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The dos and don'ts of leadership in sequential public goods experiments

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Abstract

We study the effects of leadership in the provision of public goods by examining (i) the relative importance of reward and punishment as leadership devices, (ii) whether endogenous leadership is more efficient than exogenously enforced leadership, and (iii) whether leaders contributing last, instead of first, also increase contributions. The experimental results are: (i) Reward options yield lower contributions than punishment through exclusion. (ii) Endogenous leadership is much more efficient than exogenously imposed leadership. (iii) Sequentiality itself is not beneficial for contributions since groups where the leader contributes as the last member do not contribute more than groups without a leader.

Keywords: Public goods experiment, Leadership, Exclusion power, Reward, Endogeneity

JEL classification: C72, C92, H41

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1 Introduction

The effects of leadership in sequential public goods experiments have captured a lot of interest, as several recent papers have shown that leadership by setting a good example (of being cooperative) has a positive influence on the behavior of others even when contractual relationships or hierarchical authority are absent. It has been found that sequential contributions in public goods experiments can increase the overall level of contributions, in particular if leaders provide a good example by contributing high amounts, about which other groups members are informed before they contribute. In asymmetric information settings —where leaders have private information about the marginal returns from contributing— leadership has been identified to have a positive effect on the overall level of contributions because it serves as a signaling device for information transmission (Potters et al., 2007). In symmetric information settings - where all group members know the marginal value of the public good - conditional cooperation (Fischbacher et al., 2001) or positive reciprocity (Fehr and Gächter, 2000) have been invoked as driving factors which can explain the very high positive correlations between leaders' and followers' contributions. Since such high correlations can be considered a very robust phenomenon (see, e.g., Moxnes and van der Heijden, 2003, Gächter and Renner, 2004, Potters et al., 2005, Güth et al., 2007)[1], it follows that high contributions of leaders (i.e. those who contribute first) trigger, on average, high contributions of followers (those who contribute after the leader). This pattern establishes a positive role of leadership in voluntary contribution games like the private provision of public goods.

So far, the papers dealing with the consequences of sequential contributions of leaders and followers have concentrated on (i) whether sequential contributions through leadership have a positive effect on overall contributions in comparison to simultaneous contributions (answer: "Yes", almost always significantly; see Moxnes and van der Heijden, 2003, Gächter and Renner, 2004, Potters et al., 2005, Duffy et al., 2007, Güth et al., 2007), (ii) whether followers condition their contributions on leaders's decisions ("Yes", but they contribute systematically less than leaders; see Güth et al., 2007), (iii) whether followers infer information from leaders' contributions if the latter are better informed ("Yes"; see Potters et al., 2007), (iv) whether leaders with a sanctioning device (of excluding followers from the group) trigger higher contributions from followers than leaders without formal power ("Yes"; see Güth et al., 2007). In this paper, we are going to examine three hitherto neglected research questions related to the effects of leadership in voluntary contribution games.

Question (A): Are leaders with an option to reward followers as effective as leaders with a sanctioning device?

[1] This effect is by no means confined to laboratory experiments, though. In charitable fund-raising, for instance, it is often the case that once a well-known and respected person donates to a certain project and this is publicly announced, other donors tend to follow (List and Lucking-Reiley, 2002, Vesterlund, 2003).

Question (B): Does it make a difference whether leaders volunteer to be leaders or whether they are forced exogenously to contribute before others?

Question (C): What are the consequences if leaders contribute *after* the followers instead of *before* them?

Question (A) addresses whether the carrot (i.e., reward) or the stick (i.e., punishment) at a leader's disposal yield different levels of cooperation in groups. Of course, several papers have studied the consequences of reward or punishment in public goods games, yet only in a setting where all group members can reward or punish each other and where there is not a single leader who can decide whether or not to reward or punish other group members. In the context without a leader, a reward mechanism has been found to increase the level of cooperation in comparison to a situation without reward, but punishment seems to be a more efficient —and more stable— mechanism to induce cooperation (Andreoni et al., 2003, Sutter et al., 2006, Sefton et al., 2007). So far, however, there is no paper that combines the issue of leadership in sequential public goods games with an option for the leader to reward other group members, even though it seems obvious that leaders in a group may resort to rewards to motivate other group members. In our experiment, we will allow leaders in one treatment to reward other group members, whereas in the other treatment they can punish other group members. We find that punishment works better than reward, but that leadership with reward is still clearly preferable to having no leader at all.

Question (B) examines the importance of providing a good example voluntarily, instead of being forced exogenously. As such, this question addresses whether endogenously chosen leadership has a positive effect on the level of cooperation in a group. Some recent papers have shown that the endogenous choice of rules that govern the interaction in a social dilemma situation increases the level of cooperation significantly. Gürerk et al. (2006), for instance, have found that if subjects can choose themselves whether they want to play a public goods game with or without reward and punishment devices, then they choose the game with reward and punishment options and that this choice itself (irrespective of the level of reward and punishment) increases contributions. Contrary to our paper, Gürerk et al. (2006) do not consider leadership and the role of endogenously choosing to be a leader. Rather, they report standard, simultaneous public goods games. In this paper, we will consider one treatment where one group member may opt to serve as leader of the group by contributing to the public good before other group members do so. We compare this treatment with a control treatment where the leader is determined exogenously (in the same order as in the endogenous treatment). We find that volunteering for leadership increases contributions significantly, whereas leadership itself (i.e., the sequential contribution to the public good) need not have a positive effect.

Question (C) investigates the effects of letting one group member contribute *after* the other group members instead of before the others. This question addresses the issue whether sequentiality itself (in whichever order) has a positive effect on contributions in a public goods experiment. It seems reasonable that group leaders may not always go ahead by providing an example —hoping that other group members follow it— but they sometimes wait for other group members to decide and react to their behavior instead. We compare a treatment with the leader contributing as the last one with a control treatment without a leader, finding that contributing last does not increase the level of cooperation in comparison to the control condition without leadership. Hence, reverse leadership by being the last one to contribute is no means for establishing cooperation. Rather, we show that leaders should go first, do that voluntarily, and be equipped with reward and/or punishment devices. We call these findings the dos and don'ts of leadership.

