Leadership and cooperation in public goods experiments*

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Abstract

Leadership is important for the well-functioning of organizations. We examine the effects of leadership on contributions in public goods experiments. Leadership by example is implemented by letting one group member contribute to the public good before followers do. Such leadership increases contributions in comparison to the standard voluntary contribution mechanism, especially so when it goes along with authority, which we implement by granting the leader ostracism power. Whether leadership is fixed or rotating among group members has no significant influence on contributions. Only a minority of groups succeeds in endogenously installing a leader, even though groups with leaders are much more efficient than groups without a leader.

Keywords: Public goods experiment, leadership, ostracism power, endogenous selection.
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1 Introduction

Leadership is important in economic as well as political organizations. It allows to influence the behavior of others in a desired direction through leading by example instead of relying on (often incomplete) contractual relationships or hierarchical authority. Many well-known historical persons have realized and expressed the utmost importance of leadership for the well-functioning of groups or society in the absence of formal authority or coercion, think of Albert Schweitzer ("Example is leadership.") or Mahatma Gandhi ("We must be the change we wish to see in the world."). But even in cases where leaders have formal authority, and thus access to sanctioning devices, well-behaved leaders may encourage followers to do likewise. For instance, of a boss who is the first to arrive at work and the last to leave may induce his coworkers to work hard as well.

Despite its potential to influence behavior in social dilemma situations and its importance for the performance of work teams within organizations, only recently the issue of leadership has received substantial attention in the economics literature.[1] Hermalin (1998, 2003) has developed a formal theory of leadership, showing that a leader can induce rational agents to follow his actions via leading either by example or by sacrifice. In Hermalin's (1998) model, leadership even works in situations where the leader has incentives to mislead his followers. Arce (2001) and Foss (2001) have identified leadership in their models as a means to achieve efficient outcomes in social dilemma games.

Though economic theory is clear on the potential benefits of leadership, they are hard to determine unambiguously with field data, because such data typically lack a controlled variation of conditions - such as comparing *ceteris paribus* the behavior of groups with a leader to the behavior of groups without one. Due to the opportunity of running and replicating carefully controlled treatments, economic experiments provide a suitable tool to study the behavioral effects of leadership. Meidinger and Villeval (2002) have explicitly tested the model of Hermalin (1998), showing that leader-

[1] An early exception in economics is von Stackelberg (1934). Rotemberg and Saloner (1993) analyze leadership styles in an environment with incomplete contracts. They define leadership as the degree to which the leader empathizes with the followers and find that empathy can serve as a commitment device in organizations. Political theorists or social scientists have a longer and well-established tradition of studying leadership. See, e.g., Yukl (2001) for a survey.

ship works more efficiently through reciprocity than through signaling. In a public goods frame, Moxnes and van der Heijden (2003), van der Heijden and Moxnes (2003), and Gächter and Renner (2004) have implemented leadership in the laboratory by letting a group leader decide, first, on his contribution in a public goods or public bad game. The leader's decision is then communicated to the other group members who contribute simultaneously thereafter. All papers find that, on average, contribution behavior is more cooperative with a leader, compared to a control treatment where *all* group members contribute simultaneously to the public good.[2]

In this paper we provide a comprehensive experimental study on four aspects of leadership, which we will elaborate in more detail below. First, we re-examine the effects of leadership on contributions in a public goods experiment. Second, we vary the leader's formal power and explore the impact of strong leaders with some authority on contribution behavior. Third, we check whether the way in which leadership is assigned - either to one single member or to all group members in a rotating and predetermined scheme - affects behavior. Fourth, we address whether groups want to install a leader by voting and how the outcome of the vote is related to contribution behavior.

First, regarding repetition as a hallmark of experimental economics, we think it is necessary to provide additional evidence in order to corroborate earlier findings. All previous experiments on leadership have shown that leaders' and followers' contributions are highly correlated, and that overall contributions with leadership are (in most cases significantly) higher than without leadership.

Second, an important, but hitherto neglected, aspect of leadership relates to the leader's power. All previous studies only implement leadership by letting the leader contribute before the followers, thereby restricting the leader's feasible options to setting an example and to reacting on followers' behavior in previous periods. However, leaders may have formal authority allowing them to discipline misbehaving followers, as it is typical in hierarchically structured organizations. Therefore, we implement a treatment

[2] Without addressing the issue of leadership, Potters et al. (2004) show that sequential contributions in voluntary contributions games − where some group members do not know the true value of the good − lead to a significantly higher provision of the public good. Other papers using a sequential contribution structure in a different context than leadership are, e.g., Weimann (1994), Bardsley (2000), or Levati and Neugebauer (2004).

where leadership by example is strengthened by the power to exclude one follower from the group in the ensuing period. Installing a leader with ostracism power seems akin to the opportunity of the leader of a work group to dismiss or suspend a member from the group. Punishment through ostracism, then, has costs not only for the ostracized member but also for the group itself, because it reduces the number of group members possibly contributing to the public good.[3] Therefore, the possible efficiency losses from ostracism are endogenously borne by the group itself. This is different from most previous experimental studies on punishment in social dilemma games (see, e.g., Ostrom et al., 1992; Fehr and Gächter, 2000; Sefton et al., 2002; Andreoni et al., 2003; Masclet et al., 2003), where group members can punish each other and the costs of punishing "disappear" from the experiment, meaning that the fines accrue to the experimenter.[4]

Third, the way in which a leader is appointed deserves more attention. All previous experiments have concentrated on the case where one single group member serves as a leader for the entire experiment. However, in many (political) organizations leadership is rotating among members, often according to a predetermined scheme. One of the best known examples is the presidency in the European Union. Being president in the European Union is similar to being leader in a public goods game. Furthermore, in many European countries the president of a university is selected in a rotating order from different schools. Professional associations - like the AEA - elect their president for a limited length of time. Given the different ways of installing a leader, we compare a treatment in which leadership is granted to a single group member to a treatment in which leadership rotates among all group members in a predetermined and publicly known order.

Fourth, we are interested in whether groups want to have a leader. The endogenous determination of leadership is a novel experimental feature that can provide insights into why some groups are more efficient than others and which group members are more likely to be elected as a leader. This aspect

[3] Ostracism has been modeled theoretically by Hirshleifer and Rasmussen (1989), who have shown that it can establish cooperation in a repeated prisoner's dilemma game.

