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Leadership in a Dynamic Public Goods Game: An Experimental Study*

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Abstract

We examine how leadership affects a dynamic public goods game. Using a setting where cooperation gains can be reinvested, our findings suggest that leadership has a positive impact on final wealth. Somewhat surprisingly, leadership also has a positive impact on reducing inequality within groups as measured by the Gini index. Based on a sequential prisoner's dilemma, we elicit types for conditional cooperation. Our results indicate that groups work best when led by cooperatively inclined individuals. Furthermore, early contributions by the leader are crucial and yield a high return.

This is a preliminary draft. Comments are welcome.

JEL-Classification: C72, C92, H41, D63

Keywords: Leadership, Public Goods Game, Conditional Cooperation, Inequality, Growth, Lab Experiment

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1 Introduction

1.1 Motivation

In many cases, cooperation is not a one-time affair. Instead, people commonly interact many times with each other. For this reason, the provision of a collective effort or public good is often a repeated interaction between the same agents. In addition, contributions in previous periods frequently have an impact on the provisioning quantity in the current period. In such a context, maintaining cooperation has thus further effects which go beyond pure concerns about reputation.

There are plenty of environments where it is possible for individuals to reinvest cooperation profits from the previous period into further cooperation. For example, public infrastructure can ensure that higher profits are made and those profits can then be reinvested. A similar pattern holds for companies' R&D investments: if two or more of them cooperate in R&D and make profits from it, more money will be available for further joint projects in the future. This kind of dynamic dependency is called an endowment carryover. However, it is not the only kind of such dynamic dependence in the form of a carryover. For example, there may be learning effects in providing a public good. The more that has been produced in the past, the higher the return (MPCR). Furthermore, public goods or public bads can accumulate over time. To put it in other words: many (textbook) examples of public goods take years to accumulate, provide streams of benefits (that can be reinvested) in the long run, but also require consecutive expenditures either to improve or to maintain their levels ([Battaglini et al., 2016](#)). Table 1 illustrates different forms of a carryover.

As a consequence, there is a need for studying public goods and collective action problems not only in a static, but also in a dynamic setting. In experimental economics, there has been a slowly emerging literature in the past years that attempts to fill this gap. [Sadrieh and Verbon \(2006\)](#) analyze a setting where social output today determines production possibilities tomorrow (endowment carryover), and social output is distributed unequally. [Noussair and Soo \(2008\)](#) study a dynamic public goods game with an MPCR carryover: the return on contributions is a function of decisions in previous periods. This characteristic leads to the effect that in most cases the usual pattern of declining contributions over time does not emerge. [Cadigan et al. \(2011\)](#) investigate whether subjects' behavior in a PG game with a stock level carryover comes close to the qualitative predictions of the Markov Perfect Equilibria. [Gächter et al. \(2017\)](#) and [Rockenbach et al. \(2017\)](#) both consider an endowment carryover and the effects of punishment in such a dynamic public goods game. While punishment in a static setting is usually very successful, there are drawbacks in a dynamic setting. Punishment results in the punished having fewer resources available that can be invested in further cooperation, i.e., it reduces

the potential for future cooperation gains (Rockenbach et al., 2017).

Endowment	MPCR	Stock Level
Previous outcomes affect future endowments.	“Learning-by-doing”: productivity depends on previous stages’ contributions.	Durable public goods or bads.
E.g., profits from the use of public infrastructure; R&D cooperation.	E.g., better trained personnel in public administration or military; renewable energies.	E.g., public and social capital; environmental pollution.

Table 1: Types of Carryover

Therefore, it is not obvious that standard recipes to improve cooperation do really work well in a dynamic setting.

Another promising tool to improve cooperation, which will be considered in this paper, is *leading-by-example*. In many contexts of collective action problems, economists consider leadership as an important factor that might mitigate the problem of free-riding and coordination failures, which is inherent in such environments (see, for example, Arce M, 2001; Sahin et al., 2015). Leadership is a tool that is relatively easy to implement and comparatively inexpensive. Contrary to punishment, it also does not destroy resources that can be reinvested in further periods, when we have a setting with endowment carryover. Exemplary behavior by the leader, e.g., contributing a high amount to a public good, can induce those who follow to adopt a similar behavior. However, previous research has shown that in public good games, with no endowment carryover, typically leaders give relatively more than those following them (see, for example, Güth et al., 2007; Rivas and Sutter, 2011; Gächter and Renner, 2014). Overall, most studies report a small positive effect when a subject is randomly selected to be the leader which is referred to as “exogenous leadership” (see section 1.2 for a review). Since these experiments only analyze static environments, it is still an open question whether *leading-by-example* yields an improvement in a dynamic setting, with respect to the final endowments of participants.

In our setup, leadership means that a group member decides first and the other group members can observe his or her decision right before they make their own decision, in each of the rounds (seven rounds in our experimental setup). We designed the dynamic dependency in a way that is close to that of Gächter et al. (2017), having the following features: (1) there is no consumption until the last round, i.e., the

entire wealth can be reinvested at the beginning of a new round and (2) endogenous endowments are determined by previous contributions.

As a result, this variant of a public goods game allows for both, endogenous growth and endogenous inequality. Good examples for such a setting are in a broader context the evolution of societies, but also, as mentioned before, for example R&D cooperations ([Gächter et al., 2017](#)). Thus, we are interested whether a positive effect of leading-by-example is present in a dynamic setting with endowment carryover. Due to the possibility of growth, a leader may act as a coordination device, i.e., selecting a focal point in a situation where cooperation may pay extremely. In our experiment, subjects start with 2 EUR each and could end up with 34.17 EUR each, if all subjects would cooperate to a full degree in the public goods game. Hence, a leader has probably more responsibility, as decisions of previous periods have great influence on further periods and early contributions determine future contribution capabilities. Furthermore, the dynamic setting gives us the opportunity of investigating whether the presence of a leader has an impact with regard to within group inequality.

1.2 Literature Review

The simplest scenario to implement leadership is that a leader, without formal, power makes her decision first and the other players can observe it and determine their contributions subsequently. The leader therefore has the opportunity to lead by setting a (good) example. We use such a plain setting with a random subject being determined as a leader. The implementation that is probably most close to ours is that of [Güth et al. \(2007\)](#). In their fixed treatment, one of four group members is randomly selected to be the leader and remains in that position. We chose that exogenous procedure as it is a simple clear cut treatment. Furthermore, at least in a static game, there seem to be no differences with respect to contributions between a fixed and a rotating leader (see [Güth et al., 2007](#)).

Restricting our attention to treatments of experiments in which a leader, as we do in our experiment, is exogenously determined and does not enjoy formal power or superior information, we get the following picture of results: in [Güth et al. \(2007\)](#), average contributions in the treatment with leadership are (weakly) significantly higher than those in the simultaneous treatments. Likewise, several other authors that probe exogenous leadership in treatments of their experiments find positive effects on average contributions including [McCannon \(2018\)](#), [Dannenberg \(2015\)](#), [Pogrebna et al. \(2011\)](#), [Bracha et al. \(2011\)](#) [for a two player PG game] and [Levati et al. \(2007\)](#) [for the case of asymmetric endowments]. Insignificant effects are reported by [Haigner and Wakolbinger \(2010\)](#), [Gächter and Renner \(2014\)](#) and [Sahin](#)

et al. (2015). By contrast, Rivas and Sutter (2011) encounter significantly lower contributions with exogenous leadership compared to the control treatment, suggesting that the effects of leadership can backfire, when it is forced on members of a group. And for a two player setting, Gächter et al. (2010) report lower contributions when the player with the higher valuation moves first, compared to simultaneous play. Overall, the results are mixed, most studies, however, show a positive, albeit small, effect of exogenous leadership.¹

Leaders that set a good example have a positive impact on followers (Moxnes and Van der Heijden, 2003). A common observation from static PG experiments is that leaders' and followers' contributions are correlated to a large degree (see, for example, Arbak and Villeval, 2013). In addition, leaders also greatly shape the expectations of the followers (Gächter and Renner, 2014). However, the literature also shows that followers systematically contribute less than leaders (see, for example, Güth et al., 2007; Haigner and Wakolbinger, 2010; Rivas and Sutter, 2011; Arbak and Villeval, 2013; Gächter and Renner, 2014; Dannenberg, 2015; Cappelen et al., 2016). As a result of this selfish-biased conditional cooperation (Neugebauer et al., 2009), leaders are relatively worse off giving rise to a 'leader's curse' (Gächter and Renner, 2014).

Related to the question of who makes a good leader, Gächter et al. (2012) try to give an answer by classifying subjects. They elicit within subject leader and (conditional) follower contributions as well as beliefs, using the strategy method. The main finding is that cooperative leaders contribute more than non-cooperative ones, even after controlling for optimism. In addition, subjects that would behave conditionally cooperative, as followers, give significantly more if they are leaders. As a result, groups perform best when led by weak or strong conditional cooperators.

We are interested whether these findings, are resembled in a dynamic public goods game. Do small positive effects of exogenous leadership add up over time? Or do they vanish due to leader exploitation and relative deprivation as imperfect conditional cooperation by followers creates endogenous within group inequality, limiting the leader's capability to set a good example? A further contribution which we attempt to achieve with our experiment, is a classification of the subjects into different cooperation types - before the actual public goods game. We elicit the subjects cooperation types by means of a sequential prisoner's dilemma. Our main aim in this context, is to investigate the impact of different leader types on the success of a group.

The remainder of this paper is organized as follows. Section 2 describes the ex-

¹We are aware that our approach of using exogenous leadership is a relatively conservative test of leadership. Larger effects of leadership usually show up in treatments where it is endogenous (Rivas and Sutter, 2011; Haigner and Wakolbinger, 2010), endowed with formal power (Güth et al., 2007; Levati et al., 2007; Gürer et al., 2009; Sutter and Rivas, 2014) or an informational edge (Potters et al., 2005; Levati et al., 2007).

perimental design. Section 3 gives an overview on hypothesis and research questions whereas section 4 presents and discusses the results of the experiment. Section 5 concludes the paper.

2 Experimental Design and Procedures

Our experiment consists of two parts. Part I, which is a sequential prisoner's dilemma, is the same for all subjects. We used this decision task to classify subjects cooperation types. In part II of the experiment, subjects performed a dynamic public goods game which was either played simultaneously (*PG Sim*) or sequentially with a leader who moved first (*PG Seq*). We used a between-subject design, hence, subjects either participated in *PG Sim* or in *PG Seq*.

2.1 Part I

Eliciting conditional cooperation types

Before entering one of the two main treatments (*PG Sim* or *PG Seq*) we elicit conditional cooperation types of all subjects by a sequential prisoner's dilemma.² We matched the subjects in groups of two people and both players are endowed with 1 Euro.