The rest of the paper is organized as follows: In the following section we introduce the public goods game. Section 3 presents the experimental design. Results are reported in section 4. A conclusion is offered in section 5.

2 The basic public goods game

The basic game is a standard voluntary contribution mechanism (VCM, hereafter). We set up groups of 4 members who interact for T periods. In every period each member is endowed with an initial endowment e, that he can keep for himself or contribute to the public good, where member i's contribution in period t has to satisfy $0 \leq c_{it} \leq e$. The sum of individual contributions in period t is denoted by $C_t = \sum_{i=1}^{4} c_{it}$. Payoffs in period t are given by :

$$u_{it}(c_{it}, C_t) = e - c_{it} + \beta C_t,$$

where $0 < \beta < 1 < 4\beta$. The latter implies that the dominant strategy for a payoff-maximizing subject is to contribute zero to the public good and keep e for himself, while the Pareto optimum is to contribute everything to the public good. If all group members free-ride (by contributing zero), their payoff is e, while if everyone contributes everything to the public good their payoff is $4\beta e > e$.

3 The experiment

3.1 Treatments

In order to address our research questions (A) to (C) we have designed the following six experimental treatments[2]:

(1) *CONTROL*. This is the standard VCM introduced above. In this treatment all four group members contribute simultaneously to the public good. Hence, there is no leader present in the group.

(2) *REWARD*. In this treatment, one group member is randomly determined at the beginning of the experiment to be group leader for the whole experiment. In each period the leader has to make his contribution first, which is then communicated (in anonymous form, of course) to the other group members. Only then the other members decide simultaneously on their contribution. After all group members have made their contributions, the leader gets informed about all contributions and may reward one of the other members with 10 ECU (experimental currency units). The reward is costly for the leader and for the non-rewarded members, as each of them has to pay costs of 2 ECU. This design feature is motivated by making reward also costly for the non-rewarded members, as exclusion is (potentially) costly for the non-excluded members.

(3) *EXCLUSION*. Like in treatment *REWARD*, there is a fixed leader who contributes before the other group members. After observing the other members' contributions, the leader may (but need not) exclude one of them from the group for the next period. In case of an exclusion, the group consists of only three members in the next period, i.e. of one leader and two followers. The exclusion is costly for the excluded member —because he cannot benefit from the public good in the next period, even though he still receives the endowment e— and for the non-excluded members, including the leader, as the exclusion reduces the number of potential contributors to the public good.

(4) *ENDOGENOUS*. In this variation of the VCM, any group member can choose in each single period to become the leader by being the first one to contribute to the public good. Once one member makes a contribution, it is communicated to the other group members who then have to contribute simultaneously. In case no group member volunteers to be the leader and contribute first within the first 60 seconds of a period, then there is no leader and all members have to contribute simultaneously (i.e. independently of each other and without knowing what any other

[2] Treatments *CONTROL* and *EXCLUSION* are identical to treatments introduced in Güth et al. (2007). For the data analysis of these treatments, we report the data already presented in Güth et al. (2007). Treatment *CONTROL* here is denoted as treatment *C*, and *EXCLUSION* is denoted as *SLf* in Güth et al. (2007).

member has done in the respective period). Note that in the latter case, the conditions in treatment *ENDOGENOUS* are identical to those in treatment *CONTROL*.

(5) *EXOGENOUS*. This treatment is a replication of treatment *ENDOGENOUS*, subject to the following modification. The role of leader in each period is determined exogenously by using the endogenously evolved patterns of leadership in treatment *ENDOGENOUS*. To be precise, the four members of a group k in treatment *ENDOGENOUS* were labelled as members 1 to 4. For each period we recorded which member —if any— volunteered to be leader. This endogenously evolved sequence of leaders in a group k was then implemented exogenously in one group in treatment *EXOGENOUS*.[3] By doing so, we can control the sequence in which single group members are leaders in a group, and we can check whether an identical sequence of group members being leaders has different effects, contingent on leadership having emerged endogenously (in *ENDOGENOUS*) or having been enforced exogenously (in *EXOGENOUS*).

(6) *LAST*. Like in *REWARD* and *EXCLUSION*, one group member is randomly determined as a leader. However, the leader does not contribute *before* the other group members make their contributions, but *after* them. This means that the three "normal" group members contribute simultaneously, and that the leader gets informed about their contributions before deciding on his own.

Note that for answering our research question (A) on the comparative effects of rewards and sanctions and the general effects of leadership we will compare contribution levels in treatments *CONTROL*, *REWARD* and *EXCLUSION*. Question (B) on the effects of voluntariness can be resolved by checking the differences between treatments *ENDOGENOUS* and *EXOGENOUS*. Question (C) on the influence of a reverse sequential order of contributions will be addressed by comparing treatments *CONTROL* and *LAST*.

One should also bear in mind that if subjects are profit-maximizing, then their dominant strategy is to contribute zero in the public goods game, irrespective of the treatment. Rewards do not change this standard prediction because reward is costly. By applying backward induction, it can then be shown that leaders have no incentive to reward other group members, which in turn implies that group members have no incentive to contribute positive amounts. In *EXCLUSION* the leader is indifferent between excluding a follower or not, since he expects the follower to contribute zero anyway.

[3] We had 3 groups less in EXOGENOUS than in ENDOGENOUS due to no-show-ups.

3.2 Procedures

Each treatment consists of 24 periods throughout which group composition never changes (partner design). We use $e = 25$ and $\beta = 0.4$. In treatments *REWARD, ENDOGENOUS, EXOGENOUS*, and *LAST* there are two parts. Until period 16 the design is as explained in the previous subsection. In periods 17 and 21, however, subjects can vote whether they want to have (or allow the existence of) a leader or not in periods 17 to 20, and 21 to 24, respectively. The group has a leader —or the possibility of having a leader in *ENDOGENOUS*— only if all four group members vote for leadership, otherwise the members have to contribute simultaneously to the public good in the respective four-period phase.[4]

The experiment was computerized (using z-Tree, Fischbacher, 2007) and all sessions were conducted at the Max Planck Institute of Economics in Jena (Germany). Table 1 shows the number of groups (of four subjects each) in the different treatments.

