Leadership with Individual Rewards and Punishments

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Abstract: In a public goods experiment, leaders with reward or punishment power induce higher team cooperation compared to leader-free teams without any reward or punishment possibilities. When equipped with reward or punishment instruments, however, leader-free teams perform as well as teams with leaders. We conclude that the instruments as such are more effective in fostering cooperation than a leader.

Keywords: Leadership, Public Goods, Punishment, Reward

JEL classification: C92, H41, M5

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1. Introduction

Sequential public goods games emerged as the workhorse for experimental investigation of the impact of leadership on cooperation in teams. In these experiments, usually, the leader contributes first and can set an example. The followers are informed about the leader's contribution before contributing themselves simultaneously. This type of leadership can increase cooperation in teams (see Sutter and Rivas, 2014, and the references cited therein). The followers, however, persistently undercut the leader's contribution, which leads to a decay of cooperation over time as in simultaneous public goods experiments without a leader.

In reality, leaders are often equipped with instruments such as bonuses and fines to individually reward or punish the followers. The question arises whether a leader who is equipped with such instruments and able to set an example by contributing first, can motivate the followers to contribute higher amounts than a leader who lacks any instrument. Given the frequent occurrence of such authorities in organizations, e.g., in the military, it is astonishing that no study systematically investigated the influence of leaders with reward or punishment power on cooperation in teams so far.[1]

Ample evidence from public goods experiments show that *decentralized* (peer) reward or punishment can foster cooperation. The absence of a coordination device, however, often hinders the efficient use of these instruments. A small number of studies investigated *centralized* use of reward and punishment when team members contribute *simultaneously*. O'Gorman et al. (2009) find that centralized punishment does not increase cooperation more than decentralized punishment. Nosenzo and Sefton (2012) report a similar result in case of both reward and punishment. In contrast to the centralized authority in the simultaneous contribution setting, a leader in a *sequential* setting is possibly more effective in increasing contributions since she can set a clear example, and in case of reluctant followers, she can use the instruments for their motivation.

2. Experimental Design and Procedures

All treatments base on a public goods game sharing the following basic design. The game is played for 20 periods in fixed groups of four. In each period, each player receives an endowment of $e = 20$ and decides on her contribution $0 \leq c_i \leq e$ to the public good. The sum of contributions $C = \sum_{i=1}^{4} c_i$ is multiplied by 1.6 and equally split among all group members

[1] In previous studies, the leader can punish (exclude) or reward just one single follower (cf. Güth et al. 2007 or Sutter and Rivas 2014). Gürerk et al. (2009) focus on leader's choice of reward or punishment in a simultaneous setting.

($MPCR = 0.4$). The individual payoff is given by: $\pi_i = e - c_i + 0.4C$. After each period, each player is informed about individual contributions, payoffs, and the allocated points (if applicable).

To investigate whether leaders with reward and punishment possibilities increase team cooperation, we conduct the leader treatments L-REW and L-PUN, and compare them to the peer treatment P, in which a leader is absent and teammates contribute simultaneously. In L-REW and L-PUN, one player is randomly chosen to serve as the leader for all periods. The followers contribute after receiving feedback about the leader's contribution. The leader is equipped with additional 20 points that she can use for individual rewards or punishments keeping the "unused" points.[2] In L-REW (L-PUN), every received point increases (decreases) a follower's payoff by 3 points.

We programmed the experiment with z-Tree (Fischbacher 2007) and conducted it at the RWTH Aachen University using ORSEE (Greiner 2015) for subject recruitment. After the experimenter read the instructions (see Appendix) aloud, subjects could privately ask clarifying questions. Sessions lasted approx. 60 minutes. When a session was finished, each subject was paid privately. Average payoff was €12.70. In the treatments P, L-REW, and L-PUN, 144 subjects participated in 36 independent observations (12 per treatment).