[4] An exception is Masclet (2003), who has implemented sanctions as exclusion from social activities. Although similar to our punishment mechanism, this form of sanction is applied for the purpose of investigating how threats of exclusion can support cooperation within a group of peers. No leader has been present in Masclet's study and, therefore, the relationship between a leader's strength and overall cooperation levels has not been investigated.

of leadership is related to the growing literature on endogenous institutional choice. Early experimental studies of endogenously changing the institutional structure in common-pool-resource dilemmas have been carried out by Messick et al. (1983), Samuelson et al. (1984), and Samuelson and Messick (1986). Participants in these experiments can delegate via a collective vote their decision on how much to extract from a common pool resource to a leader. When the common pool is near depletion, subjects have a stronger tendency to delegate their decision to a leader. More recently, the endogenous evolution of institutions has been studied by Kirchsteiger et al. (2004) and Brown et al. (2004). Kirchsteiger et al. (2004) investigate which information standards evolve endogenously when market participants can decide about which other market participants to inform about own trade offers. Brown et al. (2004) provide evidence for the endogenous emergence of long-term relationships between firms and workers in the absence of third party enforcement of contracts. In contrast to these more recent studies, we focus on the question whether groups opt endogenously for leadership in a social dilemma situation and which factors are important for this institutional choice.

Our results show that leadership has a positive impact on contribution levels. Moreover, strong leaders with ostracism power induce substantially higher contributions than leaders without such formal power. The way of appointing a group leader − either a single group member or all group members in turn − has no significant influence on efficiency levels. When given the opportunity to endogenously select a leader, only about 40% of groups succeed in appointing a leader, even though groups with a leader outperform groups without a leader by far.

In the following, we will deal with the basic model of the public goods game in Section 2. Section 3 is devoted to the experimental design. The experimental results are presented in Section 4. A concluding discussion is offered in Section 5.

2 The public goods game

The basic game is the voluntary contribution mechanism (hereafter, VCM), as introduced by Isaac et al. (1984). Let $I = \{1, \ldots, 4\}$ denote a group of 4 individuals who interact for $t = 1, \ldots, T$ periods. In each period t, individual $i \in I$ is endowed with income e, which can be either privately consumed or invested in a public good. Each individual's contribution at time t, $c_{i,t}$, must satisfy $0 \leq c_{i,t} \leq e$. Denoting by C_t the sum of individual contributions in t, i.e., $C_t = \sum_{j=1}^{4} c_{j,t}$, the monetary payoff of individual i in period t is linear in $c_{i,t}$ and C_t, and takes the following form:

$$u_{i,t}(c_{i,t}, C_t) = e - c_{i,t} + \beta C_t, \tag{1}$$

where $0 < \beta < 1 < 4\beta$. Due to $\beta < 1$, the dominant strategy for each player is to contribute nothing to the public good. If this is done by all, every individual i earns $u_{i,t} = e$. Since $4\beta > 1$, the socially efficient outcome (maximizing the sum of $u_{i,t}(\cdot)$ over $i \in I$) is, however, to contribute everything, which yields a payoff $u_{i,t} = 4\beta e$ for all $i \in I$.

We consider three types of this game: the standard-VCM, the VCM with leadership, and the VCM with strong leadership. Our control treatment is the standard-VCM, in which all 4 group members make their contribution decisions privately and simultaneously.

The VCM with leadership has two decision stages in each period. First, the *leader*, l, chooses his contribution $c_{l,t}$, which is announced to the *followers*. Then, the followers decide simultaneously about $c_{j,t}$ (with $j \neq l$). Applying backward induction, the theoretical prediction for the VCM with leadership coincides with that for the standard-VCM: Because of $\beta < 1$, the followers' dominant strategy in stage 2 is to contribute zero; a rational leader will anticipate this and free-ride as well in stage 1.

The VCM with strong leadership adds a third stage to the previous ones. After being informed about the followers' contributions $c_{j,t}$, the leader can select one other individual o ($\neq l$) whom he excludes from the group in the *next* period $t+1$. In this case, the ostracized individual o earns $u_{o,t+1} = e$ in period $t+1$ (i.e., he is excluded from contributing to, and consuming, the public good in the following period),[5] with the remaining group members playing a 3-person public goods game, implying that $C_{t+1} = \sum_{i \neq o} c_{i,t+1}$. When determining the opportunistic benchmark solution for the VCM with a strong leader, we assume that the leader will ostracize

[5] Note that the traditional definition of pure public goods implies non-excludability, which would be at odds with the possibility to ostracize other group members. However, the concept of local public goods is easily compatible with exclusion and, thus, ostracism, in particular since the exclusion always applies for the *next* period.

someone only when this yields a material payoff for the leader. However, since excluding another group member reduces the possible efficiency gains, the leader should never exclude anybody in stage three of a given period. Given that followers rationally anticipate such behavior, they will all decide to free-ride in the second stage, yielding $c_{j,t} = 0$ for all $j \in I \setminus \{l\}$. Since followers do not follow the leader, the leader's optimal decision in the first stage is $c_{l,t} = 0$. Summing up, under the assumption of payoff maximization we can expect the same (zero) contributions in the standard-VCM, the VCM with leadership, and also the VCM with strong leadership.

3 Experimental procedures

The experiment is based on the three types of the VCM introduced in the previous section: the standard-VCM as control (henceforth C-treatment), the VCM with leadership (henceforth L-treatment), and the VCM with strong leadership (henceforth SL-treatment). Each treatment has 24 periods, in which we set $e = 25$ and $\beta = 0.4$. In the treatments with leadership, subjects are informed in the experimental instructions (given in the Appendix) that there are two parts: (1) an exogenous part in periods 1–16, and (2) an endogenous part in periods 17–24, where groups have to decide themselves whether they want a leader or not.

To investigate whether contributions depend on the way in which a leader is appointed, we implement two ways of installing a leader in the exogenous part. In the *fixed* (f-) treatments, *one* of four group members is randomly selected to be the leader and remains in charge for the entire exogenous part. In the *rotating* (r-) treatments, *each* of the four group members is appointed as leader for four consecutive periods where the sequence of rotation is predetermined and commonly known.

