the last five periods, or over the entire 10 periods ($z = .68, 1.24$ and $.72$, for the 10 periods, the last five periods, and period 9 respectively). The final MPCR averages .62 in HM and .50 in LM. The difference between the two treatments is also not significant ($z = .57$).

4. Summary

The strong tendency for voluntary contributions to public goods to decrease over time, widely observed in previous studies, does not carry over to the particular environment studied

here, in which the value of the public good depends on both previous and current contributions. Many groups in our experiment were able to reach levels of contribution close to the maximum possible and thereby achieve highly efficient outcomes over the course of ten periods. Only a minority of groups saw contributions decrease and fall to or close to zero. This was the case even when the initial marginal per-capita return equaled .1. There is no significant difference between the treatments in terms of average level of contributions or final MPCR. Thus the initial value/cost ratio for the public good appears to become largely irrelevant in determining long run outcomes for the dynamic public goods we have studied.

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Figure 1. Group Contribution Levels as % of Optimum (High MPCR of .4)

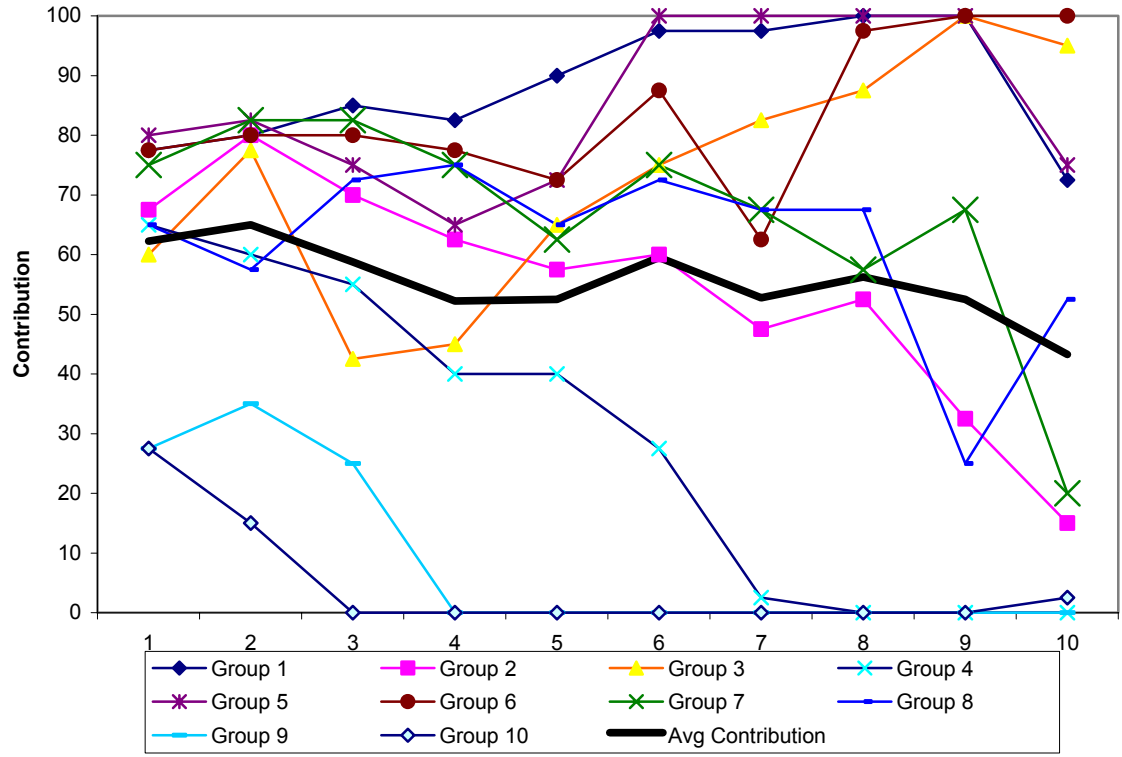


Figure 2. Group Contribution Levels as % of Optimum (Low MPCR of .1)

