

# Leadership in public goods experiments - On the role of reward, punishment and endogenous leadership

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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, and (ii) whether endogenous leadership is more efficient than exogenously enforced leadership. 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.

*Keywords:* Public goods experiment, Leadership, Exclusion power, Reward, Endogenous leadership

*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 group 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)<sup>1</sup>, 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 the following two research questions on 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?

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<sup>1</sup>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 (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, however 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, Gürer et al., 2006, 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, while 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. A recent working paper by Arbak and Villeval (2007) has addressed the issue of endogenous leadership for the first time. They have set up groups of three subjects. Each of them can volunteer as leader in a two-stage public goods game. The leader's contribution in the first stage is announced to the other group members who can then decide on their contribution in the second stage. If two or three group members volunteer as leader, then only one is picked randomly. Arbak and Villeval (2007) find in their experiment with random rematching that about one quarter of subjects is willing to serve as leader (which is typically costly since followers contribute on average less than leaders). Hence, about 56% of groups have a leader across the 30 rounds of the experiment. While the main focus of the paper by Arbak and Villeval (2007) is on examining the reasons why subjects volunteer as leaders, they also try to assess the effects of endogenous leadership by comparing their benchmark treatment to a treatment with imposed leadership, finding that endogenous leadership yields higher contributions on average. However, the comparison is partly confounded by the fact that in the treatment with exogenously imposed leadership there is a leader in 100% of cases, which means that the differences between the endogenous and exogenous leadership treatment may be caused by the voluntary leadership of leaders in the endogenous treatment or the differences between both treatments in having a leader at all in a group. In this paper, we try to account for this confound

in the following way. 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. We then compare this treatment with a control treatment where the leader is determined exogenously in the exactly same order as in the endogenous treatment. This means that when there is no leader in a given period and group in the endogenous treatment, we will also have no leader in this period in a matched group with exogenously imposed leadership. We find that voluntary leadership increases contributions significantly, while leadership itself (i.e., the sequential contribution to the public good) need not have a positive effect (compared to a standard public goods game without 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 we have designed the following five experimental treatments<sup>2</sup>:

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<sup>2</sup>Treatments *CONTROL* and *EXCLUSION* are taken from 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).

- (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 her 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 2 ECU if one group member is rewarded.
- (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— 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 15 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 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*. 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*).

Note that for answering our research question (A) on the comparative effects of rewards and sanctions 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*.

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.

## 3.2 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*, *EXCLUSION*, and *ENDOGENOUS* 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.<sup>3</sup> 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.<sup>4</sup>

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.

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<sup>3</sup>This was communicated to the participants at the beginning of the experiment, as can be seen in the instructions in the appendix. Note that the voting outcome in part two in treatment *ENDOGENOUS* determined also whether there was any leadership in *EXOGENOUS*. Hence, there was no voting in treatment *EXOGENOUS*.

<sup>4</sup>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.

Treatment	# of groups
<i>CONTROL</i>	14
<i>REWARD</i>	19
<i>EXCLUSION</i>	14
<i>ENDOGENOUS</i>	17
<i>EXOGENOUS</i>	14

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 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 five 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 4.1.4). 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. Table 3 shows how frequently a leader decides to reward a follower with 10 ECU, or punish a follower through exclusion. The difference is remarkable, as the average relative frequency of reward is 0.41, but only 0.12 for exclusion.