The two different ways of installing a leader and the two forms of leadership (with and without ostracism power) yield a 2x2 experimental design with the following four leadership treatments: Lf, Lr, SLf, and SLr.[6] The

[6] In the treatment with rotating strong leaders (SLr) we have ruled out the leader's ostracism power in stage three of the final (i.e. fourth) period of leadership (i.e., the leader cannot ostracize anyone for the next round), because that might have caused problems in the next period in case the ostracized person were the predetermined next leader. In both strong leader treatments (SLr and SLf), we have also restricted the leader's power to ostracize only *one* other group member, because if the leader excluded more than one other member, contributing to the public good would be inefficient not only individually,

characteristics of our total set of five different treatments are summarized in Table 1.[7] The relation of these treatments to our main research questions, detailed in the introduction, is shown in Table 2.

Table 1 and Table 2 about here

Leadership in the endogenous part is determined as follows: Periods 17–24 are split into two phases of four periods each. Before periods 17 and 21, subjects vote on leadership for periods 17–20 and 21–24, respectively. In the f-treatments, a leader is installed if the leader himself wants to remain leader and all three followers accept him as leader. Otherwise, the group has no leader and all group members contribute simultaneously to the public good in the respective four-period phase. In the r-treatments, subjects have to indicate for each group member (including themselves) whether they would accept that member as leader. If there is a single person within a group who is unanimously accepted, this person becomes the leader and stays in charge throughout the respective 4-period phase. If more than one person is unanimously accepted, one of these persons is randomly selected as leader. In all other cases, the group has no leader and all members contribute simultaneously to the public good. Both in the f- and r-treatments, group members are informed about the other group members' contributions in the exogenous part before voting in periods 17 and 21.

All experimental sessions were run computerized with the help of z-Tree (Fischbacher, 1999) at the laboratory of the Max Planck Institute in Jena (Germany) between November 2003 and March 2004. For each of our five treatments we ran two sessions with 7 four-person groups (in partner design), yielding 14 independent observations per treatment. A total of 280 undergraduate students from various disciplines participated in at most one session, earning on average about €14 (including a show-up fee of €2.50).

but also for the group as a whole (since $2\beta < 1$).

[7] We ran an additional 'control' treatment by implementing the Lr-treatment *without* the endogenous part, i.e. with 16 periods only (denoted $Lr16$). Contributions in all treatments with leadership might, indeed, depend on the prospect of the endogenous vote on leadership, which was announced right from the start. To provide evidence that there is no spillover from the endogenous to the exogenous part, we compared contributions in $Lr16$ with those in the exogenous part of Lr, finding that there is no significant difference between them, neither in overall averages nor in single periods (detailed results are available upon request; $N = 14$ in $Lr16$, as in the other treatments). This evidence makes us confident that our results do no depend on the introduction of the endogenous phase.

Participants received written instructions which were read aloud to establish common knowledge. Understanding of the rules was assured by a control questionnaire that subjects had to answer before the experiment. After each period, participants got feedback on all individual contribution decisions in their group, identified by membership number, and their period payoffs. Concerning the vote on leadership before periods 17 and 21, group members were only informed about whether and which group member had been installed as the leader, but not about individual voting behavior.

4 Results

4.1 Leadership in the exogenous part

4.1.1 The impact of (strong) leadership on contribution levels

Table 3 presents the average contributions in the control-treatment, the treatments with a leader, and those with a strong leader.[8] Regarding periods 1–16, average contributions range from 10.04 (out of 25) in the C-treatment to 19.80 in the SL-treatments. Groups with leadership contribute significantly more than the control groups without leadership ($p < 0.08$ for C vs. L; $p < 0.01$ for C vs. SL; Mann-Whitney U-test[9]). This establishes our first result, which corroborates the experimental evidence discussed in the introduction.

Result 1 *Leadership increases private contributions to a public good significantly.*

Table 3 about here

Table 3 also indicates that contributions are substantially higher with a strong leader (19.8 in SL) than with a weak one (13.4 in L). The difference is highly significant ($p < 0.01$; Mann-Whitney U-test). This yields our second result.

Result 2 *Leadership with ostracism power leads to substantially higher contributions than leadership without such power.*

[8] In this subsection, we pool the data from Lf and Lr, and from SLf and SLr, in order to study the pure effects of (strong) leadership. In the next subsection we will show that pooling is justified.

[9] All tests reported in this paper are two-sided.

Figure 1 about here

Figure 1 shows the time path of average contributions in each class of treatments. In each single period, average contributions are always the lowest in the C-treatment and the highest in the SL-treatments, with the L-treatment in between. Contributions in the C- and L-treatments decline significantly in the course of the experiment (with slope coefficients of -0.41 in C, and -0.33 in L; $p < 0.05$), but the slopes are not significantly different from each other (Chow-test). The latter result implies that the higher overall contributions in the L-treatments are due to a shift in the level of contributions (i.e. a higher intercept in the regression), but not to a less steep downward trend of contributions across time. Contributions in the SL-treatments are basically stable (slope -0.03; $p > 0.5$). Both the intercept and the slope are significantly larger with strong leadership than in the C- and L-treatments.

4.1.2 The effects of how a leader is appointed

Table 4 reports the average contributions for each treatment with leadership. Additionally, Figures 2 and 3 display the time paths of the average contributions in the exogenous part. As regards the L-treatments, the way in which a leader is appointed - either once and for all as in Lf or in a predetermined and rotating scheme as in Lr - has no significant influence on overall contributions. Overall average contributions are 13.1 in Lf, and 13.7 in Lr ($p > 0.3$; Mann-Whitney U-test). Looking at Figure 2 we also see that the average contributions in Lr and Lf frequently intersect in the course of periods 1-16.