3. Results

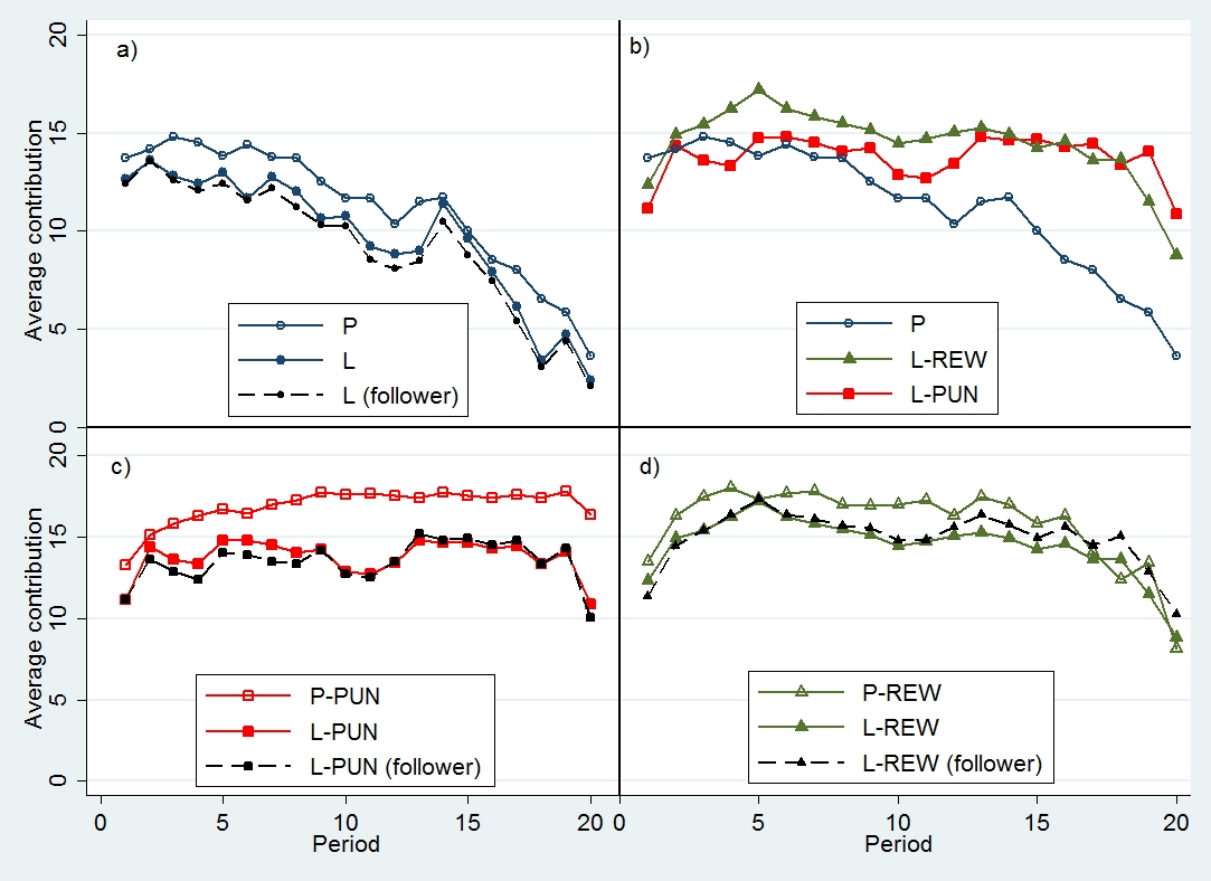
Figure 1 depicts the evolution of average contributions. Over all 20 periods, in L-REW, contributions (including the leader) are weakly significantly higher than contributions in P (14.5 vs 11.3 points, p=0.078), but significantly so for periods 11-20 (13.6 vs 8.8 points, p=0.033).[3] Over all 20 periods, contributions in L-PUN are not significantly different from contributions in P (13.8 vs 11.3, p=0.272) but weakly significantly higher in periods 11-20 (13.8 vs 8.8 points, p=0.083).

Result 1. Leadership with rewards or punishments induces higher contributions than a simultaneous peer-treatment without any instrument, differences being (weakly) significant for reward (punishment) in the second half of the experiment.