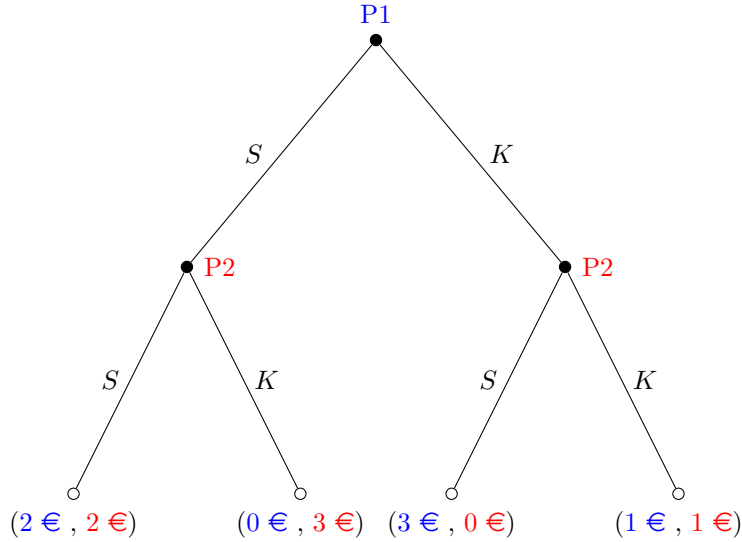


Figure 1: Payoff structure of the sequential prisoner's dilemma

First, Player 1 decides whether to send his Euro to Player 2 (choose action *S*) or keep the Euro for himself (choose action *K*). After observing his choice, Player 2 can

²This method is used for example by [Miettinen et al. \(2017\)](#) and described in further detail in [Kosfeld \(2017\)](#).

decide, conditionally on the choice of Player 1, whether to send 1 Euro (action S) or keep it (action K). If the Euro is sent to the other player, it doubles. Therefore, it is socially optimal that both players send their Euro. However, pursuing their own interest means that none of the two players sends their Euro. Hence, the decision situation of part I resembles a sequential prisoner’s dilemma. Figure 1 depicts the payoff structure of this game.

All subjects state their decisions for being either Player 1 or 2 (strategy method) and they are randomly allocated to one of these roles at the end of the experiment and paid accordingly. In addition, we asked them how many percent of participants they consider to choose the cooperative action when Player 1 cooperates/defects.³ Based on the participants’ conditional second mover’s choice, we can classify subjects along the lines of altruists (unconditional cooperators), conditional cooperators (cooperate only if the first-mover cooperates), free-riders (never cooperate) and mismatchers (play the opposite of the other player).⁴

Type	Behavior
Conditional cooperator (CC)	Cooperates only if the other player also cooperates
Selfish (SF)	Never cooperates (free-rider)
Altruist (AL)	Always cooperates
Mismatcher (MM)	Does the opposite of the other player

Table 2: Different cooperation types

2.2 Part II

Simultaneous Treatment (*PG Sim*)

In the main part of our experiment, subjects play a dynamic public goods game in one of two treatments (between-subject design), either *PG Sim* or *PG Seq*. The earnings of a given round serve as the endowment for the next round. In both conditions, subjects are randomly assigned to groups of four people, which stay the same for one period consisting of seven rounds. After each period, subjects are randomly rematched. In total, the game is played for four periods (see Table 3).

Period	1	2	3	4
Round	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7

Table 3: Structure of periods and rounds

³We did not incentivize this guessing task in order to keep cognitive load on a moderate level.

⁴In our experiment, we only had one subject which we classified as *mismatcher*. Since this subject responded to cooperation with selfish behavior, we also classified it as a *selfish* type for our further analysis.

In round 1 of every period, each participant is endowed with $E_i^1 = 20$ Taler, which he can either keep for himself in his “private account” or contribute to the public good labeled as a “group account” (g_i denotes the individual contribution to the group account). The MPCR for the group account is 0.375 which means that the group account has a return of 1.5.

Hence, the earnings at the end of round 1 are given by:

$$E_i^2 = E_i^1 - g_i^1 + \frac{1.5}{4} \sum_{j=1}^4 g_j^1$$

which serve as the endowment in round 2. Consequently, the endowment for round t is given by:

$$E_i^t = E_i^{t-1} - g_i^{t-1} + \frac{1.5}{4} \sum_{j=1}^4 g_j^{t-1}$$

and the final payoff of a period is given by the endowment after round 7, which is:

$$\pi_i = E_i^7 - g_i^7 + \frac{1.5}{4} \sum_{j=1}^4 g_j^7.$$

In each round of a period, subjects simultaneously make their decisions without knowledge of other participants’ contributions prior to taking their own contribution decision in *PG Sim*. After each round, they are informed how many Taler the other group members contributed and about their and the others’ new endowment. After finishing a period, subjects are randomly rematched to new groups of four. One of the four periods is randomly chosen for payment (random incentive mechanism).

Sequential Treatment (*PG Seq*)

Treatment *PG Seq* is similar to treatment *PG Sim*, except that one subject is randomly allocated to the role of a leader at the beginning of a period. This participant (leader) moves first in all rounds of a period. The other subjects (followers) are informed about the leader’s contribution and subsequently decide upon their own contribution choice in all rounds of a period. In every period a new leader is randomly selected. Everything else is identical to *PG Sim*.

2.3 Participants and Procedures

The experimental sessions were conducted in the Regensburg Economic Science Lab (RESL) in February 2018 using zTree ([Fischbacher, 2007](#)) for programming and

Orsee ([Greiner, 2004](#)) for recruitment. 92 participants (45 men and 47 women; mean age: 23), most of them enrolled in business administration, economics or a related subject, took part in four experimental sessions with a minimum of 20 and a maximum of 24 subjects per session. Before entering the room, participants were randomly assigned a cabin with a computer. For both parts of the experiment, we provided participants with written instructions as well as a verbal summary that was read aloud. Subjects were not aware of the content of part II of the experiment before finishing part I. We payed participants in Euro at the end of the experiment. In total, the experiment lasted about 75 minutes and generated average earnings of about 14.12 EUR (including a show-up fee of 4 EUR).⁵

3 Hypotheses and Research Questions

3.1 Wealth

Under the assumption of selfish, payoff-maximizing players, the unique equilibrium of the simultaneous game, *PG Sim*, is that all players contribute zero in each round (consider the online appendix of [Gächter et al., 2017](#), for a formal proof). A simple backwards induction argument also renders zero contributions in each round as the unique equilibrium of the sequential game *PG Seq* (hence, we abstain from providing a formal proof here). Therefore, zero contributions, and thus no difference in final payoffs should emerge in both treatments assuming only selfish players.

However, if one presumes a substantial proportion of subjects whose patterns of behavior can be described as reciprocal types that exhibit conditional cooperation ([Keser and Van Winden, 2000](#); [Fischbacher et al., 2001](#)), the picture changes. [Ambrus and Pathak \(2011\)](#) set up such a model and adopt it to a static public goods game. As conditional cooperators are backward-looking in determining their contributions, selfish players can influence future contributions of reciprocal players positively by contributing a large amount. The more rounds that are left, the higher the influence of these contributions. It is therefore in the interest of selfish players to contribute, especially in early rounds of a period, as this causes a positive reaction of the reciprocal players affecting the remaining periods. In the course of a period, this incentive for selfish players is getting lower and lower, which leads to a decreasing pattern of their contributions. This driving force of [Ambrus and Pathak \(2011\)](#)'s model is also reasonable in our dynamic setting with endowment carryover. In addition, more contributions by selfish players have a positive impact on contribution capabilities of the reciprocal types thus constituting a second incentive for them to

⁵In part I of the experiment, payoffs were given in EUR. For part II, we used Taler as experimental currency unit (ECU) with an exchange rate of 1 Euro = 10 Taler.

contribute in early rounds.

The sources of a possible positive impact of leadership are twofold: *First*, due to their exposition, the initial contribution of a leader offers a chance for amelioration: it gives clues for everyone else about the distribution of types and the degree of optimism the leader has over the occurrence of cooperation. Reciprocal types are no longer dependent on their expectations about the contributions of others, instead the leader’s first contribution is setting a salient example. The leader acts as a ‘belief manager’ (Gächter and Renner, 2014). As early contributions determine later contribution capabilities, the (positive) signal that the leader can give here might have a big impact. *Second* and likewise, the leader can give a positive signal inducing conditional cooperators to reciprocate in other periods by his particular visibility. This is even true for the very last round of a given period: a selfish leader has incentives to make a positive contribution in the last period, since reciprocal types can respond to her contribution. In the simultaneous game this is not the case, so selfish types should choose a contribution of zero in the last round. Taken together, this gives rise to our first hypothesis:

Hypothesis 1. *Assuming a substantial fraction of conditional cooperators, we expect non-negative contributions in both treatments. In addition, we expect that contributions in PG Seq are larger than in PG Sim.*

3.2 Inequality

As described in Section 1.2, followers typically contribute less than leaders. Followers adopt a quasi-matching strategy and donate systematically less compared to the leaders (McCannon, 2018) displaying signs of imperfect or selfish-biased conditional cooperation (Neugebauer et al., 2009). In our dynamic setting, this effect would intensify round by round, so that the leader would be impoverished relative to the followers. Compared to PG Sim larger inequality would be the result. This leads to the following hypothesis:

Hypothesis 2a. *PG Seq leads to **higher** average within group inequality compared to PG Sim.*

An alternative view would insist that due to the leaders influence (Gächter and Renner, 2014), the followers may have a more homogeneous contribution pattern than subjects in PG Sim. Despite the discrepancy between a leader’s and her followers’ contributions, this would give rise to reduced inequality compared to PG Sim which consequently yields the following alternative hypothesis:

Hypothesis 2b. *PG Seq leads to **lower** average within group inequality compared PG Sim.*

So in summary, we have two competing hypotheses. Accordingly, it is unclear to us a priori whether leadership (*PG Seq*) leads to an increase or decrease in inequality within a group compared to *PG Sim*.

3.3 Leader Types

As in the one-shot-game scenario of [Gächter et al. \(2012\)](#), we also expect cooperative types to be the better leaders with respect to average final earnings of a group. Due to a kind of “false consensus effect” and their social preferences, we expect them to make higher initial contributions. In addition, we especially expect conditional cooperators to promote cooperation by giving the group the right signals for cooperation. In the spirit of [Ambrus and Pathak \(2011\)](#)’s model, we expect strategic leadership of selfish types with a declining pattern of their contributions.

Hypothesis 3. *Within PG Seq we expect that groups work best when led by cooperatively inclined individuals.*

4 Results

In this section we present the results of our experiment. First, we focus on the effect of leadership by comparing both treatments. This mainly involves trying to answer the question of whether leadership has an impact on the wealth of group members and inequality within groups. For each of the two questions, we also consider the influence of the behavioral type of the leader.

In the exploratory part of the analysis, our interest is twofold: On the one hand, we want to know whether leadership reduces the number of individuals that are likely to find themselves in a sucker position, not benefiting from any cooperation gains. The criterion for “no gains from cooperation” (NGC) can be regarded as a stricter version of the Pareto criteria. There are gains from cooperation in a group as long as *all* group members *strictly* improve their earnings compared to the previous round, in absolute terms. A violation of this pattern naturally occurs, when some members of the group contribute relatively few money to the group pot, while others spend more (free-rider behavior), or when all group members stop contributing money to the group pot. We try to find out if leadership leads to a delayed occurrence of the *no gains from cooperation condition* (NGC condition).