Table 4 and Figures 2 and 3 about here

Turning to the SL-treatments, overall average contributions are weakly significantly higher when the leader is fixed (20.8 in SLf) than when he rotates (18.8 in SLr) ($p = 0.062$; Mann-Whitney U-test). However, Figure 3 reveals that contributions in SLr are markedly lower than in SLf only in each fourth period, where rotating leaders have no power to exclude another group member from interaction in the next period. Therefore, if we consider only those periods where ostracism is possible, average contributions in SLr

rise to 19.91 and are no longer significantly lower than in SLf ($p > 0.2$; two-sided Mann-Whitney U-test). Therefore, we state:

Result 3 *Whether a leader is appointed once and for all or in a predetermined and rotating order has no significant influence on contribution levels.*

4.1.3 Leaders' and followers' contributions and profits

Table 5 presents the average contributions and profits of leaders and followers in the exogenous part of the experiment. Within each single treatment, leaders' contributions are significantly higher than followers' contributions ($p < 0.05$ in any treatment; Wilcoxon signed-rank test). However, leaders' and followers' contributions are highly significantly correlated. Figures 4 and 5 show the average contributions of leaders and followers in single periods. When the leader is fixed (Figure 4), the average contributions of leaders and followers almost go hand in hand, with leaders' contributions always above the followers' ones. Pearson correlation coefficients are 0.92 in SLf and 0.95 in Lf ($p < 0.01$ in both treatments).

Table 5 and Figures 4 and 5 about here

The time path of leaders' and followers' contributions is slightly less synchronized in the treatments with rotating leadership (Figure 5), but the Pearson correlation coefficient is still very high and significant (0.80 in SLr, 0.95 in Lr; $p < 0.01$ in both treatments). In every fourth period - when leadership is about to change - we observe something similar to the well-known termination effect in experimental public goods games. This effect is particularly strong in SLr, where followers reduce their contributions significantly in every fourth round ($p < 0.05$; Wilcoxon signed-rank test; $N = 14$).[10] This evidence can be summarized by:

Result 4 *Contributions of leaders and followers are very highly and positively correlated. Hence, followers follow their leaders, but also exploit leaders by contributing significantly less than leaders.*

Figure 6 about here

[10] This effect is responsible for the weakly significant difference in overall contributions between SLr and SLf, as discussed in section 4.1.2.

Figure 6 illustrates the relation between leaders' and followers' contributions by showing on the vertical axis the average contribution of followers in a single period, whereas the leader's contribution in the same period is given on the horizontal axis. We have aggregated in Figure 6 the data from both Lr and Lf, respectively SLr and SLf, because the relational pattern does not differ significantly between rotating and fixed leadership. In general, followers contribute more the higher are the leader's contributions.[11] However, for each class of the leader's contributions, followers contribute significantly more with strong leadership (SL) than with weak leadership (L) ($p < 0.05$; Wilcoxon signed-ranks test). Hence, ostracism power narrows the gap between the followers' and the leader's contributions. We summarize this evidence as follows:

Result 5 *Followers condition their behavior on their leader's contribution. This effect is even stronger in the SL-treatments than in the L-treatments.*

Concerning the payoffs of leaders and followers in periods $1-16$ (indicated on the right hand side of Table 5), we find that followers earn more than leaders in any treatment ($p < 0.05$ in any treatment; Wilcoxon signed-ranks test). For leaders it is interesting to check whether they earn at least more than the average payoff in the control treatment with no leader. In fact, leaders without ostracism power earn slightly less than subjects in the C-treatment, implying that leadership does not pay off for the leader himself, even though the difference is far from being significant. Only strong leaders gain significantly compared to subjects in the C-treatment ($p < 0.01$ in C vs. SLf, $p = 0.06$ in C vs. SLr; Mann-Whitney U-test). In contrast, followers gain from leadership in any treatment, compared to the C-treatment (with $p < 0.1$ in C vs. Lf, and $p < 0.05$ in any other comparison of C with either Lr, SLf or SLr; Mann-Whitney U-tests). These observations lead us to our next result.

Result 6 *Compared to the average payoffs in the control-treatment, leadership always pays for followers, but for leaders only when they are endowed with ostracism power.*

[11] A single exception to this monotonic pattern is in $SLr + SLf$ when the leaders contributes zero, what happened only 4 times, though.

4.1.4 Exerting ostracism power - Causes and consequences

Strong leaders use their ostracism power contingent on the way they are appointed. In the rotating scheme (*SLr*), leaders exclude one other group member in 24% of the possible periods, whereas leaders who are appointed for the whole exogenous part of the experiment (*SLf*) exclude another group member in only 13% of possible cases, which is significantly less frequent than in *SLr* ($p < 0.01$; χ^2-test).[12]

Interestingly, there is a clear negative correlation between the number of ostracized group members and the followers' contributions in *SLr* ($r = -0.80$; $p < 0.01$), but not in *SLf* ($r = -0.22$; $p > 0.4$). This suggests that ostracism goes hand in hand with lower contributions more frequently in the rotating than in the fixed treatment. The causality may, of course, be two-sided. Leaders may ostracize other group members when their contribution is low. But, as a reaction, group members might also reduce their contribution because they feel treated badly by the leader. To check for the direction of the causality as well as to investigate whether exclusion is strategically motivated - by the leader's intent to induce more cooperation in the future through ostracism in the present period - we compared the contributions of an ostracized group member in the periods *before* ($c_{o,t-1}$) and *after* ($c_{o,t+1}$) being excluded in period t (where $c_{o,t} = 0$ is imposed). We can reject the null hypothesis of $c_{o,t-1} = c_{o,t+1}$ in favor of the alternative $c_{o,t-1} < c_{o,t+1}$ ($p < 0.001$ in *SLf*, $p < 0.05$ in *SLr*; Wilcoxon signed-ranks test). Hence, there is a future efficiency gain from exerting ostracism power, which we summarize in:

Result 7 *Ostrazised group members increase their contributions after being excluded from the group. Hence, followers react systematically when leaders exert their power.*

Ostracized group members contribute significantly less than the other followers in their group ($p < 0.01$ for both *SLf* and *SLr*, Wilcoxon signed-rank test). Figure 7 shows the relative frequency of exclusion as a function of the excluded group member's deviation from the followers' average

[12] Recall that a leader in *SLr* – who is appointed for 4 periods – cannot exclude another group member at the end of his fourth period (when the exclusion would become effective in the first period with the next leader). In *SLf*, the fixed leader has no such restriction.

contribution.[13] The numbers above the bars indicate the total number of observations in the various deviation intervals.