[2] This design feature is similar to Gürerk et al. (2009) but differs from Sutter and Rivas (2014).

[3] We use two-sided Wilcoxon rank-sum (signed-rank) tests for between (within) treatment comparisons. See Table A2 in the Appendix for treatment averages.

Figure 1: Average contributions.



To analyze teammates' contribution decisions we use the panel regressions presented in Table 1. In line with the non-parametric tests presented before, we observe that the leader dummy is significant in L-REW, but it is not in L-PUN. In both leader treatments, leaders' contributions have a significant influence on followers' contributions. Other followers' contributions, or other peers' contributions, respectively, also do significantly influence a teammate's contribution decision. This effect, however, is less strong in the leader treatments (see the respective significant interaction variable).

Decomposing the leader influence from the instrument effect

To disentangle the leader influence from the effect of the respective instrument, we conduct two more peer treatments, P-REW and P-PUN with reward or punishment possibilities, and compare them to L-REW and L-PUN. In P-REW and P-PUN, each subject is given 5 additional points which she can either keep in the private account or use to reward (or punish) other

teammates individually. In addition, we conducted the L-treatment, where the leader has no additional power besides being able to set an example.[4]

We observe no significant differences between L-REW and P-REW (14.5 points vs 15.9, p=0.237), and between L-PUN and P-PUN (13.8 vs 16.9, p=0.106), respectively, though peer treatments showing somewhat higher average contributions.

Result 2. Leaders have no additional effect in increasing contributions compared to the instruments alone.

This finding receives further support from the fact that the L-treatment does not increase contributions (p=0.564) compared to the P-treatment. In line with previous studies, we find that in L, followers contribute significantly less than leaders (p=0.021).

Table 1: Determinants of contributions.

Dependent variable: Teammate's contribution	L-REW & P	L-PUN & P	L & P	L-REW & P-REW	L-PUN & P-PUN	L-REW, L-PUN & L
Leader dummy	5.208** (2.151)	2.045 (1.578)	−0.952 (0.608)	1.423 (2.639)	−0.904 (2.316)	
Leader contribution	0.142** (0.058)	0.219** (0.088)	0.441*** (0.034)	0.142** (0.058)	0.212*** (0.082)	0.404*** (0.036)
Other followers' (peers') average contribution in t-1	0.811*** (0.029)	0.816*** (0.031)	0.818*** (0.032)	0.645*** (0.090)	0.680*** (0.078)	0.430*** (0.045)
Leader x Other followers' (peers') average contribution in t-1	−0.388*** (0.087)	−0.324*** (0.081)	−0.447*** (0.067)	−0.225* (0.121)	−0.255** (0.105)	
Reward dummy						6.208*** (1.777)
Reward x Leader contribution						−0.255*** (0.082)
Punishment dummy						3.724** (1.752)
Punishment x Leader contribution						−0.164* (0.085)
Constant	1.671*** (0.375)	1.613*** (0.374)	1.585*** (0.376)	5.501*** (1.584)	5.578*** (1.613)	0.472 (0.481)
Observations	1596	1596	1596	1596	1596	2052
R^2 overall	0.465	0.569	0.549	0.341	0.650	0.580

* Significant at 10%, ** at 5%, *** at 1%. Cluster robust standard errors in parentheses.

[4] These additional three treatments have also 12 independent observations each, with another set of 144 participants.

Use of instruments

To compare the use of reward and punishment by leaders and peers, we run a hurdle regression model (see Table A2 in the Appendix). The hurdle (probit) part reveals the probability to get a reward or punishment dependent on a teammate's contribution. Given a teammate is rewarded or punished, the main (tobit) part sheds light on to the magnitude of reward and punishment.

We see that the contribution level increases the chances to be rewarded. In L-REW, contributing more than the leader also increases the chances for a reward. Interestingly, in P-REW, contributing more than others is detrimental to get a reward.[5] In the punishment treatments, the relative contribution compared to others, and to the punishing teammate, are both decisive for punishment.