On the other hand, in the last part of the analysis, we focus on treatment *PG Seq* only, to get a deeper insight about the underlying mechanisms of successful leadership. We try to find out whether the followers behavior is also dependent on their behavioral types, with regard to their reaction on a leader's contribution. In addition, we aim at opening the black box of different success of different leader types. In particular, we wonder if we can observe the predicted pattern of decreasing relative contributions of selfish leaders, and thus strategic leadership behavior. We conclude with illustrative examples of successful and less successful leadership.

Overall, our results suggest that leadership is an important driver for the success of a group. Especially the behavior of the leader in the first round(s) is crucial for the further course of the group. Conversely, leadership has a negative effect, when the leader gives too little in the first round, compared to a setup without any leader. Additionally we find that the cooperation type of the leader matters a lot: groups led by cooperatively inclined types are significantly more successful. The leader herself, however, is on average not better off than the participants in the simultaneous treatment *PG Sim*. So it is mainly the followers who profit from leadership.

4.1 Wealth

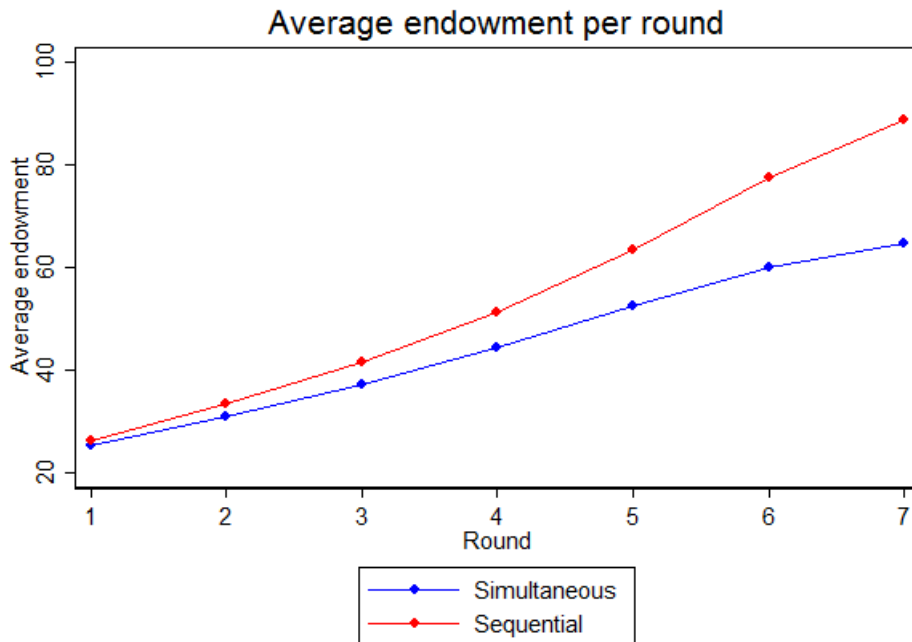


Figure 2: Average endowment at the end of each round by treatment

Let us begin with the question of whether group members are better off in the end, when they are in a group with a leader. Comparing final earnings of participants at the end of round 7, we identify a significant treatment effect ($p=0.025$, clustered two-sided two-sample t -test). Participants in the sequential treatment *PG Seq* earn on average about 89 Taler compared to 65 Taler average earnings in *PG Sim* at the end of round 7 - which is an increase of around 37%. Figure 2 depicts average endowments at the end of each round by treatment.

	Endowment (end of round 7)			
	(1)	(2)	(3)	(4)
Sequential Treatment	23.847** (10.511)	-10.780 (8.342)	-9.796 (8.768)	-19.472*** (7.451)
ST X CC leader		54.339*** (13.505)		
ST X AL leader		24.365** (11.929)		
ST X Leader gave 20 in R1			80.742*** (16.219)	64.331*** (14.886)
No gains from cooperation in R1				-51.290*** (5.358)
Constant	60.439*** (8.297)	58.545*** (8.406)	63.949*** (7.735)	98.612*** (7.877)
Period controls	YES	YES	YES	YES
Observations	368	368	368	368
Subjects	92	92	92	92
R^2 overall	0.024	0.075	0.140	0.232

Note: Random effects regression with period controls. Cluster-robust standard errors (on the subject-level) are in parentheses. In column (2) the variable “Sequential Treatment” can be interpreted as *Sequential Treatment* times a *selfish leader*.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Regression Table - Endowment

This is illustrated again in column (1) of Table 4, where we estimated a random-effects model with period controls. Here, we also use the information from part I of the experiment, regarding the cooperation type of the leader. Additionally, we also

included variables concerning (i) whether there were no gains from cooperation for at least one subject already in round 1 (NGC criterion) and (ii) whether the leader contributed his full endowment of 20 Taler in round 1.

It becomes apparent that the leader's cooperation type is essential (see also Figure 3). Leadership with a conditional cooperator as first-mover improves earnings a lot (more than an altruist) while a selfish leader worsens the outcome (although not significantly). We will discuss this in more detail later on in the exploratory part of the analysis (see Section 4.3.2).

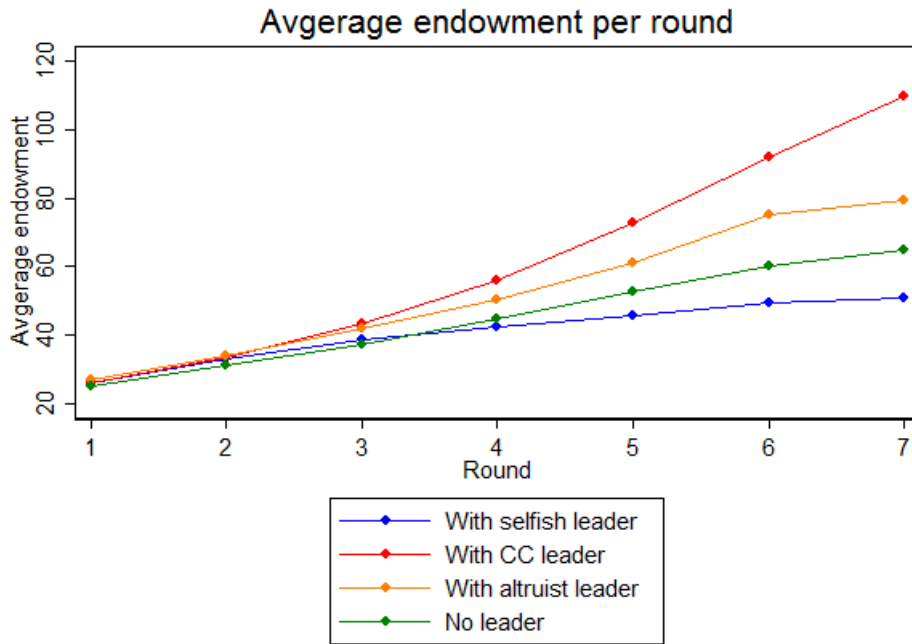


Figure 3: Average endowment per round - split up by leader type and treatment

As well, the first contribution of a leader is vital for the final outcomes. The best signal a leader may give at the beginning is to contribute his entire endowment of 20 Taler. For this reason, we split the leaders into two groups: those who sacrifice their whole initial endowment of 20 Taler by putting it in the group account, and all others that contribute less. Comparing both groups, we only find a significant positive effect, compared to *PG Sim*, if there is leading by a very good example (see column (3) of Table 4). This underlines the fact that the leader has a significant influence for generating an environment of trust and cooperation within the group from the beginning on by setting a very good example.

Likewise, if there are no mutual benefits of cooperation in round 1, this will have persistent effects on final outcomes (see column (4) of Table 4). Subjects in groups, realizing the NGC criterion already in round 1, suffer from large and negative effects on their final earnings. The coordinating role of leadership is also reflected in the

fact that the presence of a leader delays the first appearance of the NGC condition, as we will show in the exploratory part of the analysis (see Section 4.3.1). This is an important aspect which can explain why a leader can be valuable for the group.

We have now investigated whether the presence of a leader has benefits in terms of the final assets of the group members. In addition, we saw how the leader can already shape the game in round 1. Our results can be summarized as follows:

Observation 1. *Our findings suggest that leadership has a positive impact on final wealth. In addition, the behavioral type of the leader has a major impact. The members of groups led by a conditional cooperator are best off, on average. Furthermore, an exemplary large contribution of the leader in the beginning (20 Taler) yields a high return. If there are no mutual benefits of cooperation in round 1, this has persistent negative effects on final outcomes.*

4.2 Equality

A question that naturally arises in connection with a dynamic public goods game with endowment carryover is that of inequality. In our setting, inequality can endogenously arise through different contributions of the group members to the public good. Therefore, the question is exciting, whether leadership has a significant impact here.

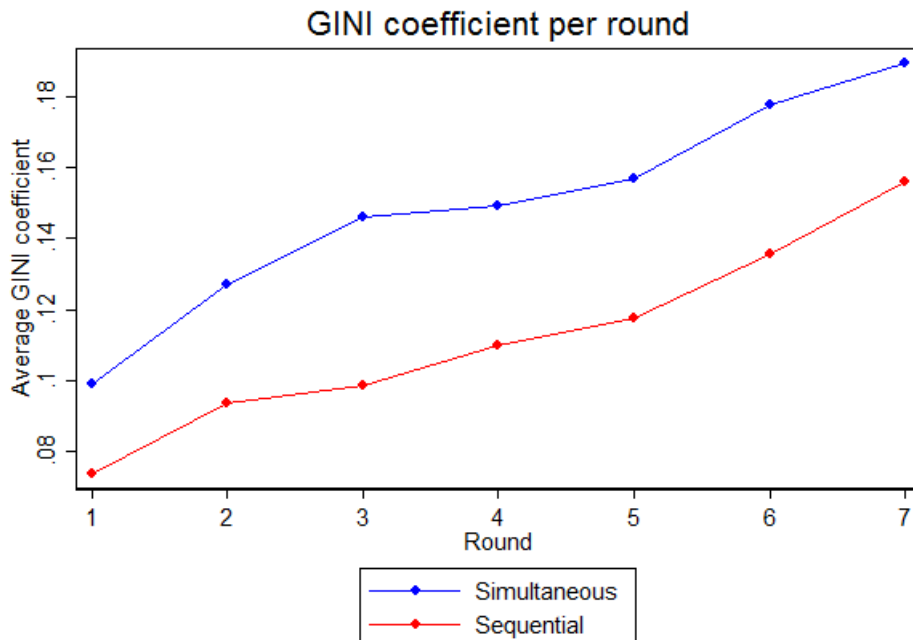


Figure 4: Average gini coefficient at the end of each round by treatment

Recalling Hypothesis 2a, leaders suffers some kind of curse. Previous research has shown that leaders, on average, earn less than followers. They are, so to speak,

exploited by the followers. This pattern should lead to an increase in inequality. However, as reflected in Hypothesis 2b, the same line of research also states that leaders have a great influence on the expectations and contributions of the followers. Thus, if a leader has a big impact on the followers, it can be expected that the contributions to the public good will become more even. More even followers' contributions would result in less within-group inequality. It is exciting to see which effect predominates here and whether we even find a treatment effect.