Figure 7 about here

Figure 7 reveals that group members are more often excluded, the more they deviate negatively from the followers' average contribution.[14] For instance, if a group member contributes 6.67 or more units *less* than the followers' average, then the relative frequency of being excluded is in both treatments 40% or higher. In the interval $[-6.67, -1.67)$ only slightly more than 20% of the deviations lead to exclusion. Figure 7 also reveals that the large majority of contributions are close to the followers' average, indicating a high degree of homogeneity among followers. This evidence supports the following result:

Result 8 *Punishment through ostracism is more frequent the more a follower deviates negatively from the average contribution of the followers.*

4.2 Leadership in the endogenous part

Table 6 summarizes the relative frequency of successfully installing a leader (either in period 17 or in period 21), and the average contributions with and without a leader. About one third of the groups in the L-treatments choose to have a (weak) leader, and about one half of the groups install a strong leader in the SL-treatments. The difference in relative frequencies between the L- and the SL-treatments is however not significant; neither is the difference between the rotating- and the fixed-treatments, given a certain type of leadership strength.

Table 6 about here

Running a probit regression, we find that the likelihood to install a leader is significantly higher the higher the average contributions in periods 1-16

[13] Note that subject i's maximum negative (positive) deviation from the followers' average contribution is -16.67 (16.67), which applies if i contributes 0 (25) while each of the other two followers fully contributes (free-rides).

[14] The same picture would practically result if we took into account deviations from the *leader's* contribution. Since contributions of the leader and the followers are highly significantly correlated, deviations from the followers' average contribution are qualitatively equivalent to (although quantitatively smaller than) deviations from the leader's contribution.

have been ($p < 0.05$; probit analysis with pooling of treatments, controlling for leaders' strength and method of appointment - fixed vs. rotating - in the exogenous part). Hence, more efficient groups in periods 1-16 are more likely to maintain the institution of leadership.

Groups with a leader in the endogenous part contribute significantly more than groups without a leader (see columns [2] and [3] in Table 6; $p < 0.05$ in any treatment, Wilcoxon signed ranks test).[15] The difference is particularly striking in the Lf-treatment, where groups with leaders contribute on average 15.55, compared to 3.61 if there is no leader. Columns [4] and [5] in Table 6 show the contributions of leaders and followers in case a leader has been installed. Like in the exogenous part, leaders contribute significantly more than followers in each single treatment ($p < 0.05$, Wilcoxon signed ranks test), and even followers contribute significantly more than groups without a leader (with the exception of Lr; in all other treatments we have $p < 0.05$; Mann-Whitney U-test). We summarize these results in:

Result 9 *Only about 40% of groups are successful in appointing a leader. Failing to appoint a leader has, however, high efficiency costs, because contributions in group with a leader are significantly higher than in group without a leader.*

Next, we examine who is elected as leader. In the r-treatments (Lr, SLr), leaders are appointed in 20 out of 56 possible cases. In 12 out of the successful cases, leadership is assigned to the group member with the highest contribution as leader in the exogenous part (periods 1–16). In all other eight cases, leadership is granted to the member with the highest contribution as follower (which coincides with being the follower-up concerning the contributions as leader). Therefore, when given the choice to elect the leader among the four group members, subjects clearly condition their acceptance of a leader on the very member's behavior in the exogenous part. In the f-treatments (Lf, SLf), the exogenously determined leader is endogenously reappointed in 27 out of 56 cases. As already indicated above,

[15] For the test, we used a very conservative measure by including only those groups which experienced both having and not having a leader in periods 17–24. The frequency of appointing a leader does not differ between period 17 and period 21. Over all four treatments, 20 out of 56 groups appointed a leader for periods 17-20, and 27 out of 56 groups for periods 21-24. Only 12 groups managed to elect a leader in both phases, whereas 22 never agreed on a leader.

re-appointment is more likely the higher the average and the leader's contributions in the exogenous part.

It is, of course, also interesting to check why the appointment of a leader fails. Here, we find a remarkable influence of the leader's strength. Whereas failure in the L-treatments is typically due to the (weak) leader refusing leadership, it is the followers who turn down the (willing) strong leader in the SL-treatments. In particular, 11 out of 18 failures to appoint a leader in Lf are exclusively due to the (fixed) leader's dissent (when all followers vote for leadership), and only 4 to a follower's disagreement (when the leader wants to go on as leader). In the three remaining cases of failure, both the leader and one or more of the followers vote against leadership. To the contrary, 8 out of 11 failures in SLf are caused by one or more followers vetoing (when the leader is willing to act as leader), and only in a single case the leader refuses to act as leader (when all followers want him as leader). There are 2 other cases where both the leader and the followers do not want (to be) a leader. Judging by a Fisher-exact test, the Lf- and SLf-treatments significantly differ with respect to why leadership fails ($p < 0.05$). The effect is very similar in the r-treatments where subjects can select any group member as leader. In Lr, 14 out of 20 failures to appoint a leader are caused by one member refusing leadership when all others want him as leader, whereas only 6 out of 16 failures in SLr are due to the same reason ($p < 0.06$). We can summarize these results as follows:

Result 10 *Leaders with ostracism power want to remain leaders, but followers often turn them down, unless contribution levels were very high in the exogenous part. Leaders without ostracism power feel exploited in case of relatively low contribution levels in the exogenous part, and therefore refuse to act as leaders, even though their followers typically vote for leadership.*

5 Conclusions

In this paper we have studied the influence of leadership on cooperation in an experimental public goods game. Our results provide a compelling case for the institution of leadership, because private contributions to the public good are substantially higher when a group has a leader than when it has none. When leaders are additionally equipped with the authority to ostrazise other group members, they are even more efficient in achieving -

and sustaining - very high cooperation levels, compared to relatively weak leaders who can only commit to a certain contribution level. Whether a leader is appointed for the whole 'lifetime' of a group or whether all group members become leader in a rotating way does not have a significant influence on cooperation. Hence, what matters is the presence of a leader as well as his strength. This has also become clear in the endogenous part of the experiment. Though less than half of the groups have successfully installed a leader, their contributions have on average been about twice as high as the ones of groups which failed to appoint a leader.