Overall, given rewarded, the magnitude of reward increases with the contribution. In L-REW, the reward also increases with the contribution difference between the reward-receiving teammate and the rewarding teammate (leader), but not so in P-REW. In the latter, the reward increases with the contribution difference between the rewarded and the other two teammates. In P-PUN, the magnitude of punishment decreases with the contribution level. In L-PUN, leaders do not care for the absolute contribution level. They rather punish a follower the harder, the greater the contribution difference between the other two teammates and the punished subject is.

4. Concluding Remarks

We find that leaders with reward or punishment possibilities foster team performance, compared to the setting without a leader and any instruments. To decompose the observed effect, we conducted additional treatments with peer rewarding or punishment, respectively. We find no significant differences between the respective leader and peer treatments. We conclude that the instruments as such are more effective to foster cooperation than a leader with reward or punishment power. This finding implies that in teams with mutual monitoring possibilities, a leader (with instruments) may not be necessary. Social forces among the peers may suffice for maintaining cooperation.

In our setting, the leader appointment was exogenous. Experimental evidence (e.g., Haigner and Wakolbinger 2010 or Rivas and Sutter 2011) show that endogenously emerging leaders may increase cooperation more than exogenously installed leaders. Future research could

[5] This could be explained by the fact that in P-REW, in 84% of cases, rewarded teammates contributed 20.

investigate whether endogenously chosen leaders may use the instruments more effectively than exogenously appointed leaders.

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A.1 Instructions (L-PUN)

General information

We welcome you to this economics experiment. It is very important for you to read the following instructions carefully. If you have any questions please direct them to us.

In this experiment you can earn money. The exact amount of your payout depends on your decisions and on the other participants' decisions.

While the experiment is running, it is not allowed to communicate with other participants. Non-compliance leads to the exclusion from the experiment and from all payments. All decisions are anonymous, i.e. no other participant gets to know the identity of the participant who makes a specific decision. Anonymity is also ensured during the payout process, i.e. no participant gets to know the amount of other participants' payouts.

During the experiment your income will be calculated in points. The earned amount of points will be converted to Euro with the following exchange rate:

80 points = 1 Euro.

At the end of this experiment you will receive your payout according to the total number of accumulated points as well as 2.50 Euro for showing up.

In the following we will provide you with a detailed description of the experiment.

Rounds and group

- The experiment consists of 20 rounds with each round having the same structure.
- You are a member of a group with 4 members in total. During the experiment the group composition will always stay the same.
    - One group member will randomly be assigned the role of a type A participant, the remaining three members will be type B participants.
    - During the experiment you will maintain your role and only interact with members of your group.
    - Each participant receives a starting capital of 100 points.

Course of the experiment

Each round consists of two stages:

Stage 1: Contributions of the group members

- In every round, each group member receives 20 points.
- Each group member has to decide how many of the 20 points he or she wants to contribute for the group. Points which are not contributed remain with the group member. Possible amounts to contribute are integral numbers from 0 to 20. First, the type A member decides how much to contribute for the group.

- After being informed about the contribution of the type A member, type B members decide on their own contribution.
- The sum of the contributions of all group members (type A and type B) gets multiplied with 1.6 and forms the group result.

  (sum of contributions x 1.6 = group result)
- Each group member (type A and type B) receives a quarter of the group result independently from their own contribution (group result / 4 = individual share of the group result).

Stage 2

- The type A member gets to see how much each group member has contributed.
- The type A member now receives 20 additional points and has to decide if and how many of these 20 points he or she wants to assign to each type B member.
- With each point which the type A member assigns to a type B member, the income of the type B member gets reduced by 3 points.
- Points which are not assigned are kept by the type A member.

Please notice: The order in which type B members are displayed will be determined randomly for each round. Therefore, it is not possible to identify a type B member over the rounds by the position on the displayed lists.

<u>Calculation of you round income</u>

Round income for type A members =

20 (endowment for the round)

- your contribution

+ 1.6 x sum of the contributions of all group members / 4

+ 20 (points which can be assigned to type B members)

- sum of points which are actually assigned to type B members

Round income for type B members =

20 (endowment for the round)

- your contribution

+ 1.6 x sum of the contributions of all group members / 4

- 3 x number of received points

Information at the end of each round

At the end of each round you will be provided with an overview of the group results. For each group member you will get to know: contribution for the group, income after stage 1, assigned or received points, round income.