A common measurement for inequality is the Gini index that we compute for every group and round. We used a random-effects regression where the GINI coefficient of a group is the panel variable and the rounds are the time variable. In general, inequality raises with each round in both treatments of the dynamic public goods game.

	GINI coefficient			
	(1)	(2)	(3)	(4)
Sequential Treatment	-0.037*** (0.013)	0.003 (0.018)	-0.033** (0.014)	-0.027** (0.013)
ST X CC leader		-0.058*** (0.020)		
ST X AL leader		-0.041 (0.026)		
ST X Leader gave 20 in R1			-0.011 (0.020)	-0.002 (0.019)
No gains from cooperation in R1				0.028** (0.013)
Constant	0.099*** (0.013)	0.100*** (0.013)	0.098*** (0.013)	0.079*** (0.016)
Period controls	YES	YES	YES	YES
Round controls	YES	YES	YES	YES
Observations	644	644	644	644
Groups	92	92	92	92
R^2 overall	0.193	0.246	0.195	0.224

Note: Random effects regression with period and round controls. Cluster-robust standard errors (on the group-level) are in parentheses. In column (2) the variable “Sequential Treatment” can be interpreted as *Sequential Treatment* times a *selfish leader*.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Regression Table - GINI coefficient

With respect to within group equality, we can report a significant positive treatment effect. The result is a bit surprising, as the effect is very clear. Within group inequality is lower in *PG Seq* (see Figure 4) and this effect is significant (see column (1) in Table 5). Again the leader’s type does matter a lot. A conditional cooperator as a leader has a significant effect in reducing inequality as measured by the Gini index, while the effect for other leader types is insignificant (see column (2) in Table 5). In terms of inequality, the leader’s contribution of 20 in round 1 has no effect, whereas groups that achieve no gains from cooperation *for all* group members in round 1, have significantly higher inequality. This brings us to the following summary:

Observation 2. *Somewhat surprisingly, leadership also has a positive impact on reducing inequality within groups as measured by the Gini index. Moreover, groups led by conditional cooperators have significantly lower inequality. If there are no mutual benefits of cooperation in round 1, this increases inequality significantly.*

4.3 Exploratory Part

4.3.1 No gains from cooperation criterion

As we have seen in the previous parts, having at least one group member that does not strictly improve his or her endowment already in round 1, has a persistent effect, resulting in lower final earnings of *all* group members. In this section we show that leadership can be an useful tool in preventing an early emergence of the NGC condition.

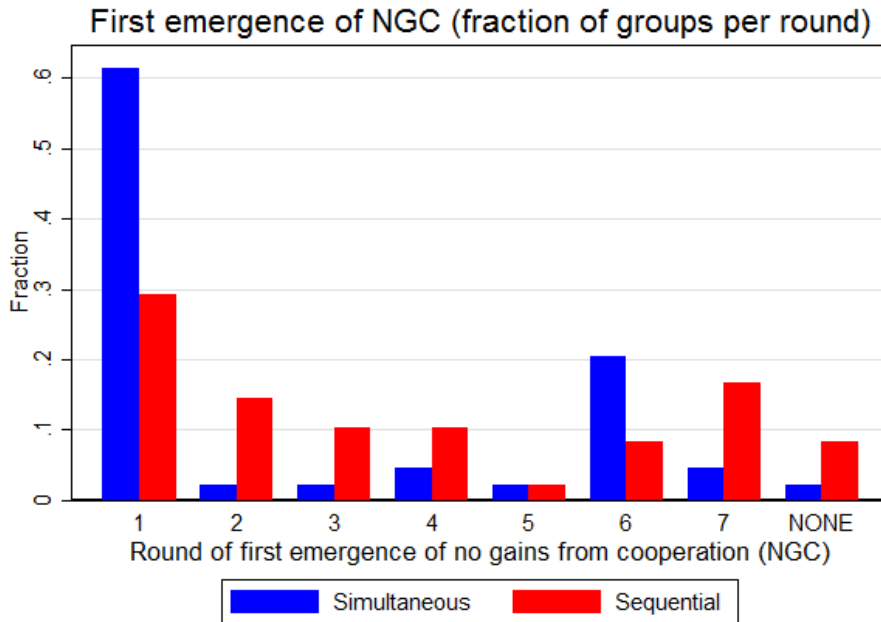


Figure 5: First emergence of *no gains from cooperation condition*

As Figure 5 indicates, we find evidence that leadership plays a pivotal role in establishing stable cooperation for multiple rounds. In *PG Sim* in more than 60% of the cases at least one individual does not strictly improve, already after the first round. By contrast, in *PG Seq* only in around 30% of the cases the criterion for no gains from cooperation is met after the first round, highlighting the leader's role in coordinating others contributions. On average, at least one subject within a group does not strictly improve for the first time after 2.75 rounds in *PG Sim* compared to 3.75 rounds in *PG Seq* ($p=0.0289$, two-sided two-sample t -test). The sequential treatment therefore delays the first occurrence, on average, by exactly one round. We can further see that in treatment *PG Sim* there is a second peak in round 6, whereas in *PG Seq* this second peak occurs only in round 7.

	Round of first emergence of NGC		
	(1)	(2)	(3)
Sequential Treatment	1.000*** (0.351)	0.092 (0.361)	0.186 (0.384)
ST X Leader gave 20		2.179*** (0.399)	
ST X CC leader			1.243*** (0.388)
ST X AL leader			0.689* (0.405)
Constant	2.609*** (0.361)	2.703*** (0.349)	2.571*** (0.360)
Period controls	YES	YES	YES
Observations	368	368	368
Subjects	92	92	92
R^2 overall	0.055	0.140	0.088

Note: Random effects regression with period and round controls. Cluster-robust standard errors (on the group-level) are in parentheses. In column (3) the variable “Sequential Treatment” can be interpreted as *Sequential Treatment* times a *selfish leader*. NGC is an abbreviation for “no gains from cooperation for at least one group member”.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Regression Table - No gains from cooperation (NGC)

In Table 6 we can see that the sequential treatment *PG Seq* with a leader has a significant effect on deferring the first appearance of a situation where at least one subject of the group has no benefits from cooperation (the dependent variable is the round in which at least one group member does not strictly improve for the first time). It is interesting to see that a very good example of a leader (20 Taler in round 1) leads to a long-term benefit of cooperation for all group members. Actually, this leadership effort is a risky endeavor. The leader gives his entire endowment to the group pot. If the followers will not respond positively, the leader will clearly be worse off. So it is all the more astonishing that this leadership effort leads to the opposite, resulting in a longer phase in which everyone benefits (see column (2) of Table 6). This indicates that most of the subjects are more willing to match the leader than to free-ride, because otherwise there would be a high probability that the leader himself does not increase his endowment, from round 1 to round 2, when giving 20 Taler in the beginning. This claim is confirmed in the next section where we look at the reactions of the followers on a leader's contribution. Controlling for the type of the leader (column (3) of Table 6), we again find that it is the conditional cooperators that have a positive impact when selected to be leaders.

Observation 3. *Leadership can be an useful tool in preventing an early emergence of a NGC condition. As our analysis shows, the sequential treatment delays the first occurrence of the event, that at least one individual does not strictly improve, on average, by exactly one round. We see again that the first contribution and the behavioral type of the leader are crucial.*

4.3.2 Analysis of *PG Seq*

In this section we want to take a closer look behind the mechanisms of effective leadership and investigate why some groups in *PG Seq* are more successful than other ones. We begin by analyzing the followers reaction and then proceed by looking at the behavior of the leaders.

Follower Behavior

The follower's reaction is decisive for successful leading-by-example. Only if they respond adequately, it will be ensured that leadership on the one hand has success in terms of the final endowments of the group members, but on the other hand that the leader does not fare worse either.

We consider the reactions to a leader's contribution both relative to a subject's own endowment and in absolute terms. Focusing on absolute contributions first, Table 7 (*left*) indicates that for every Taler, a leader gives in a round, followers give on average 0.822 Taler to the public good. Additionally, follower type heterogeneity

leads to different reactions. Although all types react positively to higher contributions of the leader, this reaction is particularly pronounced for followers that were classified as conditional cooperators and altruists as the coefficients in Table 7 reveal. Selfish follower types match a Taler given by the leader by only 0.56 Taler which is much less compared to the amount given by conditional cooperators and altruists. A similar pattern emerges for relative contributions (see Table 7 (*right*)). Our result is summarized in Observation 4. This high degree of matching a leader's contribution further illustrates why the behavior of the leader matters a lot, since even selfish types react positively on the amount spent by the leader.

	Contribution			Relative Contribution	
	(1)	(2)		(1)	(2)
Leader contribution	0.822*** (0.056)		Rel. Leader contribution	0.835*** (0.027)	
LC X SF type		0.560*** (0.095)	RLC X SF type		0.639*** (0.101)
LC X CC type		0.837*** (0.056)	RLC X CC type		0.853*** (0.024)
LC X AL type		0.909*** (0.085)	RLC X AL type		0.869*** (0.080)
Constant	1.526 (1.235)	1.830* (1.087)	Constant	0.021 (0.037)	0.033 (0.036)
Period controls	YES	YES	Period controls	YES	YES
Round controls	YES	YES	Round controls	YES	YES
Observations	1008	1008	Observations	1008	1008
Subjects	47	47	Subjects	47	47
R^2	0.781	0.791	R^2	0.701	0.711

Note: OLS regression with period controls. Cluster-robust standard errors (on the subject-level) are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Note: OLS regression with period controls. Cluster-robust standard errors (on the subject-level) are in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Regression Table - Matching of leader contribution (absolute and relative)

Observation 4. *In general, followers react positively to a leader's contribution matching it to a large degree, both in absolute and in relative terms. The type of the follower plays a major role as selfish followers exhibit a much smaller reaction.*

Leader Behavior

We have already mentioned two results on leadership. At first, it seems important that they set a good example. On the other hand, the behavioral type of the leader

also seems to play a major role as Figure 3 illustrates. Next we try to open the black box of successful leadership by a little.

First of all, we wonder why conditional cooperators prosper as leaders with respect to their group members' final earnings. Our first guess that they - driven by some kind of false consensus effect - contribute a lot to the group pot at first, does not meet the mechanism. As Figure 6 shows, conditional cooperators have the lowest average initial leader contribution of all types. Rather, as Figure 6 also shows, it is their persistence that makes CC types successful. A behavior that can probably be explained by a false consensus effect, is the one of that subjects which we classified as altruists. When they are leaders, they start with very high relative contributions in the beginning, but display a faster decline than the CC types afterwards. By contrast, we discover signs of strategic leadership by selfish types. They start with very high contributions in the first two rounds, revising them sharply afterwards. What came to our mind was a strategy the New York Times (Gleick, 1986) described as a 'tranquilizer strategy' for the PD game: to lull the opponent for a few moves and then try to exploit him.