Leadership by example works, because followers follow their leaders. That means that followers condition their contribution levels on their leader's initial contribution. This result provides clear evidence for the behavioral concept of conditional cooperation.[16] Previous experimental studies have established the importance of conditional cooperation (see, e.g. Keser and van Winden, 2000; Brandts and Schram, 2001; Fischbacher et al., 2001), however none of them has addressed its relevance for leadership in groups. The concept of conditional cooperation would blame leaders for the poor success of their groups. If the leader provides a poor example by contributing little, there is little reason for followers to provide higher contributions. In fact, they contribute typically less than the leader, even though followers' contributions are still highly correlated with the leader's contribution.

Leadership with ostracism power works even better than leadership which is restricted to setting an example. Hence, backing up the leader's good example with a punishment opportunity reinforces the effects of leadership. It is the latter finding which enables us to combine two hitherto unrelated strands of experimental work, namely the one on leadership (see the recent contributions of Gächter and Renner, 2004, Moxnes and van der Heijden, 2003, or van der Heijden and Moxnes, 2003) with the one on cooperation and punishment (see Fehr and Gächter, 2000; Andreoni et al., 2003; Masclet et al., 2003). Since in (economic as well as political) organizations leaders are not only voluntarily setting an example, but are also equipped with authority and devices for promotions or sanctions, our approach to combine leadership and punishment in a unitary framework could initiate further (ex-

[16]As Fischbacher et al. (2001) suggest, conditional cooperation can be considered as a motivation in its own or be a consequence of some fairness preferences like inequity aversion or reciprocity (see, e.g., Sugden, 1984; Palfrey and Prisbrey, 1997; Fehr and Schmidt, 1999; Bolton and Ockenfels 2000).

perimental) work on leadership in organizations. Future research might, for instance, explore the relative importance of leadership versus punishment or the influence of group size on the efficiency of leadership in promoting cooperation.

Our data also suggest that determining a leader either once and for all or in a predetermined and rotating order does not have a noticable influence on cooperation levels within groups. This result is a nice complement to Gächter and Renner's (2004) finding that it does not matter for contribution levels whether the leader is chosen randomly among the group members or whether the most, or least, cooperative member is (exogenously) assigned to be leader.

Concerning the endogenous determination of a leader, we have found that the groups which have higher contributions in the exogenous part of the experiment are also those that are more likely to appoint a leader in the endogenous part. This finding implies that the institution of leadership is more likely maintained if it has been beneficial in the past. This resembles to what Kirchsteiger et al. (2004) and Brown et al. (2004) have found for endogenously evolving market institutions. Brown et al. (2004), for instance, provide evidence that endogenously formed employment relationships (with no third party enforcement) have a higher probability of becoming long-term relations when the private exchange between employer and employee has been beneficial for both parties. In our case, the endogenous installation of a leader is more likely when it has been more efficient in the past. Successful implementation of a leader pays off in terms of higher profits (both for leaders and followers in case of strong leaders), because groups with an endogenously selected leader contribute on average almost twice the amount of groups which failed to elect a leader.

Examining the process of appointing a leader, we have found that leaders with ostracism power want to remain leaders, but followers often turn them down, unless the institution has been successful in sustaining very high contribution levels in the exogenous part. Leaders without ostracism power, on the contrary, often feel exploited in case of relatively low contribution levels in the exogenous part, and therefore refuse to act as leaders, even when their followers vote for leadership. Failure to appoint a leader entails high efficiency costs. However, when leaders provide a good example and followers follow their leaders closely, failure is less likely to occur since the institution of leadership can pay off for leaders and followers alike under such conditions. In conclusion, it seems that we can rephrase Albert Schweitzer's quote from the introduction: "Example is leadership, but only good example is successful leadership."

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Tables and Figures

Treatment	Leader is present	Leader has ostracism power	Leader's appointment
C - Control	no	–	–
Lf - Leader fixed	yes	no	fixed
Lr - Leader rotating	yes	no	rotating
SLf - Strong leader fixed	yes	yes	fixed
SLr - Strong leader rotating	yes	yes	rotating

Table 1. Summary of experimental design

Research question	Approach for testing
Does leadership increase contributions?	C vs. (Lf, Lr) / C vs. (SLf, SLr)
Is a powerful leader better?	(Lf, Lr) vs. (SLf, SLr)
Does the way of appointment matter?	Lf vs. Lr / SLf vs. SLr
Do groups want to have a leader?	Endogenous part (periods 17-24)

Table 2. Research questions and treatments

Treatment	Periods 1-16	Overall
C - Control/no leader ($N = 14$)	10.04	8.35
L - Leader ($N = 28$)	13.41	11.92
SL - Strong leader ($N = 28$)	19.80	18.26

Table 3. Aggregate average contributions

Treatment	Periods 1-16	Overall
Lf - Leader fixed ($N = 14$)	13.10	11.36
Lr - Leader rotating ($N = 14$)	13.73	12.49
SLf - Strong leader fixed ($N = 14$)	20.76	19.42
SLr - Strong leader rotating ($N = 14$)	18.84	17.10

Table 4. Average contributions in the treatments with leadership

Treatment	Contributions		Profit	
C - Control	10.04		31.02	
	Leaders	Followers	Leaders	Followers
Lf - Leader fixed	15.28	12.37	30.68	33.58
Lr - Leader rotating	16.28	12.88	30.69	34.09
SLf - Strong leader fixed	21.76	20.42	36.42	36.76
SLr - Strong leader rotating	21.43	17.98	33.71	35.89

Table 5. Average contributions and profits of leaders and followers in the exogenous part

	Leader appointed (rel. frequency)	Contributions *without* leader	Contributions *with* leader	With leadership Leaders	With leadership Followers
	[1]	[2]	[3]	[4]	[5]
Lf	0.36	3.61	15.55	16.98	15.08
Lr	0.29	9.47	11.35	17.44	9.32
SLf	0.61	9.33	21.54	22.62	21.18
SLr	0.43	10.73	18.81	22.17	17.69