Treatment	# of groups
CONTROL	14
REWARD	19
EXCLUSION	14
ENDOGENOUS	17
EXOGENOUS	14
LAST	18

Table 1: Number of groups by treatment

A total of 384 students with different majors participated in the experiment, earning on average 14 euros (including a show-up fee of 2.50 euros). Subjects received the instructions on paper. To ensure full understanding, all subjects had to answer control questions before the experiment started. At the end of each period, subjects were informed about the contributions of every group member (identified by the member number) as well as their own profits. After the voting stage before periods 17 and 21, subjects were informed whether or not leadership had received unanimous support.

At the end of the experiment subjects were paid one by one. The final payment was determined as follows. From each block of four periods (i.e. periods 1-4, 5-8, 9-12, 13-16, 17-20, and 21-24) one period was randomly chosen for payment. The earnings of these six periods were added up, and converted into euros with the conversion rate: 1 ECU = 0.06 euro.

[4]Note that in treatments *REWARD* and *EXCLUSION* group members vote on whether the fixed leader continues to be leader. In treatment *ENDOGENOUS*, voting for leadership means that in periods 17-20 or 21-24 it shall also be possible that one group member volunteers to contribute first. This decision and the ensuing sequence of leadership was then implemented exogenously in EXOGENOUS.

4 Results

4.1 Question (A): On the effects of leadership, reward and exclusion

4.1.1 Contributions

Table 2 presents the average contributions and standard deviations in all six treatments. In this subsection we consider the data from treatments *CONTROL*, *REWARD* and *EXCLUSION*, and only the first 16 periods (since we will analyze the voting phase in subsection 4.1.3). The average contributions in *CONTROL* are around 40% of a subject's endowment. They are considerably higher both in *REWARD* (around 55%) and *EXCLUSION* (around 80%). Figure 1 shows the time trend of contributions. In *CONTROL* and *REWARD* we see a typical downward trend of contributions. In *EXCLUSION*, however, contributions are stable at a very high level during periods 1 to 16.

	Periods 1 - 16		Periods 17 - 24		Freq. approving leadership	
	Avg.contribution	(Std.dev.)	Avg.contribution	(Std.dev.)	Period 17	Period 21
CONTROL	10.04	(8.91)	4.96	(7.56)	----	----
REWARD	14.16	(7.96)	8.70	(9.60)	26.3%	47.4%
EXCLUSION	20.78	(7.16)	16.78	(9.94)	57.1%	64.3%
ENDOGENOUS	15.70	(8.97)	10.95	(9.81)	41.2%	58.8%
EXOGENOUS	8.74	(8.50)	4.12	(5.84)	----	----
LAST	10.88	(8.43)	7.86	(8.20)	11.1%	16.7%

Table 2: Average contributions and frequency of approving leadership

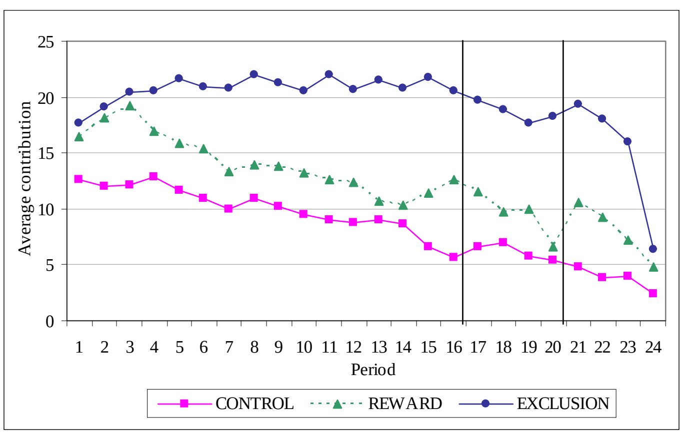

Figure 1: Average contributions in *CONTROL*, *REWARD* and *EXCLUSION*

OLS regression clustered by group		
Dependent variable: contribution		
	Coefficient	Robust Std.Err.
REWARD	3.68*	2.12
EXCLUSION	10.92***	2.12
Subject is leader	1.76***	0.56
Period	-0.28***	0.07
Constant	12.45***	1.66
Number of observations	2981	
Number of groups	47	

***signif. at 1% level **signif. at 5% level *signif. at 10% level

Table 3: Estimation of the contribution in *CONTROL*, *REWARD* and *EXCLUSION*

Table 3 shows the results of an OLS estimation[5] where the dependent variable is the contribution to the public good, and the independent variables are the period and dummies for *REWARD*, for *EXCLUSION*, and for being the leader in the group. Groups with leaders that have a reward option have weakly significantly higher contributions than we observe in the *CONTROL*-treatment without a leader. Exclusion power, however, yields the highest contributions, and the contributions in *EXCLUSION* are significantly higher than in *REWARD*.

Güth et al. (2007) have shown that leadership itself (without any reward or sanctioning device) leads to higher contributions than in a control treatment without a leader. Comparing their data for the treatments with leadership to our *REWARD*-treatment shows that a reward-device does not raise contributions significantly above the level which prevails if groups have leaders, but leaders have no reward option. Our question (A), however, does not focus on comparing leadership with or without reward option, but on the relative performance of leadership with a reward, respectively punishment, option. Our results show that punishment yields higher contributions, and that they remain stable rather than decline across periods like in REWARD.

The estimations in Table 3 also show that the leaders in a group contribute systematically more than the other group members. Hence, the leaders' example is typically not fully copied, but rather the other group members contribute almost 2 ECU less. Nevertheless, the correlation between leaders' and followers' contributions is positive and highly significant in all treatments.[6] The average contributions decrease across periods, but this effect is driven only by treatments *CONTROL* and *REWARD*, as can be inferred from Figure 1. We summarize the results from this subsection as follows:

Result 1. Having a leader with reward possibilities or a leader with exclusion power yields higher contributions, compared with a control treatment without leader. However, exclusion as a sanctioning

[5] A censored tobit-model (which accounts for the lower limit of zero ECU and the upper limit of 25 ECU) yields practically the same results. Note that we report some further OLS-regressions later on in the paper. We have checked also for these regressions that using a censored tobit-model would not have changed the results noticably.