We find evidence for this claim in our data as selfish types contribute more in their initial contribution when they are leaders. In round 1 of *PG Seq* 61.54% of the leaders, which we classified as "selfish", contributed their whole amount of 20 Taler. However, only 21.74% of the selfish followers also contributed this amount. In treatment *PG Sim* by comparison, 25.00% of the selfish types contributed 20 Taler in round 1.

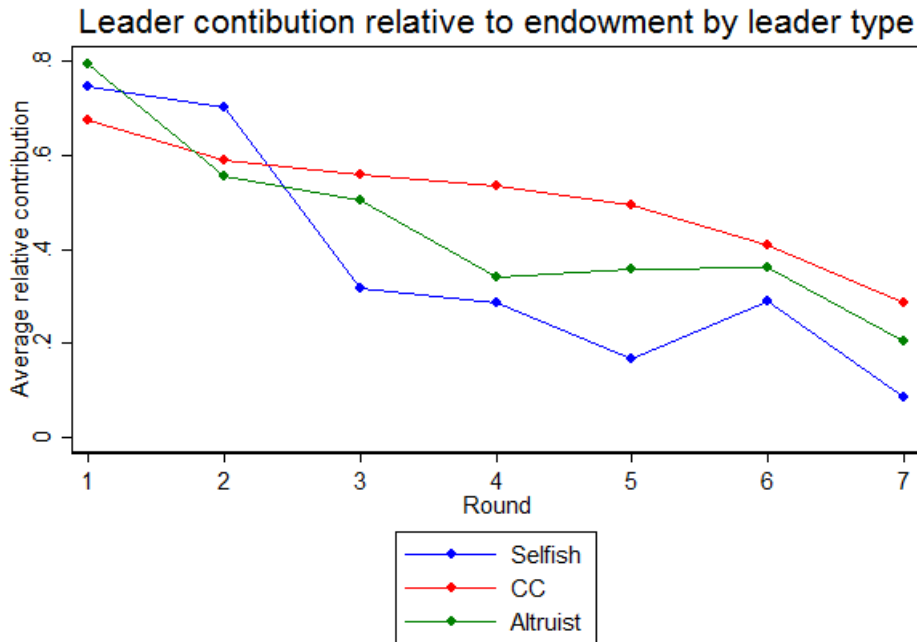


Figure 6: Leader's relative contribution by behavioral type and round

Overall, a high early contribution by the leader in round 1 of a period has a large impact on final earnings in round 7 of the respective period. In columns (2) to (5) of Table 8 we can see that a leader first contribution of 20 Taler has a massive effect on final wealth. E.g., in column (5) we see that contributing 20 Taler in round 1, increases the final endowment of *every* group member by around 105 Taler on average. We find further evidence that the relationship between first leader’s contributions and final wealth is rather non-linear as it can also be seen by Figure 7, where we only find distinct peaks for contributions of 15 and 20 Taler.

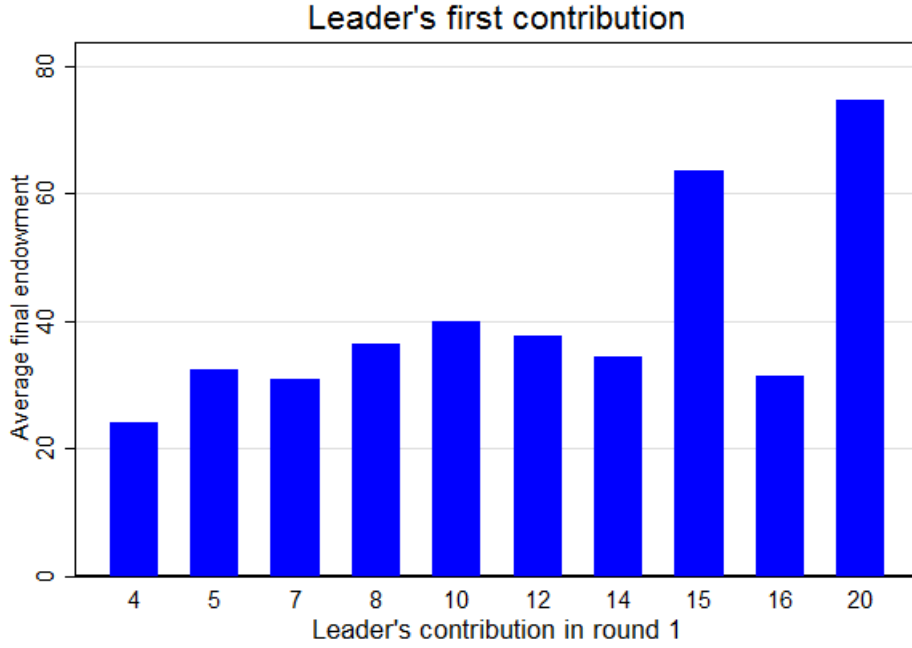


Figure 7: Final endowment by leader’s first contribution

To support our claim that this effect is only driven by very high contributions, we also ran a robustness check, where we used the *amount of Taler spent in round 1 by the leader* as independent variable, instead of a dummy variable (spending 20 Taler [1] or less [0]). We found a positive and significant effect of around 8 Taler for each group member, for each Taler the leader spends in round 1. However, this effect harshly decreases or even vanishes, when we exclude the amounts larger than 15 Taler as first leader contributions (see *Appendix A*). A possible driver behind this pattern might be that (only) very high early contribution can be interpreted as a signal of trust and, hence, they can induce sufficiently reciprocal types to contribute a high amount as well, which might finally lead to a stable cooperation for several rounds.

We have already reported that group members are more successful when they

have a conditional cooperator as leader. Column (3) of Table 8 reveals that the relationship is also significant considering only *PG Seq*.

	Endowment (end of round 7)				
	(1)	(2)	(3)	(4)	(5)
Is leader	-26.540** (12.829)	-25.883** (12.463)	-27.073** (12.954)	-17.263 (14.595)	-17.322 (14.386)
Leader gave 20 in R1		78.685*** (16.803)	105.650*** (15.954)	111.301*** (17.660)	105.082*** (17.340)
Leader is CC			93.953*** (16.025)	94.023*** (15.882)	90.854*** (15.386)
Leader is AL			40.873** (16.853)	40.965** (16.775)	39.697** (16.944)
LG20 X Is leader				-24.646 (29.151)	-24.879 (29.168)
NGC in R1					-19.096** (8.571)
Constant	80.073*** (11.066)	53.680*** (9.413)	-21.052 (14.059)	-23.389* (13.766)	-7.924 (15.564)
Period controls	YES	YES	YES	YES	YES
Observations	192	192	192	192	192
Subjects	48	48	48	48	48
R^2 overall	0.029	0.189	0.362	0.363	0.367

Note: Random effects regression with period controls. Cluster-robust standard errors (on the subject-level) are in parentheses. NGC is an abbreviation for “no gains from cooperation for at least one group member”.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 8: Regression Table - Endowment (only *PD Seq*)

However, being the leader is not necessarily good for own payoffs as column (1) of Table 8 reveals. Leaders face some kind of curse as their earnings are lower than those of other group members. This result is not very surprising and can be explained by incomplete or selfish-biased conditional cooperation by followers. Figure 8 illustrates this circumstance graphically. However, it has to be said that leaders

do not fare worse in the end than average participants in *PG Sim*. This, too, is depicted in 8.

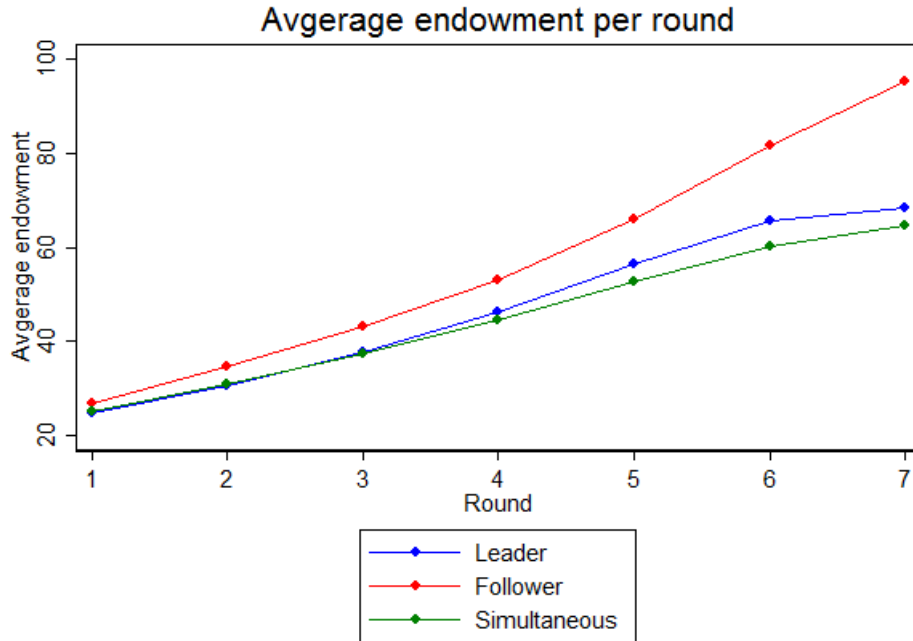


Figure 8: Average endowment by treatment + leader/non-leader

Observation 5. *We find that that the leader type has a significant effect on final earnings of the group members. The results suggest that leaders classified as conditional cooperators are successful because they give persistently a large fraction of their endowment over the course of a period. Very high first contributions by the leader, yield a high return concerning final earnings. The leader herself is, however, not significantly better of than an average subject in PG Sim.*

Examples of Successful and Less Successful Leadership

To illustrate the effect of successful and less successful leadership we present some exemplary groups in this section. The blue line in the graphs represents the leader contributions, while the red lines represents the follower contributions.

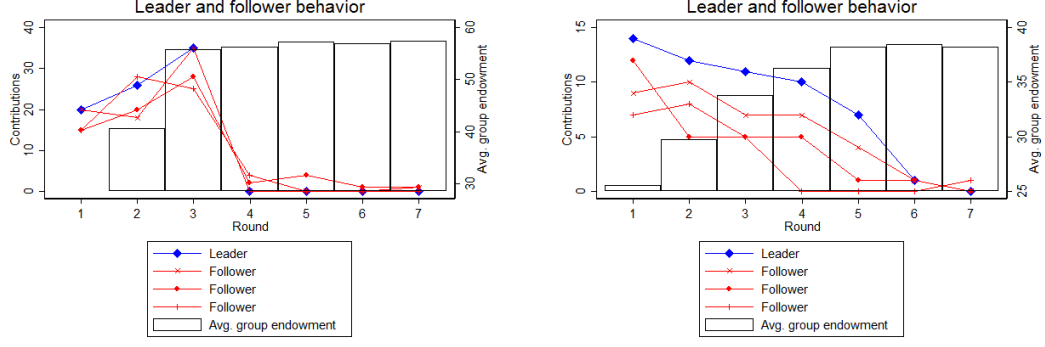


Figure 9: Less successful leadership

Figure 9 shows two examples of less successful leadership. In the left part we see that the leader stops contributing after three rounds, although the followers matched him before (at least partly). This results in a breakdown of cooperation and almost no further growth after round 3. In the right part we can observe a leader who started with a medium contribution in the first round. After this the leader decreases his contribution in every subsequent round and the followers mimic this behavior, resulting in a very low final average endowment.