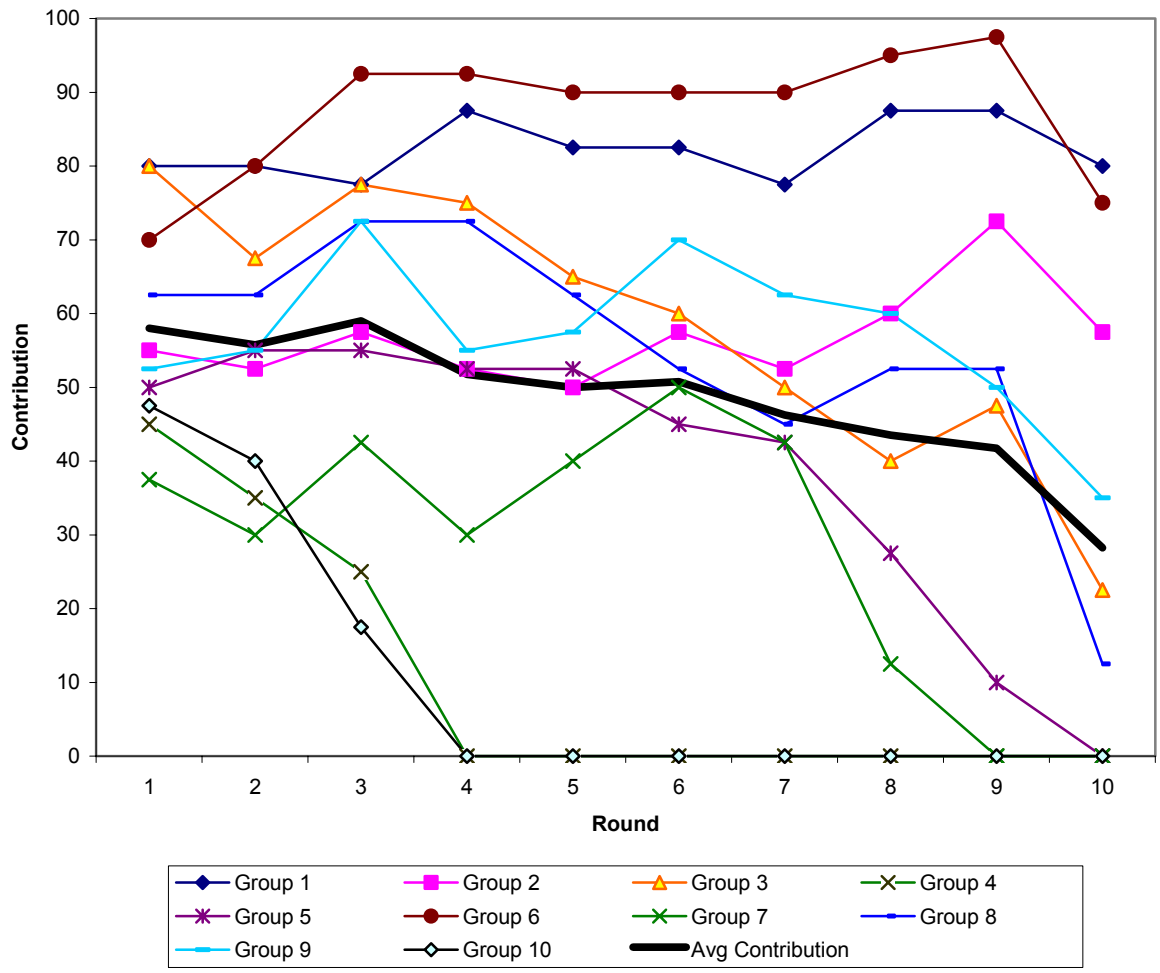


Figure 3. MPCR Levels (High MPCR of .4)

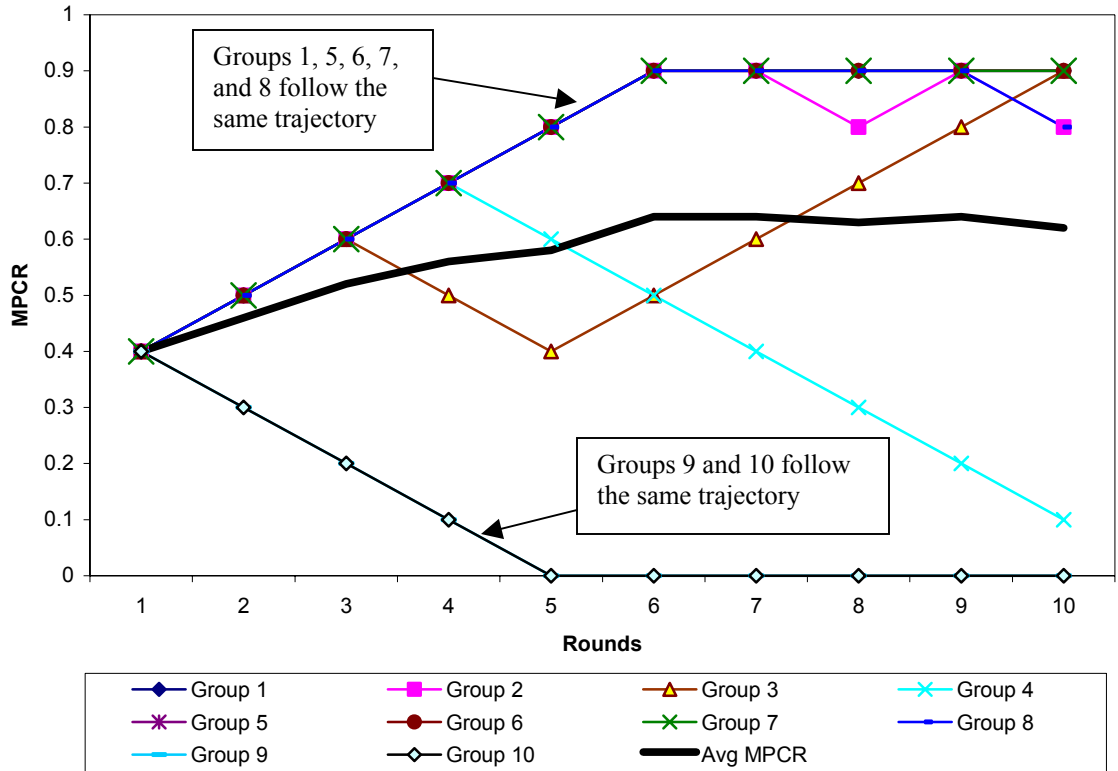


Figure 4. MPCR Levels (Low MPCR of .1)