	Periods 1 - 16		Periods 17 - 24		Freq. approving leadership		Average earnings
	Avg.contribution	(Std.dev.)	Avg.contributio	(Std.dev.)	Period 17	Period 21	Periods 1 - 16
<i>CONTROL</i>	10.04	(8.91)	4.96	(7.56)	----	----	31.02
<i>REWARD</i>	14.16	(9.76)	8.70	(9.60)	26.3%	47.4%	33.91
<i>EXCLUSION</i>	20.78	(7.16)	16.86	(9.90)	57.1%	64.3%	36.68
<i>ENDOGENOUS</i>	15.70	(8.97)	10.95	(9.81)	41.2%	58.8%	34.42
<i>EXOGENOUS</i>	8.74	(8.50)	4.12	(5.84)	----	----	30.24

Table 2: Average contributions and earnings in ECU, and frequency of approving leadership

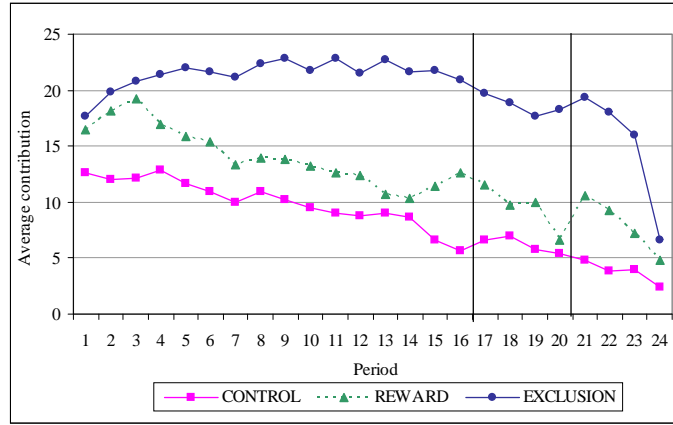


Figure 1: Average contributions in *CONTROL*, *REWARD* and *EXCLUSION*

Period	Frequency leader decided to reward a follower	Frequency leader decided to exclude a follower
1	0.63	0.14
2	0.63	0.07
3	0.53	0.14
4	0.26	0.07
5	0.58	0.14
6	0.37	0.07
7	0.37	0.07
8	0.26	0.29
9	0.37	0.21
10	0.42	0.14
11	0.37	0.14
12	0.32	0.21
13	0.42	0.14
14	0.26	0.00
15	0.42	0.07
16	0.32	0.00
Average	0.41	0.12

Table 3: Frequency leaders decide to reward/exclude a follower

Random Effects Tobit Regression		
Dependent variable: contribution		
	Coefficient	Std.Err.
<i>REWARD</i>	6.99***	2.50
<i>EXCLUSION</i>	10.69***	2.78
Subject is leader	1.49	4.04
Subject is leader * <i>REWARD</i>	2.27	5.23
Period	-0.64***	0.07
Period * <i>REWARD</i>	-0.19*	0.10
Period * <i>EXCLUSION</i>	1.39***	0.13
Constant	15.07***	1.78
Number of observations	2981	
Number of groups	188	

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

Table 4: Estimation of the contribution in *CONTROL*, *REWARD* and *EXCLUSION*

Table 4 shows the results of a random effects Tobit estimation where the dependent variable is the contribution to the public good. The independent variables are the period, dummies for *REWARD* and *EXCLUSION*, a dummy for being the leader in the group, and interaction variables between the latter and *REWARD*, and between the period and *REWARD* and *EXCLUSION*. Groups with leaders that have a reward option have 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*. Together with the evidence presented in Table 3, we can conclude that the effect of exclusion does not rely on a high frequency of exclusions. Instead, the mere existence of the possibility of being excluded is a strong motivation for contributing high amounts to the public good. Judging from the evidence in Table 3 and Figure 1, though, it seems as if the average contributions in the *REWARD*-treatment are strongly correlated with the relative frequency with which the leader rewards a group member (correlation coefficient = 0.43,  $p < 0.05$ ). Contrary to punishment then, the reward option has to be used in order to stimulate higher contributions.

Concerning the intertemporal development of contributions, our estimates confirm what we have observed in Figure 1: the decline in contributions occurs only in *CONTROL* and *REWARD*, but not in *EXCLUSION*. Hence, only the exclusion option yields stable contributions over time.