[6] The Pearson correlation coefficient between the leader's and the followers' contributions across all periods is 0.707 in *REWARD* and 0.755 in *EXCLUSION* ($p - value = 0.00$).

device is more effective than a reward option. Leaders contribute more than the other group members.

4.1.2 Causes and consequences of being rewarded or excluded

The previous subsection has shown that both a reward- and an exclusion-device increases contributions. In this subsection we examine which group members are rewarded, respectively excluded, and how these members react to reward or exclusion. Figure 2 shows how the relative frequency of reward or exclusion depends on the rewarded or excluded member's contribution in relation to the other group members' contributions. The emerging pattern is straightforward. The less a group member contributes in relation to the other group members, the more (less) likely this member is excluded (rewarded). Hence, leaders condition reward or exclusion on relative contributions.[7] [8]

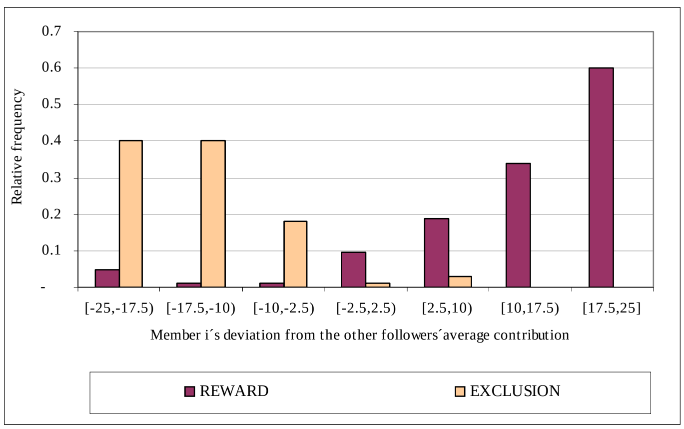

Figure 2: Reward and exclusion depending on the deviation from the other followers' contribution

[7]This statement remains true also when the rewarded or excluded member's contribution is related to the leader's contribution. Since leader's and followers' contributions are highly positively correlated, the pattern shown in Figure 2 was almost exactly replicated if we used on the horizontal axis the difference between the respective group member's and the leader's contribution.

[8]Like Fehr and Gächter (2000), we also observe a positive, but relatively small number of low contributors that punish high contributors. Herrmann et al. (2008) use the term antisocial punishment for such cases, and they demonstrate that antisocial punishment is widespread around the world, though it is contained by strong norms of civic cooperation and positive attitudes towards the rule of law. Nikiforakis (2008) shows that the positive effects of a punishment device on contributions in a group may be contained if counter-punishment is possible.

Probit regressions clustered by group				
Dependent variable:	Subject rewarded		Subject excluded	
	Marginal effect	Robust Std.Err.	Marginal effect	Robust Std.Err.
Positive deviation from other followers	0.011***	0.003	-0.001	0.002
Negative deviation from other followers	-0.006	0.006	0.001	0.002
Positive deviation from leader	0.003	0.002	0.003	0.003
Negative deviation from leader	-0.006**	0.003	0.004**	0.002
Period	-0.004***	0.001	-0.001	0.001
Number of observations	912		645	
Number of groups	19		14	

***signif. at 1% level **signif. at 5% level

Table 4: Estimations of the probability of being rewarded and excluded

Table 4 confirms the basic insights from Figure 2 by reporting the results from a probit estimation of the probability of being rewarded, respectively excluded. The independent variables are the positive and negative deviation from the other followers' and the leader's contribution, and the period.

The probit estimation on the left-hand side of Table 4 shows that the probability of being rewarded increases with the positive deviation from the other followers' contribution, and decreases with the negative deviation from the leader's contribution, and across periods. The higher the negative deviation from the leader's contribution, the higher the probability of being excluded, as can be seen on the right-hand side of Table 4. The deviation from the other followers' contributions is not significant for exclusion, although Figure 2 suggests such a relation. One explanation lies in the high correlation between the deviation from the other followers' and the leader's contribution, both of which are considered in the estimation.

It seems noteworthy that the likelihood for rewarding is significantly decreasing across periods, whereas the decision to punish via exclusion is not decreasing over time. The decrease in reward may be one of the reasons why *REWARD* does not reach the contribution levels observed in *EXCLUSION*.

Table 5 shows the effects of being rewarded or excluded on a member's contribution in the next period. We show OLS estimations (clustering for the group) where the dependent variable is the contribution to the public good. The independent variables in *REWARD* are a dummy variable that takes value 1 if a group member was rewarded in the previous period, the contribution of the group lagged by one period, a dummy variable that indicates if the subject is a leader, and the period. In *EXCLUSION* we use a dummy if a particular group member was excluded in the previous period, keeping the other variables identical to the regression for *REWARD*.