Please notice: The order in which type B members are displayed will be determined randomly for each round. Therefore, it is not possible to identify a type B member over the rounds by the position on the displayed lists.

Total income

The total income will result from the starting capital of 100 points plus the sum of the earnings from each of the 20 rounds. At the end of the experiment your total income will be paid out with the exchange rate of 1 Euro per 80 points. As already mentioned, you will additionally receive 2.50 Euro for showing up.

A.2 Additional Tables

Table A1: Treatment averages over all periods. Standard deviations in parentheses.

			Contributions			
Treatment	**L**	**P**	**L-REW**	**P-REW**	**L-PUN**	**P-PUN**
All	9.8 (8.7)	11.3 (8.0)	14.5 (7.8)	15.9 (7.4)	13.8 (8.2)	16.9 (5.5)
Leader	11.2 (8.4)	-	13.1 (7.7)	-	14.6 (8.0)	-
Follower	9.3 (8.7)	-	15.0 (7.7)	-	13.5 (8.2)	-
			Payoffs			
Treatment	**L**	**P**	**L-REW**	**P-REW**	**L-PUN**	**P-PUN**
All	25.9 (6.3)	26.8 (6.0)	38.8 (7.7)	40.4 (7.5)	31.6 (11.0)	32.6 (6.3)
Leader	24.4 (5.8)	-	40.0 (4.8)	-	45.8 (8.5)	-
Follower	26.3 (6.3)	-	38.4 (8.4)	-	26.9 (7.0)	-
			Use of instruments			
Treatment	**L**	**P**	**L-REW**	**P-REW**	**L-PUN**	**P-PUN**
All	-	-	-	11.7 (6.1)	-	2.5 (4.0)
Leader	-	-	10.2 (6.0)	-	1.6 (4.0)	-

Table A2: Determinants of punishment and reward decisions.

Dependent variable: punishment (reward) subject *i* receives	L-PUN (1)		L-REW (2)		P-PUN (3)		P-REW (4)	
	Probit	Tobit	Probit	Tobit	Probit	Tobit	Probit	Tobit
i's contribution	−0.032*	−0.153	0.143***	0.287***	−0.015	−0.155*	0.112***	0.159***
	(0.018)	(0.113)	(0.013)	(0.036)	(0.035)	(0.086)	(0.030)	(0.027)
i contributes less (REW: more) than the punishing (rewarding) subject (0/1)	0.709**		0.581*		0.871***		-1.109***	
	(0.346)		(0.235)		(0.221)		(0.196)	
Difference between *i*'s and the punishing (rewarding) subject´s contribution		−0.130		0.104***		0.014		−0.103***
		(0.167)		(0.025)		(0.085)		(0.012)
i's contribution is lower (REW: higher) than the average contribution of the other two subjects in the group (0/1)	2.007***		−0.309		0.660***		−0.006	
	(0.275)		(0.368)		(0.251)		(0.147)	
Difference between *i*'s and the average contribution of the other two subjects in the group		−0.690***		0.026		−0.257***		0.076***
		(0.213)		(0.049)		(0.077)		(0.016)
i makes the lowest (REW: highest) contribution (0/1)	−0.548**		0.220		−0.208		0.486	
	(0.217)		(0.302)		(0.202)		(0.344)	
Constant	−1.670***	−5.033*	−1.464***	−1.723***	−1.347**	−1.196	−1.569***	−1.992***
	(0.397)	(2.853)	(0.161)	(0.520)	(0.665)	(1.859)	(0.259)	(0.495)
Observations	720	720	720	720	2880	2880	2880	2880
Pseudo R^2	0.524	0.222	0.519	0.242	0.246	0.152	0.375	0.192

* Significant at 10%, ** at 5%, *** at 1%. Since in P-treatments, each subject can reward/punish the peers, we have four times more observations than in the L-treatments