The estimation in Table 4 also shows that the leaders in a group do not contribute systematically more than the other group members. The average contribution of leaders in *REWARD* (*EXCLUSION*) is 16.16 ECU (21.82 ECU), while followers contribute on average 13.50 ECU (20.65 ECU), which amounts to 84% (95%) of the leaders' contributions. The correlation between leaders' and followers' contributions is positive and highly significant in both treatments.<sup>5</sup> We summarize this subsection as follows:

<sup>5</sup>The Pearson correlation coefficient between the leader's and the followers' contributions is 0.681 in *REWARD* and 0.831 in *EXCLUSION* ( $p - value = 0.00$ ).

*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 device is more effective than a reward option.*

### 4.1.2 Efficiency

Table 2 shows that average earnings are the highest in *EXCLUSION*, followed by *REWARD*, and then *CONTROL*, but the differences are not as remarkable as with the average contributions.<sup>6</sup> This happens even though *EXCLUSION* and *REWARD* imply costs that affect negatively the earnings—and therefore the efficiency.<sup>7</sup> Measuring efficiency as the actually obtained earnings as a percentage of the maximum possible earnings, we find that average efficiency is very high in *EXCLUSION* (92%), followed by *REWARD* (83%), and *CONTROL* (78%). Maximum earnings in *EXCLUSION* and *CONTROL* are 40 ECU per group member and period. They are achieved if every subject contributes the full endowment to the public good and nobody is excluded. In *REWARD* the maximum earnings are achieved when every subject contributes the full endowment and one subject is rewarded with 10 ECU—which costs 6 ECU to the group, yielding 41 ECU per group member and period. Figure 2 shows the average earnings (with dotted lines) and efficiency (with solid lines) by period. In *CONTROL* and *REWARD*, both variables are decreasing, while in *EXCLUSION* they are stable at very high levels.

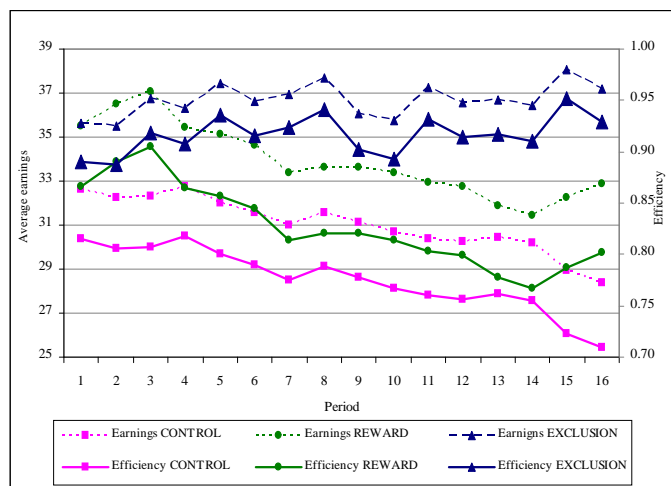


Figure 2: Average earnings and efficiency in *CONTROL*, *REWARD* and *EXCLUSION*

<sup>6</sup>Pairwise mean comparisons yield p-values < 0.01.

<sup>7</sup>Recall that in *REWARD* when a subject is rewarded, 2 ECU are deducted from the earnings of the other players—including the leader

*Result 2: EXCLUSION yields the highest efficiency, while REWARD and CONTROL do not differ with respect to efficiency.*

### 4.1.3 Causes and consequences of being rewarded or excluded

The previous subsection has shown that both reward and exclusion increase contributions. In this subsection we examine which group members are rewarded, respectively excluded, and how these members react to reward or exclusion. Figure 3 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.<sup>8 9</sup>