OLS regression clustered by group					
Dependent variable: contribution	Treatment: *REWARD*			Treatment: *EXCLUSION*	
	Coefficient	Robust Std.Err.		Coefficient	Robust Std.Err.
Rewarded previous period	4.42***	1.23	Excluded previous period	2.00*	0.99
Group contribution previous period	0.18***	0.02	Group contribution previous period	0.21***	0.02
Subject is leader	3.13***	0.87	Subject is leader	0.63	0.45
Period	-0.12**	0.06	Period	-0.08**	0.03
Constant	3.62**	1.36	Constant	4.27*	2.07
Number of observations	1140		Number of observations	813	
Number of groups	19		Number of groups	14	
***signif. at 1% level **signif. at 5% level			***signif. at 1% level **signif. at 5% level *signif. at 10% level		

Table 5: Estimations of the effect of being rewarded/excluded

Both reward and exclusion yield higher contributions of an affected group member in the next period. If a subject was rewarded with 10 ECU, contributions increase by an estimated 4.42 ECU, while if a subject was excluded, the increase is estimated at 2.00 ECU. Relatively higher contributions within a group in the previous period have also a significantly positive effect on one's own contributions, which is clear evidence of conditional cooperation (Keser and van Winden, 2000; Brandts and Schram, 2001; Fischbacher et al., 2001; Levati and Neugebauer, 2004). The dummy for the leader is significantly positive in *REWARD*, but not in *EXCLUSION*. Hence, other group members fall short in their contributions of the leader's benchmark only in *REWARD*. The separate regressions for *REWARD* and *EXCLUSION* show that the significantly positive coefficient of "Subject is leader" in Table 3 was exclusively driven by *REWARD*. The different behavior of followers in *REWARD* and *EXCLUSION* seems reasonable, given that the sanctioning device is stronger in *EXCLUSION* than in *REWARD*. We summarize the findings in this subsection as follows:

Result 2: The higher the positive (negative) deviation from the leader's or other group members' contributions, the higher the probability of being rewarded (excluded). Group members who are rewarded or excluded for one period react by choosing significantly higher contributions in the next period.

4.1.3 Periods 17-24

In this subsection we take a brief look at the data of periods 17 to 24. As indicated in Table 2, the overall pattern of average contributions across treatments does hardly change if periods 17-24 are compared to periods 1-16. In fact, the overall order of contributions across treatments is perfectly preserved.

Considering periods 17-24 allows for an insightful relation of the contributions within a group in periods 1-16 and the likelihood of voting for leadership in periods 17-20 and 21-24. Figures 3 and 4 plot the average contributions in periods 1-24 for those groups that accepted leadership twice or once in periods 17-24 and those groups that failed twice to accept leadership. It is obvious from Figure 3 that successful groups in periods 1-16 are those that succeed to keep a leader in periods 17-24, which suggests that success breeds success, since leadership leads to higher contributions, and higher contributions make leadership more likely. Those groups that did not accept any leader in periods 17-24 are those that had the lowest contributions in periods 1-16. As shown in Figure 4, the relationship between contributions in periods 1-16 and the frequency of choosing a leader is less separating for *EXCLUSION*, but it keeps the same general pattern. Those groups that veto a leader (with exclusion power in periods 17-24) are those that have the lowest contributions in periods 1-16. This indicates that bad experiences with leaders in periods 1-16 backfire when leadership can be chosen endogenously.

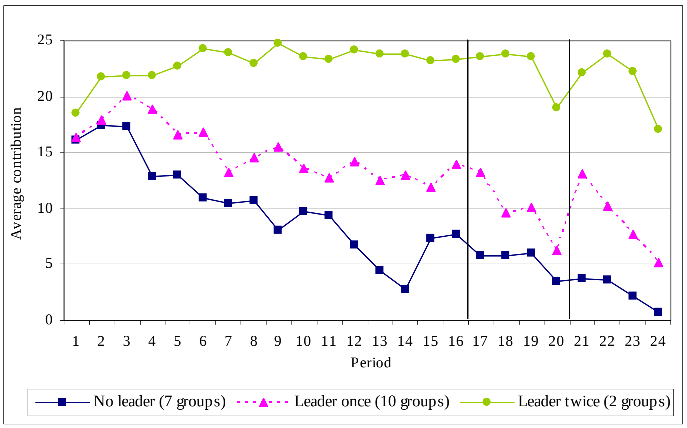

Figure 3: Average contribution in *REWARD* by type of group

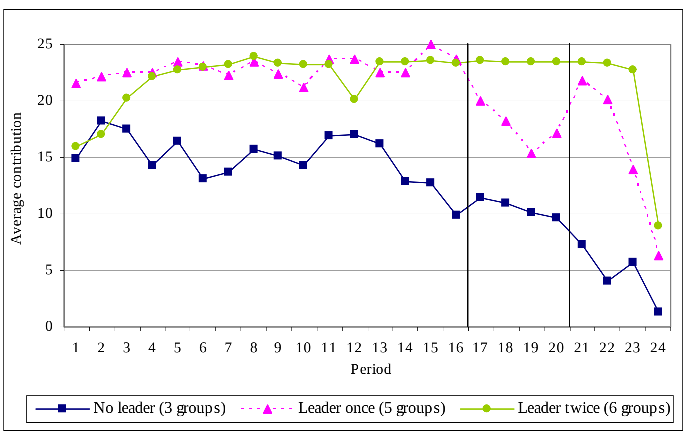

Figure 4: Average contribution in *EXCLUSION* by type of group

Probit regressions	Periods 17 and 21	
Dependent variable:	Vote for leader	
	Marginal effect	Robust Std.Err.
Subject was leader periods 1-16	-0.083	0.074
Avg own contribution periods 1-16	0.007	0.008
Avg others' contribution periods 1-16	0.016**	0.008
Std.dev. of group contrib periods 1-16	-0.002	0.013
EXCLUSION	-0.019	0.072
Period 21	0.131***	0.052
Number of observations	164	

***signif. at 1% level **signif. at 5% level

Table 6: Estimation of the probability of voting for a leader

Table 6 reports a probit regression of the likelihood of voting for a leader in period 17 or period 21. The independent variables are being a leader in periods 1-16, one's own contributions, the other group members' contributions, and the standard deviation of contributions within a group in periods 1-16. The latter variable is intended to capture whether strong heterogeneity of group members with respect to contributions has an impact on the likelihood to vote for a leader, controlling for the average level of contributions. It turns out that the likelihood to vote for a leader is significantly increasing with he other group members' contributions and that it is higher in period 21 than in period 17. The latter might be due to the bad experiences with no leader in periods 17-20. The former result shows that more cooperative groups are more likely to have a leader. We summarize the findings in this subsection as follows:

Result 3: Voting behavior in periods 17 and 21 depends strongly on behavior in periods 1 to 16. More cooperative groups are more likely to vote for leadership. Failing to accept a leader has high efficiency costs. Those groups contributing the most in periods 1 to 16, succeed in establishing a leader in both ballots and have the highest contributions in periods 17 to 24. Groups with the lowest contributions in periods 1 to 16 have no leader and therefore the lowest contributions in periods 17-20 and 21-24.