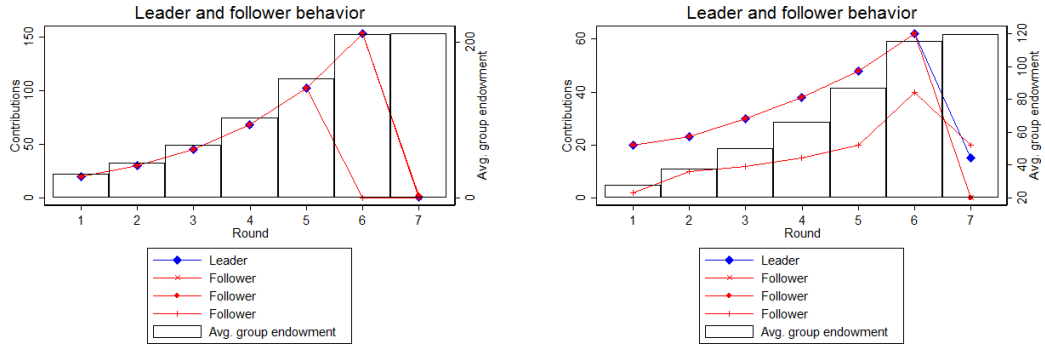


Figure 10: Successful leadership

Figure 10 shows two examples of successful leadership. In both cases the leader starts with a full contribution of 20 Taler in the beginning. In the left part we can see that the leader only deviates in the last round from full contribution. The same is true in the graph on the right part, where the leader sticks to his plan of full contribution until round 6, although one group member is a free-rider who only matches the leader partly.

5 Conclusion

In summary, the analysis of our experiment shows that leadership has a positive impact on final wealth of subjects, when there is endowment carryover. The results of static public goods games continue to hold and exogenous leadership leads to an improvement of group members' earnings.

The leaders are a bit the losers. They contribute more to the group pot and in the end receive lower payouts than the followers. So they hardly benefit from *PG Seq.* However, the average leader is not worse off than an average player in *PG Sim.* From a welfare perspective, it can be argued, considering the averages, that *leading-by-example* leads to a Pareto improvement.

In addition, leadership has other positive effects. It significantly reduces inequality in a group compared to *PG Sim.*, thus reducing the within group inequality as measured by the Gini Index. As the the Gini index refers to a utilitarian social welfare function that integrates individual inequity aversion ([Schmidt and Wichardt, 2018](#)), under these circumstances there is a further welfare improvement given social preferences. Linked to this is our result that leadership delays the point of time when at least one individual no longer benefits from cooperation.

Based on a sequential prisoner's dilemma, we elicited types for conditional cooperation in part I of the experiment. This type classification allows us to go into further detail. Regarding the question of who is a good leader in such a dynamic game, the results obtained, indicate that it is especially the conditional cooperators that stand out. The mechanism is interesting, it is apparently less a false consensus effect that makes conditional cooperator types successful with regard to group success in our game, but rather their perseverance in setting a good example.

While we see signs of strategic leadership in the selfish types, with very high contributions in the first two rounds followed by a sharp crash, conditionally cooperative types change their contribution relative to income only gradually. They are not the ones who, on average, give the highest contributions in round 1. Nevertheless, they have staying power and contribute a relatively high proportion of their income for a long time. For whom leadership by a false consensus effect could best be used as an argument are the altruists who make very high contributions at the beginning, but then quickly - speculatively because of disappointment - reduce their contributions. Regarding the reaction of the followers, we can say that followers that are either classified as conditional cooperators or altruists, match leader's contributions to a higher degree than selfish types.

If we pay attention to the contribution in the first period, it has a high impact on the final result across all groups. For the groups, it pays off if the leader prefaces by setting a very good example. The leader herself, however, benefits less.

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A Robustness checks

Regression model from Table 8 with leader first contribution as independent variable instead of dummy variable “leader gave 20”

	Endowment (end of round 7)				
	(1)	(2)	(3)	(4)	(5)
Is leader	-26.540** (12.829)	-25.703** (12.884)	-26.764** (13.514)	18.520 (32.428)	18.856 (32.583)
Leader first contr.		7.566*** (1.332)	8.513*** (1.288)	9.245*** (1.333)	8.607*** (1.291)
Leader is CC			70.065*** (14.773)	69.941*** (14.403)	67.853*** (13.880)
Leader is AL			21.795 (13.482)	22.087* (13.313)	21.946 (13.482)
LFC X Is leader				-3.210 (2.482)	-3.247 (2.497)
NGC in R1					-20.729** (9.968)
Constant	80.073*** (11.066)	-15.345 (13.489)	-75.521*** (23.036)	-85.896*** (22.693)	-64.340*** (24.940)
Period controls	YES	YES	YES	YES	YES
Observations	192	192	192	192	192
Subjects	48	48	48	48	48
R^2 overall	0.029	0.194	0.310	0.312	0.317

Note: Random effects regression with period controls. Cluster-robust standard errors (on the subject-level) are in parentheses. NGC is an abbreviation for “no gains from cooperation for at least one group member”.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 9: Regression Table - Endowment (only *PD Seq*)

Regression model from Table 8 with leader first contribution as independent variable instead of dummy variable “leader gave 20” - leader first contributions above 15 Taler are excluded

	Endowment (end of round 7)				
	(1)	(2)	(3)	(4)	(5)
Is leader	-15.031** (6.237)	-15.370** (6.346)	-15.085** (6.019)	8.060 (9.691)	8.070 (10.620)
Leader first contr.		2.642** (1.106)	1.057 (1.181)	1.640 (1.260)	2.351* (1.315)
Leader is CC			2.978 (7.543)	2.865 (7.501)	0.310 (7.828)
Leader is AL			27.856 (21.837)	27.712 (21.845)	21.354 (20.047)
LFC X Is leader				-2.505** (1.272)	-2.499* (1.305)
NGC in R1					10.455 (7.127)
Constant	48.662*** (3.819)	25.144** (10.542)	33.500*** (8.147)	28.199*** (8.785)	16.718 (11.937)
Period controls	YES	YES	YES	YES	YES
Observations	92	92	92	92	92
Subjects	46	46	46	46	46
R^2 overall	0.089	0.114	0.170	0.178	0.199

Note: Random effects regression with period controls. Cluster-robust standard errors (on the subject-level) are in parentheses. NGC is an abbreviation for “no gains from cooperation for at least one group member”.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 10: Regression Table - Endowment (only *PD Seq*)

B Balancing tables

Type	Treatment	
	<i>Simultaneous</i>	<i>Sequential</i>
<i>Selfish</i>	14	8
<i>CC</i>	26	31
<i>Altruist</i>	4	8
<i>Mismatcher</i>	0	1
<i>Total</i>	44	48
	Pearson $\chi^2(3) = 4.2424$; $p = 0.236$	

Table 11: Number of different cooperation types across treatments

Instruktionen

Herzlich willkommen zu diesem wirtschaftswissenschaftlichen Experiment! Während des Experimentes haben Sie die Möglichkeit, eine Aufgabe auszuführen, welche in den nachfolgenden Instruktionen im Detail erklärt werden wird. Dabei können Sie einen nicht unerheblichen Geldbetrag gewinnen. Wie hoch Ihre Auszahlung letztendlich sein wird, hängt von Ihren Entscheidungen und den Entscheidungen der anderen Teilnehmer ab. Während des Experiments ist es Ihnen untersagt, mit den anderen Teilnehmern zu kommunizieren. Bitte lesen Sie die vorliegenden Instruktionen gründlich durch. Sollten Sie vorab oder während des Experiments noch Fragen haben, heben Sie bitte Ihre Hand und ein Experimentator wird zu Ihrem Platz kommen.

Allgemeiner Aufbau

Das Experiment besteht aus einem **Teil 1** und einem **Teil 2**. Diese beiden Teile sind unabhängig voneinander – d.h. Ihre Entscheidungen in Teil 1 haben keinen Einfluss auf den Ausgang von Teil 2 und umgekehrt. Sie bekommen zunächst Instruktionen für Teil 1. Sobald dieser Teil abgeschlossen ist, bekommen Sie Instruktionen für Teil 2. Sowohl in Teil 1 als auch in Teil 2 können Sie Geld verdienen. Ihr endgültiger Verdienst besteht aus der Summe Ihrer Verdienste aus Teil 1 und Teil 2. Zusätzlich bekommen Sie am Ende des Experiments eine Teilnahmeprämie von **4 EUR** ausbezahlt. Diese bekommen Sie in jeden Fall, unabhängig von Ihren Entscheidungen im Experiment.

Ihre endgültige Auszahlung wird sich also folgendermaßen zusammensetzen:

$$\text{Gesamtauszahlung} = 4 \text{ EUR} + \text{Verdienst in Teil 1} + \text{Verdienst in Teil 2}$$

Ihre Gesamtauszahlung beträgt also in jedem Fall mindestens 4 EUR.