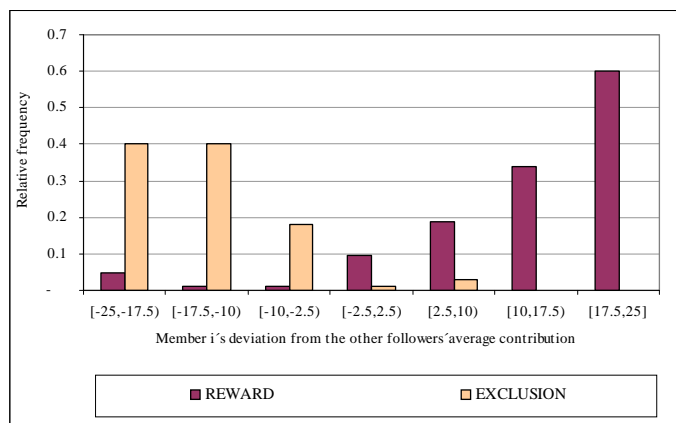


Figure 3: Reward and exclusion depending on the deviation from the other followers’ contribution

<sup>8</sup>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 3 was almost exactly replicated if we used on the horizontal axis the difference between the respective group member’s and the leader’s contribution.

<sup>9</sup>Like Fehr and Gächter (2000), we also observe a positive, but relatively small number of low contributors who 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.

Random Effects Probit Regressions				
Dependent variable:	Subject rewarded		Subject excluded	
	Marginal effect	Std.Err.	Marginal effect	Std.Err.
Positive deviation from other followers	0.01***	0.02	-0.02	0.06
Negative deviation from other followers	-0.04	0.03	-0.01	0.06
Positive deviation from leader	0.02	0.02	0.05	0.09
Negative deviation from leader	-0.02	0.02	0.13**	0.06
Period	-0.03**	0.01	-0.03	0.03
Number of observations	912		645	
Number of groups	57		42	

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

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

Table 5 confirms the basic insights from Figure 3 by reporting the results from a panel 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 5 shows that the probability of being rewarded increases with the positive deviation from the other followers’ contribution, and decreases 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 5. The deviation from the leaders’ contribution (other followers’ contribution) is not significant for *REWARD* (*EXCLUSION*). Figure 2 suggests that both probabilities are influenced by the deviation from other followers’ contribution. One explanation for not finding that both deviations influence both probabilities lies in the high correlation between the deviation from the other followers’ and the leader’s contributions, both of which are considered in the estimation.

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

Table 6 shows the effects of being rewarded or excluded on a member’s contribution in the next period. We show random effects Tobit regressions where the dependent variable is the contribution to the public good. The independent variables in *REWARD* are a dummy variable that indicates if the subject was rewarded in the previous period, a dummy variable that takes value 1 if another 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 the subject was excluded the previous period, and a dummy indicating if another group member was excluded the previous period, keeping the other variables identical to the regression for *REWARD*.

Random Effects Tobit Regression						
Dependent variable: contribution	Treatment: <i>REWARD</i>			Treatment: <i>EXCLUSION</i>		
	Coefficient	Std.Err.		Coefficient	Std.Err.	
Subject was rewarded previous period	4.00***	1.57		Subject was excluded previous period	5.17***	1.87
Other subject was rewarded previous period	2.44**	1.11		Other subject was excluded previous period	1.43	1.33
Group contribution previous period	0.15***	0.02		Group contribution previous period	0.27***	0.02
Subject is leader	3.97	3.00		Subject is leader	1.29	2.61
Period	-0.61***	0.10		Period	0.21***	0.08
Constant	11.21***	2.37		Constant	5.23**	2.45
Number of observations	1140			Number of observations	813	
Number of groups	76			Number of groups	56	

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

Table 6: Estimations of the effect of being rewarded/excluded

Both reward and exclusion yield higher contributions of the affected group member in the next period. If a subject was rewarded with 10 ECU, contributions increase by an estimated 4.00 ECU, while if a subject was excluded, the increase is estimated at 5.17 ECU. Nevertheless, the effect of another follower being affected (rewarded or excluded) is only significant in *REWARD*. If another follower was rewarded the previous period, the contribution of a non-rewarded follower increases by an estimated 2.44 ECU.<sup>10</sup> 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, Kocher et al., 2008, Fischbacher and Gächter, 2009). The dummy for the leader is not significant, confirming our findings in Table 4. We summarize this subsection as follows:

*Result 3: 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.*

#### 4.1.4 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 4 and 5 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 4 that successful groups in periods 1-16 of the *REWARD*-treatment are those that succeed to keep a leader in periods 17-24, which suggests that success breeds success, since leadership leads to higher contributions,

<sup>10</sup>This reaction may be explained by the fact that non-rewarded followers are de facto punished with 2 ECU.