4.2 Question (B): The effects of voluntary leadership

In this subsection we analyze whether voluntary leadership in a sequential public goods game may have different effects from enforcing leadership exogenously. For this purpose, we compare treatments *ENDOGENOUS* and *EXOGENOUS*, and each of them with *CONTROL*.

Table 2 has shown that the average contributions in *ENDOGENOUS* are about 50 percent higher than in *CONTROL* and almost 80 percent higher than in *EXOGENOUS*. Figure 5 displays the intertemporal development of contributions, indicating that average contributions are in each single period clearly highest if leadership is taken over voluntarily in *ENDOGENOUS*.

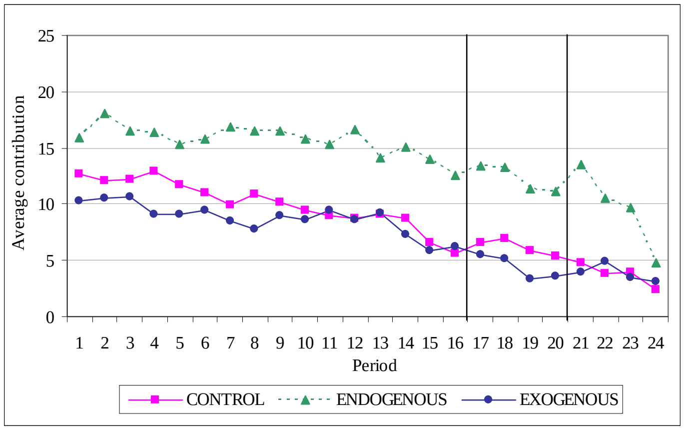

Figure 5:Average contributions in *CONTROL*, *REWARD* and *EXCLUSION*

Dependent variable: contribution		
	Coefficient	Robust Std.Err.
ENDOGENOUS	4.90**	2.37
EXOGENOUS	-2.30	1.98
Subject is leader	4.13***	0.77
ENDOGENOUS * Subject is leader	-0.99	1.05
Period	-0.27***	0.04
Constant	12.37***	1.58
Number of observations	2880	
Number of groups	45	

***signif. at 1% level **signif. at 5% level

Table 7: Estimation of the contribution in *CONTROL*, *ENDOGENOUS*, and *EXOGENOUS*

Table 7 reports an OLS-regression, showing a statistically significant treatment effect of voluntary leadership in *ENDOGENOUS*, compared to both *CONTROL* and *EXOGENOUS*. There is no significant difference between *EXOGENOUS* and *CONTROL*, though. Recall that the sequence of group members acting as leaders in *EXOGENOUS* is determined by a matched group in *ENDOGENOUS*. Hence, groups in *EXOGENOUS* also have leaders, but this forced leadership does not raise contributions above the level prevailing in *CONTROL*. Table 7 also indicates that leaders contribute significantly more than followers (similar to the *REWARD*-treatment) and that the difference in contributions of leaders and followers does not depend on whether leadership is voluntary or not. The latter shows that voluntary leadership shifts the level of contributions upwards, but it does not change the relationship between leaders' and followers' contributions.

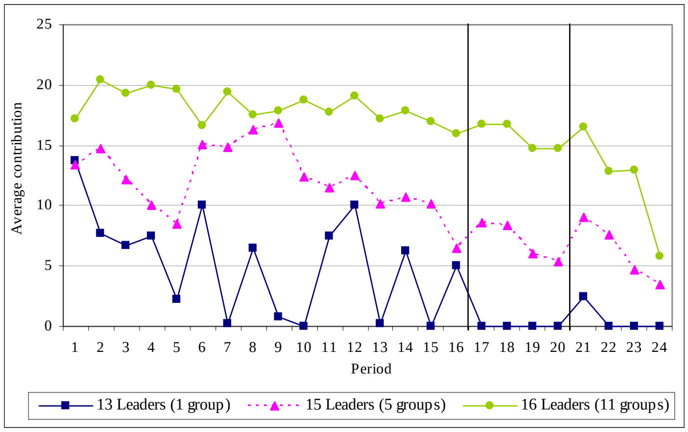

Figure 6: Average contribution in *ENDOGENOUS* by number of leaders

Figure 6 separates the groups in *ENDOGENOUS* by the frequency with which one group member volunteered as leader in periods 1-16. Note that no group ever had a leader in less than in 13 out of 16 periods, and that most groups had a leader in 15 or 16 periods. Despite these seemingly small differences in the frequency of voluntary leadership, Figure 6 has a clear message. Those groups with voluntary leadership in each single period have clearly the highest contributions. Those groups with the most frequent failure of voluntary leadership perform worst with respect to contributions. The failure to have a voluntary leader permanently in periods 1-16 continues to have detrimental effects on contributions also in periods 17-24, as Figure 6 indicates. We summarize the findings of this subsection as follows:

Result 4: Voluntary leadership increases contributions significantly. Groups with members who volunteer in each single period for leadership have the highest contributions. Exogenously forced leadership does not raise contributions above the level prevalent without leadership.

4.3 Question (C): The effects of leaders contributing *after* the other group members

In this subsection we study whether allowing the leader to observe the contributions of the other group members before taking his decision in *LAST* increases the average contribution of the group. Thus, we address the issue whether sequentiality itself (in whichever order) has a positive effect on contributions in a public goods experiment.