Table 6. Leadership and contributions in the endogenous part

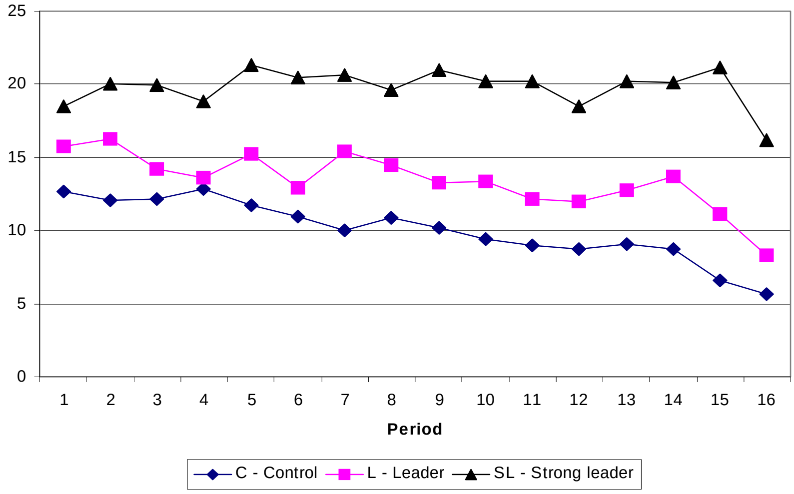

Figure 1: Average contributions in periods 1−16

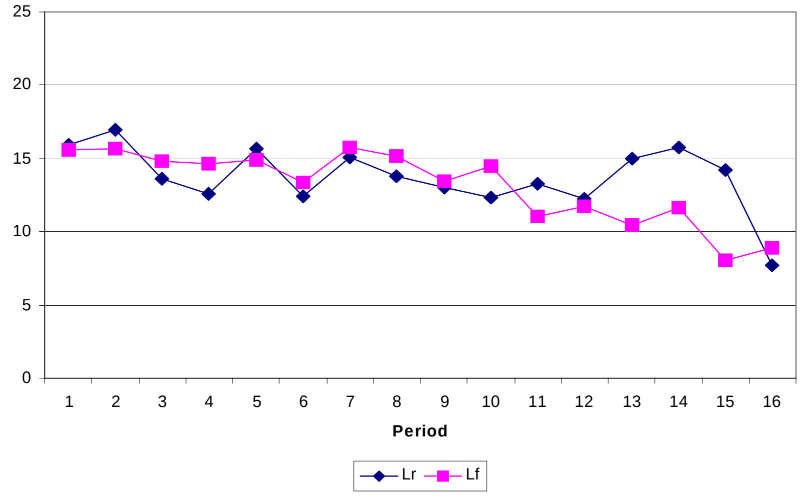

Figure 2: Average contributions in the L-treatments

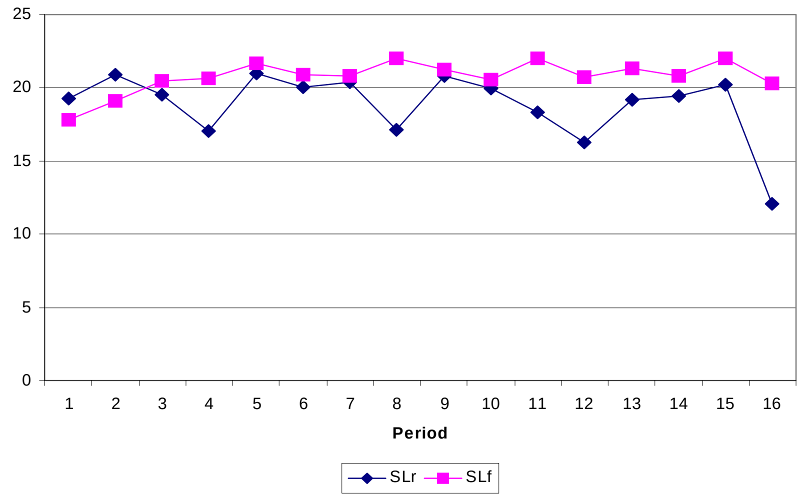

Figure 3: Average contributions in the SL-treatments

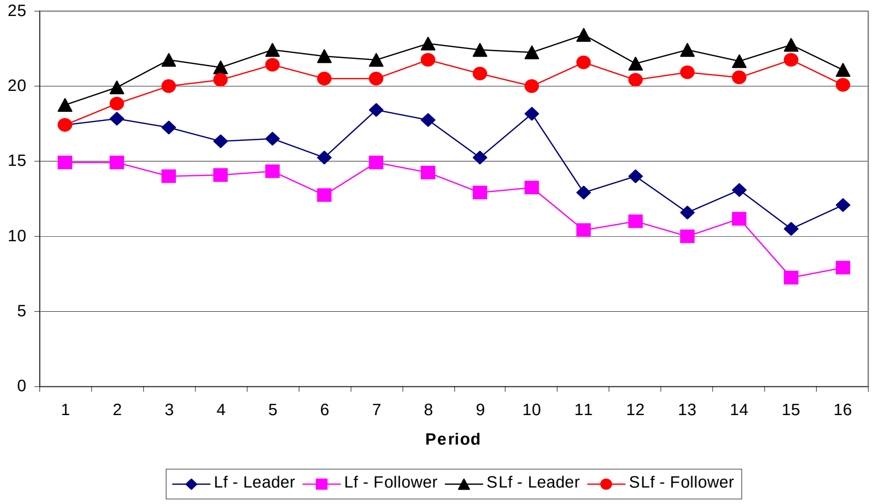

Figure 4: Leaders' and followers' contributions with fixed leader

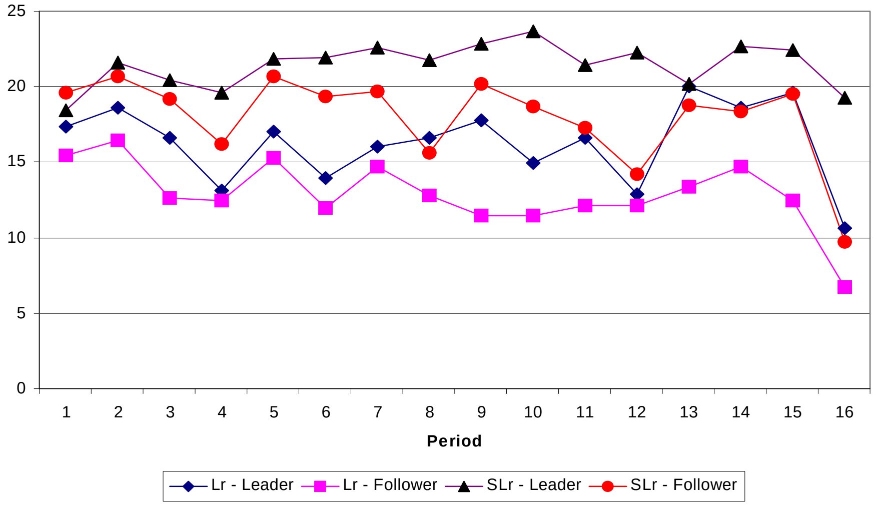

Figure 5: Leaders' and followers' contributions with rotating leader

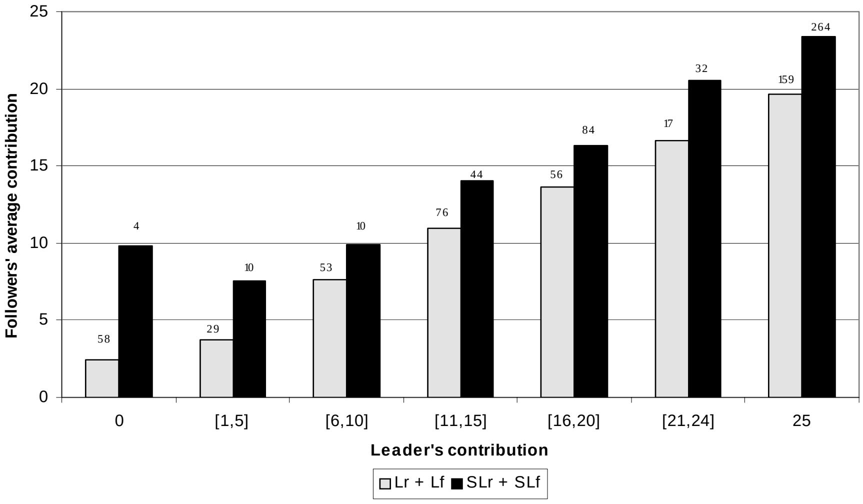

Figure 6: Relation of leader's and followers' contributions

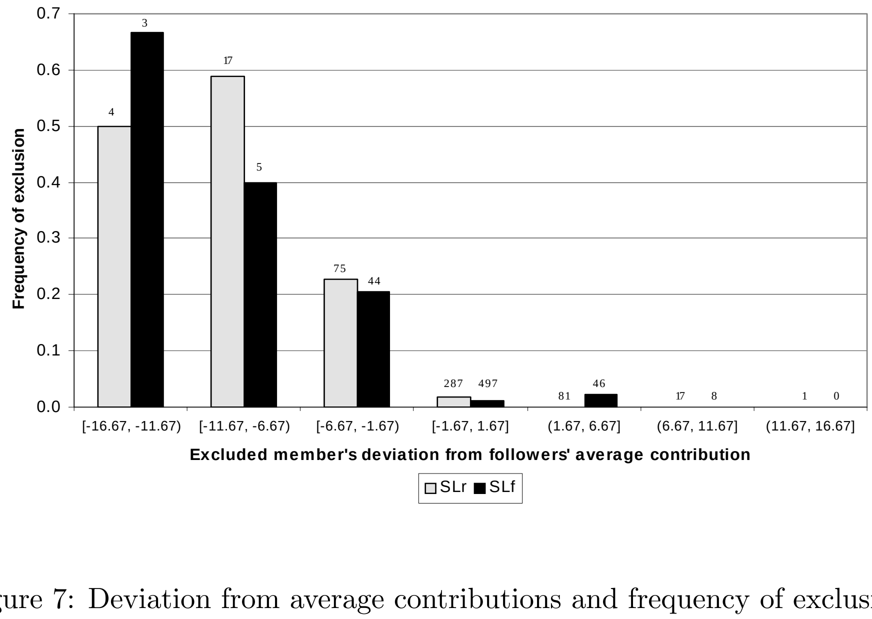

Figure 7: Deviation from average contributions and frequency of exclusion

Appendix: Experimental Instructions

This appendix contains the instructions (originally in German) we used for the strong leader (SL)-treatments. The instructions for the control (C)- and the normal leader (L)-treatments were adapted accordingly and are available upon request.

Welcome and thanks for participating in this experiment. You receive €2.50 for having shown up on time. If you read these instructions carefully, you can make good decision and earn more. The €2.50 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.

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.

[*Participants in the rotating-treatment read:* Each group member is appointed to be the "early contributor" for four consecutive periods, starting with member 1 and ending with member 4. In the following, we shall refer to the four consecutive periods in which the same group member is the early contributor as a "*phase*". Therefore:

- member 1 is the early contributor in phase 1 (i.e., in periods 1, 2, 3, and 4);
- member 2 is the early contributor in phase 2 (i.e., in periods 5, 6, 7, and 8);