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 5, 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 (permanently 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.

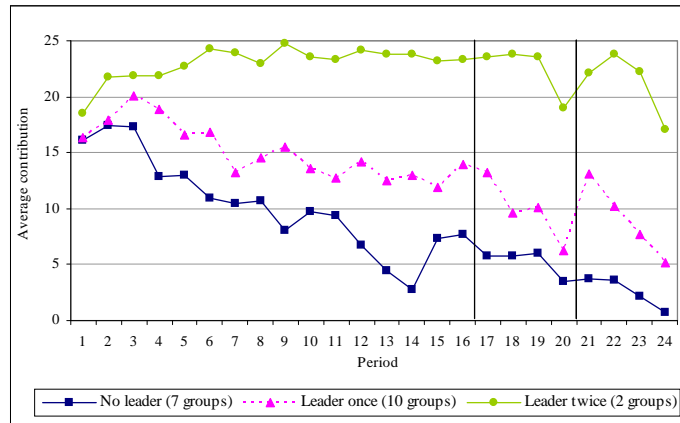


Figure 4: Average contribution in *REWARD* by type of group

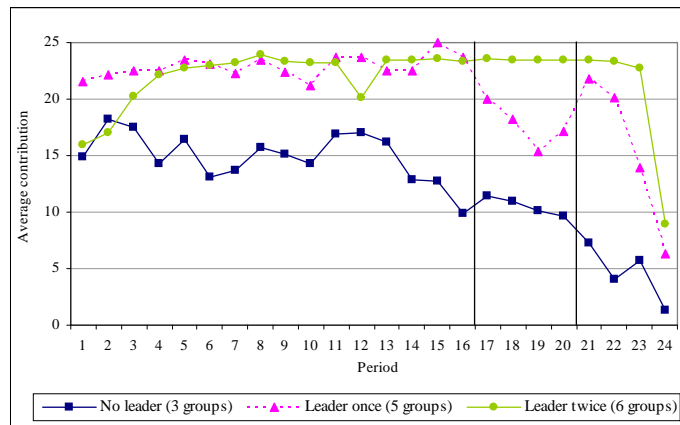


Figure 5: Average contribution in *EXCLUSION* by type of group

Random Effects Probit Regressions	Periods 17 and 21	
Dependent variable:	Vote for leader	
	Marginal effect	Std.Err.
Subject was leader periods 1-16	-0.36	0.29
Avg own contribution periods 1-16	0.03	0.03
Avg others' contribution periods 1-16	0.07**	0.03
Std.dev. of group contrib periods 1-16	-0.01	0.06
<i>EXCLUSION</i>	-0.09	0.31
Period 21	0.59***	0.22
Number of observations	254	
Number of groups	132	

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

Table 7: Estimation of the probability of voting for a leader

Table 7 reports a random effects 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. However, this variable is not significant. It turns out that the likelihood to vote for a leader is significantly increasing with the 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 this subsection as follows:

*Result 4: 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 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, as a consequence, 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 shows that the average contributions in *ENDOGENOUS* are about 50 percent higher than in *CONTROL* and almost 80 percent higher than in *EXOGENOUS*. Table 8 shows the frequency of the number of times a subject is the leader of her group, with an average of 3.88 and a maximum of 11 times. No group failed to have a leader in more than 3 periods out of 16 periods.

# of times	Frequency
0	6
1	5
2	13
3	10
4	8
5	10
6	7
7	2
8	3
10	3
11	1
Average	3.88

Table 8: # of times a subject is the leader of the group

Figure 6 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*.