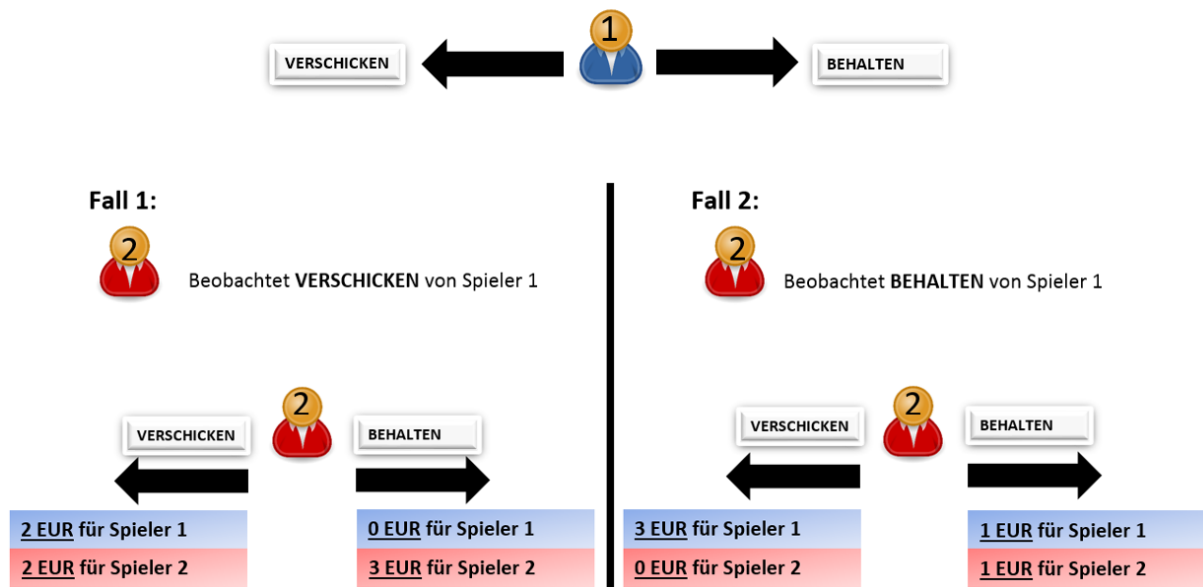
Teil 1

In Teil 1 werden Sie mit einem zufällig ausgewählten Experimental-Teilnehmer aus diesem Raum gruppiert, welcher Ihr Mitspieler für diesen Teil ist. Einer von Ihnen bekommt zufällig die Rolle als „Spieler 1“ und der andere als „Spieler 2“. Jeder von Ihnen erhält nun **1 EUR** vom Experimentator. Sie können sich nun überlegen, ob Sie diesen Euro BEHALTEN oder an Ihren Mitspieler VERSCHICKEN wollen. Wenn der Euro verschickt wird, verdoppelt er sich für Ihren Mitspieler. Ihr Mitspieler steht vor derselben Entscheidung wie Sie.

Diese Entscheidungssituation findet sequentiell statt – d.h. die Spieler treffen Ihre Entscheidungen nacheinander. Dies ist in der unten angehängten Grafik auch noch einmal dargestellt.

Zunächst trifft **Spieler 1 (BLAU)** eine Entscheidung. **Spieler 2 (ROT)** kann diese Entscheidung beobachten und trifft dann ebenfalls eine Entscheidung. Sie treffen im Experiment sowohl für

die Rolle als Spieler 1 als auch für die Rolle als Spieler 2 eine Entscheidung. Bitte folgen Sie dazu einfach den Anweisungen auf dem Bildschirm. Am Ende des Experimentes wird ausgelost, ob Sie oder Ihr Mitspieler die Rolle des „Spieler 1“ bekommen. Der andere bekommt automatisch die Rolle des „Spieler 2“. Durch die Kombination Ihrer Entscheidungen wird dann schließlich Ihre Auszahlung gebildet, wie in der unten angehängten Grafik dargestellt. Die Auszahlung für Spieler 1 ist hier in **BLAU** dargestellt und die Auszahlung für Spieler 2 ist in **ROT** dargestellt.



Beispiel

Spieler 1 entscheidet sich für **VERSCHICKEN**.

Spieler 2 entscheidet sich für **VERSCHICKEN** wenn Spieler 1 **VERSCHICKT** und für **BEHALTEN** wenn Spieler 1 **BEHÄLT**.

In diesem Szenario erhalten also beide Spieler jeweils **2 EUR**.

Beispiel

Spieler 1 entscheidet sich für **BEHALTEN**.

Spieler 2 entscheidet sich für **VERSCHICKEN** wenn Spieler 1 **VERSCHICKT** und für **VERSCHICKEN** wenn Spieler 1 **BEHÄLT**.

In diesem Szenario erhält Spieler 1 **3 EUR** und Spieler 2 **0 EUR**.

Teil 2

Teil 2 besteht aus **4 Perioden** und jede Periode besteht ihrerseits aus **7 Runden**. Dies ist in der nachfolgenden Tabelle noch einmal verdeutlicht.

Perioden	1	2	3	4
Runden	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7

In Teil 2 könne Sie Taler verdienen. Die Umrechnung beträgt dabei

10 Taler = 1 Euro

Am Ende des Experiments bekommen Sie die Ausstattung an Talern, die Sie besitzen, in EUR ausbezahlt. Für Ihre Auszahlung in Teil 2 wird eine **zufällige Periode ausgewählt**. Das heißt nur **eine der vier Perioden ist relevant für Ihre Auszahlung**. Sie wissen aber vorher nicht, welche dies ist, sondern erfahren dies erst am Ende des Experimentes.

Zu Beginn jeder Periode werden Gruppen aus jeweils **4 Teilnehmern** gebildet. Diese Gruppen sind fest für die komplette Periode – d.h. sie werden innerhalb einer Periode nicht mehr durchmischt. Jedes Gruppenmitglied wird entweder als **A, B, C** oder **D** bezeichnet. Für jede neue Periode werden Sie **zufällig einer neuen Gruppe** zugeordnet. Das heißt auch Ihre Bezeichnung (**A, B, C** oder **D**) kann sich ändern.

Die Aufgabe

Zu Beginn jeder Periode sind Sie mit **20 Talern** ausgestattet. Sie können Ihre Ausstattung an Talern in jeder Runde ganz oder teilweise in ein **Gruppenprojekt** investieren (*individueller Beitrag*). Der Teil, den Sie NICHT investieren, wandert in Ihren **Privattopf** und diesen behalten Sie für sich. Die Investitionen **aller 4 Gruppenmitglieder** wandern in einen **Gruppentopf**. Der Inhalt des Gruppentopfs wird danach **um 50 % erhöht** und unter allen Gruppenmitgliedern gleichmäßig verteilt, unabhängig davon wie viel jeder Einzelne dazu beigetragen hat.

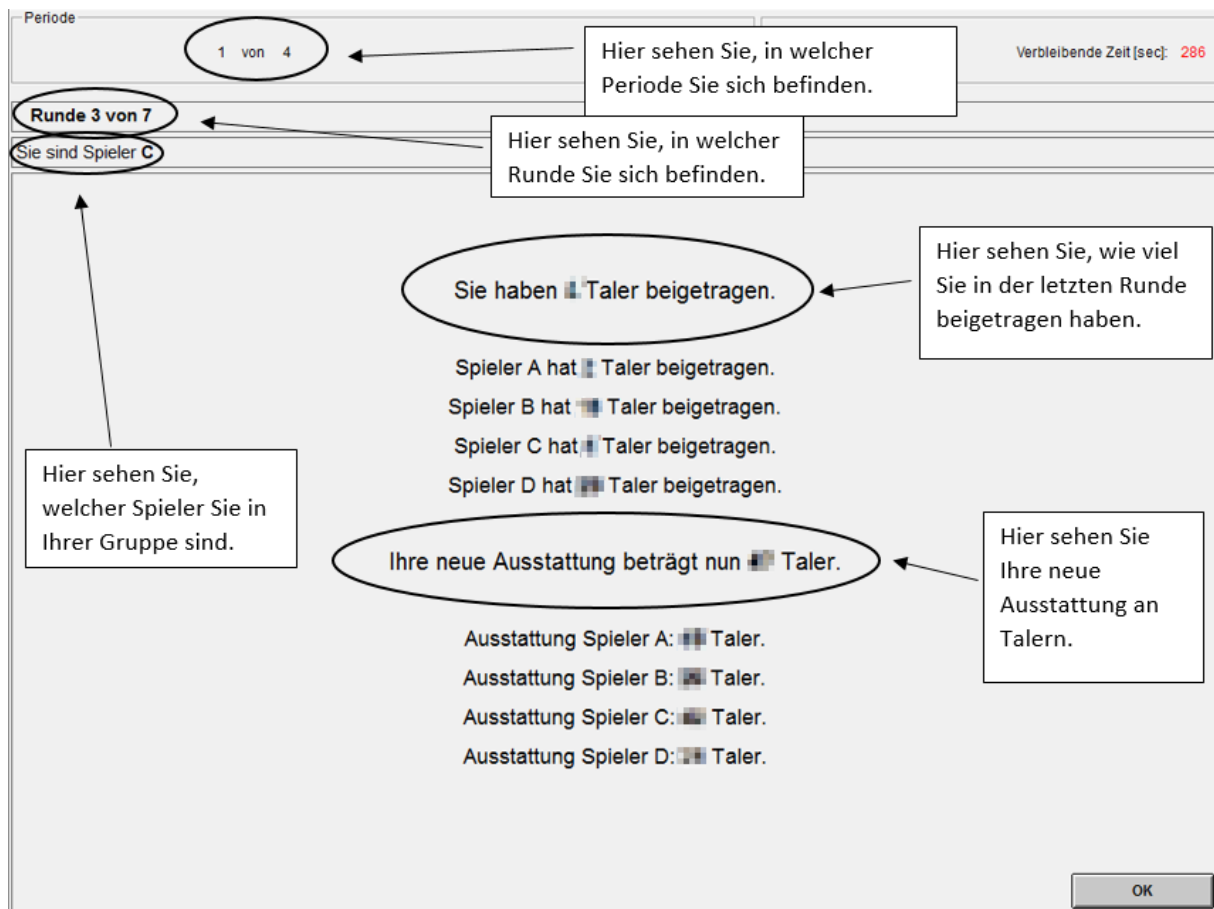
Die neue Ausstattung eines Teilnehmers am Ende einer Runde wird dann folgendermaßen berechnet:

$$\text{Neue Ausstattung} = \underbrace{\text{Alte Ausstattung} - \text{individueller Beitrag}}_{= \text{Privattopf}} + \frac{1.5 \cdot \text{Gruppentopf}}{4}$$

Nach jeder Runde erfahren Sie Ihre neue Ausstattung. **Zusätzlich sehen Sie auch** wie viel die anderen Mitglieder in Ihrer Gruppe beigetragen haben und deren aktuelle Ausstattung (siehe *Screenshot 1*).

Alle Beträge werden immer auf ganze Taler-Beträge gerundet.

Für die weiteren Runden gilt, dass jeder Spieler einen beliebigen individuellen Beitrag zum Gruppentopf wählen kann, welcher jedoch maximal so groß sein kann wie die aktuelle Ausstattung an Talern. Im Gegensatz zu Runde 1 kann die Ausstattung an Talern in den Runden 2 – 7 kleiner oder größer als 20 sein.



Screenshot 1

Der Startspieler

Zu Beginn jeder Periode, wird ein **Startspieler** zufällig bestimmt. Dieser bleibt Startspieler für die komplette Periode – d.h. für die gesamten 7 Runden. Alle Gruppenmitglieder werden darüber informiert, wer der Startspieler ist (**A, B, C** oder **D**). Jede Runde besteht nun aus den folgenden zwei Abschnitten:

1. Der ausgewählte Startspieler kann sich nun **zuerst** für einen individuellen Beitrag entscheiden (siehe *Screenshot 2*). Wenn Sie NICHT der Startspieler sind, klicken Sie einfach auf „OK“ um fortzufahren, während der Startspieler seinen individuellen Beitrag wählt (siehe *Screenshot 3*).
2. Die anderen Spieler werden über den Beitrag des Startspielers informiert und können daraufhin ihren eigenen individuellen Beitrag wählen (siehe *Screenshot 4*).