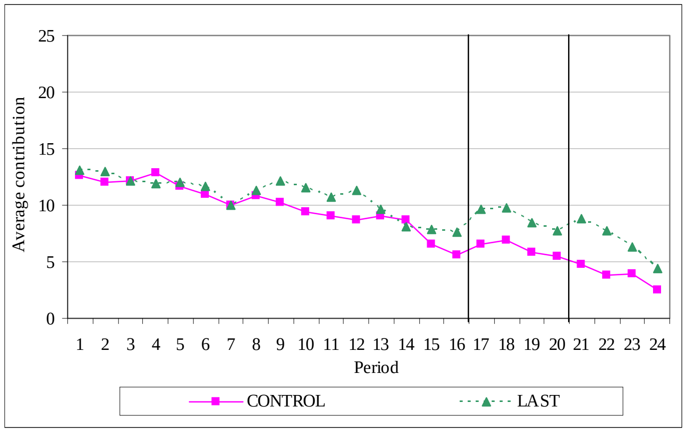

Figure 7: Average contributions in *CONTROL* and *LAST*

OLS regression clustered by group		
Dependent variable: contribution		
	Coefficient	Robust Std.Err.
LAST	1.19	2.25
Subject is leader	-1.39	1.31
Period	-0.36***	0.05
Constant	13.12***	1.57
Number of observations	2880	
Number of groups	45	

***signif. at 1% level

Table 8: Estimation of the contribution in *CONTROL* and *LAST*

Looking at Figure 7 and checking the average contributions reported in Table 2 shows that there is no difference in contributions between the *CONTROL*-treatment without leadership and treatment *LAST* where the leader only contributes after all other group members have done so. Hence, the sequential contribution procedure in *LAST* does not increase contributions, nor does it decrease them. This is confirmed in the regression results shown in Table 8, where the dummy for *LAST* is not significant.[9] Somewhat differently than in the *REWARD*- and *ENDOGENOUS*-treatment, the leaders (who contribute after the others) do not contribute significantly less than the other group members, even though the sign of "Subject is leader" is negative. We summarize the findings in this subsection as follows:

Result 5: Sequentiality itself does not raise contributions, because if leaders contribute after the other group members then contributions are not higher than in the benchmark case of no leader in CONTROL.

[9] Regressions not reported here show that the contributions in *LAST* are significantly smaller than in *REWARD*, *EXCLUSION* and *ENDOGENOUS*, but not different from those in *EXOGENOUS*. This means that the reverse leadership in *LAST* yields lower contributions than whenever leadership is taken over voluntarily or when a leader has a reward- or sanctioning device at his disposal.

5 Conclusion

We have studied the importance of leadership in the provision of public goods. Leadership has been implemented in a very simple form by allowing for sequential contributions to a public good, where the leader either contributes before or after all other group members. We have examined various aspects of leadership that have not been addressed so far in the still growing literature on leadership effects in public goods experiments. In the introduction we have formulated three main research questions. Given our experimental results, we are able to answer these questions now.

Answer (A): Leaders with an option to reward followers are less effective than leaders with a sanctioning device through exclusion. However, leadership with a reward option is still (much) more efficient than a situation without any leader. This answer has been determined by comparing treatments *REWARD* and *EXCLUSION* and by relating the level of cooperation in them with the one in *CONTROL*. We find that the higher the positive (negative) deviation from the leader's or the followers' contribution, the higher the probability of being rewarded (excluded). Contrary to punishment via exclusion, the likelihood of reward is decreasing across rounds, thereby causing lower contributions in *REWARD* than in *EXCLUSION*, even though being rewarded has been found to increase subsequent contributions more than being excluded. Of course, the effects of reward and punishment have been analyzed previously in situations where each group member can reward or punish any other group member (like in Fehr and Gächter, 2000, Sutter et al., 2006, or Sefton et al., 2007). Our paper shows that reward and punishment are both useful instruments for leaders to increase contribution levels, and the paper contributes to the literature on leadership by being the first one to consider leadership with a reward option for leaders.

Answer (B): Voluntary leadership —even without any reward or sanctioning device— yields clearly higher contributions than the benchmark case without any leader. The contributions observed in treatment *ENDOGENOUS* are about 50 percent higher than in the *CONTROL*-treatment. However, the sequential contribution through leadership does not raise contributions *per se*. The latter fact has been established by comparing contributions in *ENDOGENOUS* with those in *EXOGENOUS*, where the latter treatment is an exact replication of the former, except that the leader who contributes first is determined exogenously in the latter treatment, while in *ENDOGENOUS* one group member volunteers for being the first to set an example for the other group members. The positive effects of endogenous leadership are reminiscent of the positive effects of endogenous institutional choice in public goods experiments documented in Gürerk et al. (2006) and Sutter et al. (2006). Whenever subjects can influence the way the interaction in a social-dilemma situation is structured, this seems to affect their level of cooperation positively. Whereas Gächter and Renner (2004) have already shown that it does not matter for contribution levels whether a leader is chosen randomly among the group members or whether the most, or least, cooperative member is (exogenously) assigned to be leader, our paper has shown that endogenizing leadership has a very strong and positive effect on cooperation in groups. In particular, it seems noteworthy that endogenous leadership yields on average even higher contributions than if exogenously determined leaders have a reward device at their disposal. Hence, for the organization of groups it seems important to leave room for leadership to emerge endogenously within groups.

Answer (C): Sequentiality itself does not raise contributions. Hence, introducing a sequence of moves in the private provision of public goods is no universal means of inducing more cooperation. If leaders contribute *after* the other group members in treatment *LAST* then contributions are not higher than in the benchmark case of having no leader in *CONTROL*. It seems reasonable to assume that if leaders contribute *last* then the other group members may perceive that as a means to control them rather than as a leader setting a good example. Recent work by Falk and Kosfeld (2006), for instance, suggests that controlling the actions of others in a principal-agent-game may crowd out the intrinsic motivation of agents to behave cooperatively. Seen from this perspective, letting leaders contribute *last* might have even reduced the overall contributions below the level prevalent without leadership. This is not what we have found, though, since contributions are as high in *LAST* as in *CONTROL*.

Integrating the answers to our three research questions, it seems justified to conclude that the dos of leadership include voluntary leadership and equipping leaders with reward or sanctioning mechanisms, whereas the don'ts of leadership are forcing leadership by moving first through an exogenous authority as well as reversing the sequence of leadership by letting the leader contribute after the other group members.