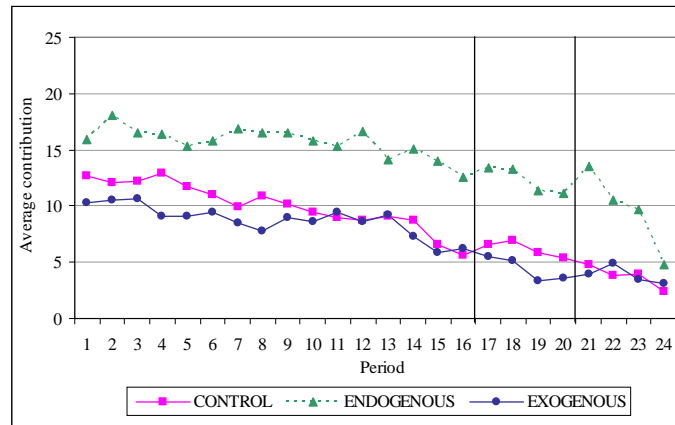


Figure 6: Average contributions in *CONTROL*, *REWARD* and *EXCLUSION*

Table 9 reports a random effects Tobit regression, showing a statistically significant positive treatment effect of voluntary leadership in *ENDOGENOUS*. There is also a significant difference between *EXOGENOUS* and *CONTROL*, but in the opposite direction. 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*; on the contrary, it decreases contributions.

Random Effects Tobit Regression		
Dependent variable: contribution		
	Coefficient	Std.Err.
<i>ENDOGENOUS</i>	5.95***	2.25
<i>EXOGENOUS</i>	-6.59***	2.33
Subject is leader	6.83***	0.79
Subject is leader * <i>ENDOGENOUS</i>	-2.62**	1.10
Period	-0.62***	0.07
Period * <i>ENDOGENOUS</i>	0.30***	0.09
Period * <i>EXOGENOUS</i>	0.27***	0.10
Constant	14.92***	1.64
Number of observations	2880	
Number of groups	180	

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

Table 9: Estimation of the contribution in *CONTROL*, *ENDOGENOUS*, and *EXOGENOUS*

Table 9 also indicates that leaders contribute significantly more than followers and that the difference in contributions of leaders and followers is smaller in *ENDOGENOUS*. Contrary to Arbak and Villeval (2007), we find that voluntary leadership not only shifts the level of contributions upwards, but also it decreases the difference between leaders' and followers' contributions.<sup>11</sup> In *EXOGENOUS*, the followers' average contributions (7.79 ECU) are on average 67% of the leaders' contributions (11.58 ECU), while in *ENDOGENOUS* the followers' contributions (15.34 ECU) correspond to 85% of the leaders' contributions (17.96 ECU).

One explanation for the difference in the contributions of leaders between the two treatments is that in *ENDOGENOUS* the most generous subjects are likely to volunteer as leaders while in *EXOGENOUS* selfish subjects could be randomly chosen to be the leader. Another explanation is that leaders anticipate that followers value the leader's contribution more —meaning that followers will reciprocate more— when leaders volunteer to be leaders than in the case when they are exogenously chosen to be leaders, and therefore leaders set more cooperative examples in *ENDOGENOUS* than in *EXOGENOUS*.

Moreover, Table 9 shows that the decrease across periods is observable especially in *CONTROL* while in the other two treatments the decrease is less remarkable.

Figure 7 shows the average earnings and efficiency of the three treatments. Both variables attain their maximum in *ENDOGENOUS*, followed by *EXOGENOUS* and *CONTROL*, which are very similar.

<sup>11</sup>Arbak and Villeval (2007) find that voluntary leaders are not more influential than imposed leaders, endogenous leaders do not induce higher contributions from the followers than imposed leaders.