- member 3 is the early contributor in phase 3 (i.e., in periods 9, 10, 11, and 12);
- member 4 is the early contributor in phase 4 (i.e., in periods 13, 14, 15, and 16).

In the last period of each 4-period phase (i.e., period 4 for member 1, period 8 for member 2, period 12 for member 3, and period 16 for member 4), the designated early contributor cannot exclude anyone. Therefore, in the first period of each phase (i.e., periods 1, 5, 9, 13) all four group members interact with each other.]

[*Participants in the fixed-treatment read:* 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 [*in the rotating-treatment*: the person whom they want to be the early contributor in their group.] [*in the fixed-treatment*: whether they want the early contributor to keep on being so or not.]

[*Participants in the rotating-treatment read:*

How you choose your preferred early contributor

In periods 17 and 21, you are requested to indicate whether you want a specific group member to become the early contributor. If you want a specific group member to be 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. You have to decide on “Yes” or ”No” for each single group member (including yourself). Please note that you can answer “Yes” for more than one group member.

- If there is a single person within your group who receives *four “Yes"*, this person will become the early contributor in the respective phase and the sequence of decisions is as described above.
- If more than one person receives four “Yes", one of these persons will be randomly selected as the early contributor.
- Otherwise (i.e., if there is no person within your group who receives *four “Yes"*), there will be no 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.]

[*Participants in the fixed-treatment read:*

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.