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Appendix: Experimental Instructions (*not intended for publication*)

This appendix contains the instructions (originally in German) we used for the *EXCLUSION*-treatment. The instructions for the other treatments were adapted appropriately and are available upon request.

Welcome and thanks for participating in this experiment. You receive 2.50 Euro for having shown up on time. If you read these instructions carefully, you can make good decisions and earn more. The 2.50 Euro and all additional amount of money will be paid out to you in cash immediately after the experiment.

During the experiment, amounts will be denoted by ECU (Experimental Currency Unit). ECU are converted to euros at the following exchange rate: 1 ECU = 0.06 Euro.

It is strictly forbidden to communicate with the other participants during the experiment. If you have any questions or concerns, please raise your hand. We will answer your questions individually. It is very important that you follow this rule. Otherwise we must exclude you from the experiment and from all payments.

Detailed information on the experiment

The experiment consists of 24 separate periods, in which you will interact with three other participants. The four of you form a group that will remain THE SAME in all 24 periods. You will never know which of the other participants are in your group. The group composition is secret for every participant.

What you have to do

At the beginning of each period, each participant receives an amount of 25 ECU. In the following, we shall refer to this amount as *your endowment*.

Your task (as well as the task of your group members) is to decide **how much of your endowment you want to contribute to a project.** Whatever you do not contribute, you keep for yourself ("ECU you keep").

In every period, your earnings are the sum of the following two parts:

1. the "ECU you keep";
2. the "income from the project".

The "*income from the project*" is determined by adding up the contributions of the four group members and multiplying the resulting sum by 0.4. That is:

Income from the project = [0.4 × (total group contribution)] ECU

Each ECU that you contribute to the project rises "income from the project" by 0.4 ECU. Since "income from the project" is the same for all four members of the group (i.e., all receive the same income from the project as this is determined by the total group contribution), each ECU that you contribute to the project rises YOUR period-earnings *as well as* the period-earnings of YOUR GROUP MEMBERS by 0.4 ECU. The same holds for the contributions of your group members: Each ECU that any of them contributes to the project increases "income from the project" (and therefore your earnings) by 0.4 ECU.

The "ECU you keep" are your endowment *minus* your contribution to the project. Each ECU that you keep for yourself raises "ECU you keep" and YOUR period-earnings by one ECU. Thus, each ECU that you keep yields money for YOU ALONE.

How you interact with your group members in each period

Within your group you are identified by a number between 1 and 4. This number will be assigned to you privately at the beginning of the experiment.

Each period consists of the following three stages:

1. One group member first decides about his/her own contribution. In the following, we shall refer to the group member who decides first as the "*early contributor*".
2. Being informed about the decision of the early contributor, the other three group members decide simultaneously and privately about their own contribution.
3. The early contributor learns about the contribution of the others, and (s)he can decide to exclude at most one of them from the group *in the next period*.

   • If the early contributor DOES NOT EXCLUDE ANYONE, next period's "income from the project" and the earnings you are due in that period are determined as before.

   • If the early contributor EXCLUDES SOMEONE, in the following period the interacting group members will be three rather than four, and the "income from the project" is determined by adding up only their three contributions. Since the excluded group member stays out of the game, his (her) earnings in the subsequent period are merely equal to his/her endowment (i.e., 25 ECU).

Consider the following example: Member 1 is the early contributor in period 1 and contributes a certain amount. Knowing the contribution of the early contributor, the three other members of the group decide on their contribution, which is then communicated to the early contributor. If the early contributor decides, for instance, to exclude member 2, this means that member 2 is excluded from the group in the next period, i.e., in period 2. Hence, in period 2 only members 1, 3 and 4 interact with each other and their earnings in period 2 are as follows: "*ECU each keeps* + [0.4 × (sum of contributions of members 1, 3, and 4)]". Since member 2 does not participate in the interaction in period 2, (s)he just keeps his/her endowment. Note that member 2 will re-enter the group in period 3.

At the beginning of the experiment, one member of each group is randomly selected to be the “early contributor” for the first 16 periods. The group member who is selected as the early contributor see this in an “Information Window", which will appear on his/her screen at the beginning of the experiment.

At the end of period 16, there will be two more phases (á four periods). In each of these two phases, group members will have the opportunity to choose themselves whether they want the early contributor to keep on being so or not.

How you choose whether you want or not an early contributor

In periods 17 and 21, you are requested to indicate whether you want the early contributor to continue being the early contributor or not. If you want him/her to keep on being the early contributor, you must press the “Yes” button on the screen. Otherwise (i.e, if you do not want him/her to be the early contributor), you must press the “No” button.

- If the early contributor receives *four “Yes"* (i.e., if (s)he wants as well to be the early contributor), (s)he will be the early contributor in the respective phase, and the sequence of decisions is as described above.
- Otherwise (i.e., if the early contributor does not receive *four “Yes"*), there will be no longer an early contributor, and you as well as your group members must make your contribution decisions simultaneously and privately. This, of course, also means that there will be no opportunity to exclude any group member in this phase.]

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 *each* of your group members as well as about your period-earnings.

Your final earnings

Your final earnings will be calculated as follows:

1. For each of the six phases of the experiment, one period will be randomly selected.
2. Your earnings in these 6 periods will be added up.
3. The resulting sum will be converted to euros and paid out to you in cash.

Before the experiment starts, we will run a control questionnaire to verify your understanding of the experiment.

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

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The dos and don’ts of leadership in sequential public goods experiments

Abstract

We study the effects of leadership in the provision of public goods by examining (i) the relative importance of reward and punishment as leadership devices, (ii) whether endogenous leadership is more efficient than exogenously enforced leadership, and (iii) whether leaders contributing last, instead of first, also increase contributions. The experimental results are: (i) Reward options yield lower contributions than punishment through exclusion. (ii) Endogenous leadership is much more efficient than exogenously imposed leadership. (iii) Sequentiality itself is not beneficial for contributions since groups where the leader contributes as the last member do not contribute more than groups without a leader.

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