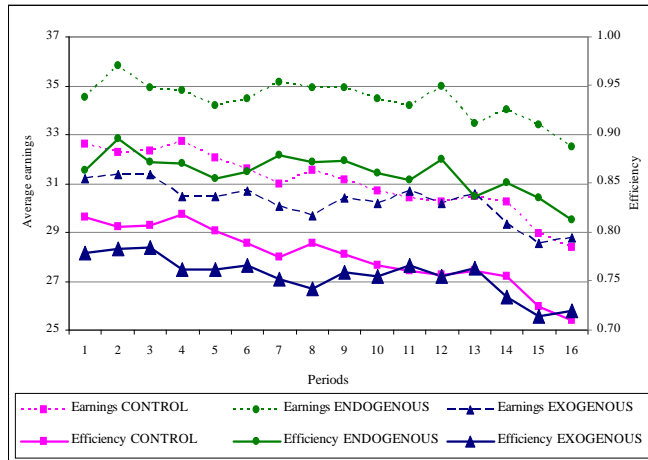


Figure 7: Average earnings and efficiency in *CONTROL*, *ENDOGENOUS* and *EXOGENOUS*

Figure 8 separates the groups in *ENDOGENOUS* by the number of periods in which a group had a 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 8 has a clear message. Those groups with voluntary leadership in each single period have clearly the highest contributions. The group with the most frequent failure of voluntary leadership performs worst with respect to contributions. The failure to have a voluntary leader in each single period of periods 1-16 continues to have detrimental effects on contributions also in periods 17-24, as Figure 8 indicates.

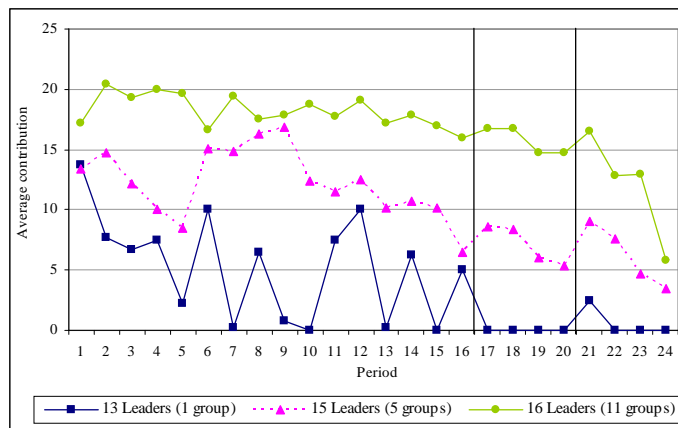


Figure 8: Average contribution in *ENDOGENOUS* by number of leaders

We summarize this subsection as follows:

*Result 5: Voluntary leadership increases contributions significantly. Groups in which members volunteer in each single period for leadership have the highest contributions. Exogenously forced leadership decreases contributions below the level prevalent without leadership.*

## 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 contributes before all other group members. In the introduction we have formulated two 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*. Moreover, the fact that it is cheap to punish a free-rider, but expensive to reward a cooperator<sup>12</sup>, is an important asymmetry that might help to explain why exclusion works better than reward. Similarly, the expected cost of being excluded is endogenous while the benefit to reward is always the same regardless of the decisions made by one’s group members.

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 only.

**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

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<sup>12</sup>The cost of exclusion is endogenous, depending on the excluded subjects’ expected decision. For example, excluding one follower who is expected to be a perfect free-rider has no expected cost to the group. On the other hand, there is always a cost of 2 ECU per non-rewarded group member in case of reward.

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. 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. A similar finding—in a slightly different design, though—has also been reported in a recent working paper by Arbak and Villeval (2007). Hence, the positive effects of voluntarily taking over the role of a leader seem to be robust. In our setting, it is also 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.

## References

- [1] Andreoni, J., Harbaugh, W., Vesterlund, L., 2003. The carrot or the stick: Rewards, punishments and cooperation. *American Economic Review* 93, 893-902.
- [2] Arbak, E, Villeval M-C, 2007. Endogenous leadership. Selection and influence. IZA Discussion Paper No. 2732.
- [3] Brandts, J., Schram, A., 2001. Cooperation and noise in public goods experiments: Applying the contribution function approach. *Journal of Public Economics* 79, 399-427.
- [4] Duffy, J., Ochs, J., Vesterlund, L., 2007. Giving little by little: Dynamic voluntary contribution games. *Journal of Public Economics* 91, 1708-1730.
- [5] Fehr, E., Gächter, S., 2000. Cooperation and punishment in public goods experiments. *American Economic Review* 90, 980-994.
- [6] Fischbacher, U., 2007. Z-tree. Zurich toolbox for readymade economic experiments. *Experimental Economics* 10, 171-178.
- [7] Fischbacher, U., Gächter, S., 2009. Social preferences, beliefs, and the dynamics of free riding in public goods experiments. *American Economic Review*, forthcoming.
- [8] Fischbacher, U., Gächter, S., Fehr, E., 2001. Are people conditionally cooperative? Evidence from a public goods experiment. *Economics Letters* 71, 397-404.

- [9] Gächter, S., Renner, E., 2004. Leading by example in the presence of free rider incentives. Working Paper, University of St. Gallen.
- [10] Gürer, Ö., Irlenbusch, B., Rockenbach, B., 2006. The competitive advantage of sanctioning institutions. *Science* 312 (7 April 2006): 108-111.
- [11] Güth, W., Levati, M.-V., Sutter, M., van der Heijden, E., 2007. Leading by example with and without exclusion power in voluntary contribution experiments. *Journal of Public Economics* 91, 1023-1042.
- [12] Herrmann, B., Thöni, C., Gächter, S., 2008. Antisocial punishment across societies. *Science* 319 (7 March 2008), 1362-1366.
- [13] Keser, C., van Winden, F., 2000. Conditional cooperation and voluntary contributions to public goods. *Scandinavian Journal of Economics* 102, 23-39.
- [14] Kocher, M., Cherry, T., Kroll, S., Netzer, J., Sutter, M., 2008. Conditional cooperation on three continents. *Economics Letters* 101, 175-178.
- [15] Levati, M. V., Neugebauer, T., 2004. An application of the English clock market mechanism to public goods games. *Experimental Economics* 7, 153-169.
- [16] List, J. A., Lucking-Reiley, D., 2002. The effects of seed money and refunds on charitable giving: Experimental evidence from a university capital campaign. *Journal of Political Economy* 110, 215-233.
- [17] Moxnes, E., van der Heijden, E. 2003. The effect of leadership in a public bad experiment. *Journal of Conflict Resolution* 47, 773-795.
- [18] Nikiforakis, N., 2008. Punishment and counter-punishment in public-good games: Can we really govern ourselves? *Journal of Public Economics* 92, 91-112.
- [19] Potters, J., Sefton, M., Vesterlund, L., 2005. After you - Endogenous sequencing in voluntary contribution games. *Journal of Public Economics* 89, 1399-1419.
- [20] Potters, J., Sefton, M., Vesterlund, L., 2007. Leading-by-example and signaling in voluntary contribution games: An experimental study. *Economic Theory* 33, 169-182.
- [21] Sefton, M., Shupp, R., Walker, J. M., 2007. The effect of rewards and sanctions in provision of public goods. *Economic Inquiry* 45, 671-690.

- [22] Sutter, M., Haigner, S., Kocher, M., 2006. Choosing the carrot or the stick? - Endogenous institutional choice in social dilemma situations. CEPR Discussion Paper 5497.
- [23] Vesterlund, L., 2003. Informational value of sequential fundraising. *Journal of Public Economics* 87, 627-657.

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

This appendix contains the instructions (originally in German) 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:

$$\text{Income from the project} = [0.4 \times (\text{total group contribution})] \text{ ECU}$$

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* +  $[0.4 \times (\text{sum of contributions of members 1, 3, and 4})]$ ”. 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.*