Ihre aktuelle Ausstattung wird Ihnen oben am Bildschirm angezeigt. Dies ist der Betrag, den Sie maximal wählen können.

Typischer Bildschirm als Startspieler

Periode	1 von 4	Verbleibende Zeit [sec]: 293
Runde 1 von 7		
Sie sind Spieler D		
Ihre Ausstattung beträgt 20 Taler.		
<p>Sie sind der Startspieler. Wie viele Ihrer 20 Taler wollen Sie zum Gruppenprojekt beitragen?</p> <p>Eingabe: <input type="text"/></p> <p>OK</p>		

Screenshot 2

Typischer Bildschirm bevor der Startspieler seine Entscheidung getroffen hat

[illegible]

Screenshot 3

Typischer Bildschirm nachdem der Startspieler seine Entscheidung getroffen hat

Periode <div style="display: flex; justify-content: space-between; align-items: center;"> 1 von 4 Verbleibende Zeit [sec]: 239 </div>	
Runde 1 von 7	
Sie sind Spieler B	
Ihre Ausstattung beträgt 20 Taler.	
Der Startspieler D hat von 20 Taler beigetragen.	
<p>Wie viele Ihrer 20 Taler wollen Sie zum Gruppenprojekt beitragen?</p> <p>Eingabe: <input style="width: 100px;" type="text"/></p>	
<div style="border: 1px solid black; background-color: #f08080; padding: 5px 15px; display: inline-block;">OK</div>	

Screenshot 4

Ablauf im Experiment

- (i) Zu Beginn werden Sie gebeten eine Reihe von **Kontrollfragen** zu beantworten. Durch die Beantwortung dieser Fragen können Sie kein Geld verdienen. Diese Fragen sind lediglich dazu da, um sicherzugehen, dass Sie das Spiel und die Regeln korrekt verstanden haben.
- (ii) Danach erhalten Sie die Möglichkeit an einem **Beispielrechner** zu testen, welche Ausstattung Sie hätten, wenn Sie und die anderen Mitglieder in Ihrer Gruppe einen bestimmten Beitrag wählen würden (maximal 20 Taler, wie in Runde 1). Ihren Beitrag können Sie unter „Ihr Beitrag“ mithilfe eines Schiebereglers einstellen und den Beitrag der anderen Gruppenmitglieder bei den Schieberegler darunter. Sie können an diesem Beispielrechner verschiedene Kombinationen testen. Auch dieser Beispielrechner ist nur dazu da, sich mit dem Prinzip der Aufgabe vertraut zu machen und Ihre Eingaben hier haben keinerlei Einfluss auf den weiteren Verlauf des Experimentes. Beachten Sie bitte, dass Sie diesen Beispielrechner maximal für 180 Sekunden (= 3 Minuten) nutzen können. Danach geht das Experiment für Sie automatisch weiter (Sie können hier nicht aktiv weiter klicken).
- (iii) Nach der Testphase mit dem Beispielrechner beginnt die **eigentliche Aufgabe** und Sie starten mit der ersten Periode wie oben beschrieben. Jede Periode läuft genau gleich ab, allerdings werden in jeder Periode zufällig neue Gruppen gebildet.

Code für Teil 2: 471

Instruktionen

Herzlich willkommen zu diesem wirtschaftswissenschaftlichen Experiment! Während des Experimentes haben Sie die Möglichkeit, eine Aufgabe auszuführen, welche in den nachfolgenden Instruktionen im Detail erklärt werden wird. Dabei können Sie einen nicht unerheblichen Geldbetrag gewinnen. Wie hoch Ihre Auszahlung letztendlich sein wird, hängt von Ihren Entscheidungen und den Entscheidungen der anderen Teilnehmer ab. Während des Experiments ist es Ihnen untersagt, mit den anderen Teilnehmern zu kommunizieren. Bitte lesen Sie die vorliegenden Instruktionen gründlich durch. Sollten Sie vorab oder während des Experiments noch Fragen haben, heben Sie bitte Ihre Hand und ein Experimentator wird zu Ihrem Platz kommen.

Allgemeiner Aufbau

Das Experiment besteht aus einem **Teil 1** und einem **Teil 2**. Diese beiden Teile sind unabhängig voneinander – d.h. Ihre Entscheidungen in Teil 1 haben keinen Einfluss auf den Ausgang von Teil 2 und umgekehrt. Sie bekommen zunächst Instruktionen für Teil 1. Sobald dieser Teil abgeschlossen ist, bekommen Sie Instruktionen für Teil 2. Sowohl in Teil 1 als auch in Teil 2 können Sie Geld verdienen. Ihr endgültiger Verdienst besteht aus der Summe Ihrer Verdienste aus Teil 1 und Teil 2. Zusätzlich bekommen Sie am Ende des Experiments eine Teilnahmeprämie von **4 EUR** ausbezahlt. Diese bekommen Sie in jeden Fall, unabhängig von Ihren Entscheidungen im Experiment.

Ihre endgültige Auszahlung wird sich also folgendermaßen zusammensetzen:

$$\text{Gesamtauszahlung} = 4 \text{ EUR} + \text{Verdienst in Teil 1} + \text{Verdienst in Teil 2}$$

Ihre Gesamtauszahlung beträgt also in jedem Fall mindestens 4 EUR.

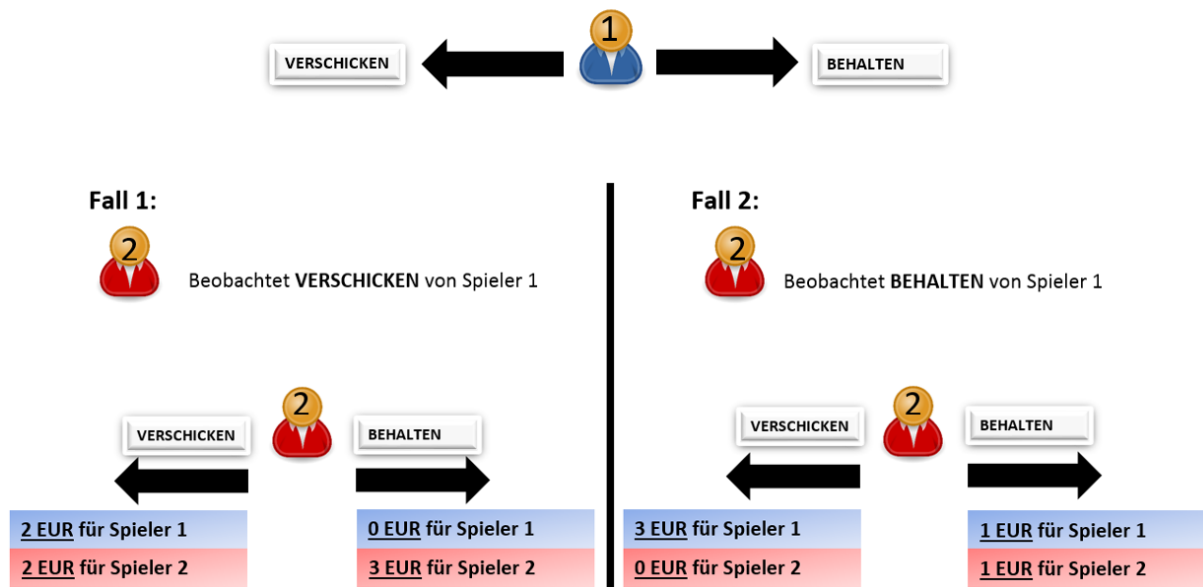
Teil 1

In Teil 1 werden Sie mit einem zufällig ausgewählten Experimental-Teilnehmer aus diesem Raum gruppiert, welcher Ihr Mitspieler für diesen Teil ist. Einer von Ihnen bekommt zufällig die Rolle als „Spieler 1“ und der andere als „Spieler 2“. Jeder von Ihnen erhält nun **1 EUR** vom Experimentator. Sie können sich nun überlegen, ob Sie diesen Euro BEHALTEN oder an Ihren Mitspieler VERSCHICKEN wollen. Wenn der Euro verschickt wird, verdoppelt er sich für Ihren Mitspieler. Ihr Mitspieler steht vor derselben Entscheidung wie Sie.

Diese Entscheidungssituation findet sequentiell statt – d.h. die Spieler treffen Ihre Entscheidungen nacheinander. Dies ist in der unten angehängten Grafik auch noch einmal dargestellt.

Zunächst trifft **Spieler 1 (BLAU)** eine Entscheidung. **Spieler 2 (ROT)** kann diese Entscheidung beobachten und trifft dann ebenfalls eine Entscheidung. Sie treffen im Experiment sowohl für

die Rolle als Spieler 1 als auch für die Rolle als Spieler 2 eine Entscheidung. Bitte folgen Sie dazu einfach den Anweisungen auf dem Bildschirm. Am Ende des Experimentes wird ausgelost, ob Sie oder Ihr Mitspieler die Rolle des „Spieler 1“ bekommen. Der andere bekommt automatisch die Rolle des „Spieler 2“. Durch die Kombination Ihrer Entscheidungen wird dann schließlich Ihre Auszahlung gebildet, wie in der unten angehängten Grafik dargestellt. Die Auszahlung für Spieler 1 ist hier in **BLAU** dargestellt und die Auszahlung für Spieler 2 ist in **ROT** dargestellt.



Beispiel

Spieler 1 entscheidet sich für **VERSCHICKEN**.

Spieler 2 entscheidet sich für **VERSCHICKEN** wenn Spieler 1 **VERSCHICKT** und für **BEHALTEN** wenn Spieler 1 **BEHÄLT**.

In diesem Szenario erhalten also beide Spieler jeweils **2 EUR**.

Beispiel

Spieler 1 entscheidet sich für **BEHALTEN**.

Spieler 2 entscheidet sich für **VERSCHICKEN** wenn Spieler 1 **VERSCHICKT** und für **VERSCHICKEN** wenn Spieler 1 **BEHÄLT**.

In diesem Szenario erhält Spieler 1 **3 EUR** und Spieler 2 **0 EUR**.

Teil 2

Teil 2 besteht aus **4 Perioden** und jede Periode besteht ihrerseits aus **7 Runden**. Dies ist in der nachfolgenden Tabelle noch einmal verdeutlicht.

Perioden	1	2	3	4
Runden	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7	1 2 3 4 5 6 7

In Teil 2 könne Sie Taler verdienen. Die Umrechnung beträgt dabei

10 Taler = 1 Euro

Am Ende des Experiments bekommen Sie die Ausstattung an Talern, die Sie besitzen, in EUR ausbezahlt. Für Ihre Auszahlung in Teil 2 wird eine **zufällige Periode ausgewählt**. Das heißt nur **eine der vier Perioden ist relevant für Ihre Auszahlung**. Sie wissen aber vorher nicht, welche dies ist, sondern erfahren dies erst am Ende des Experimentes.

Zu Beginn jeder Periode werden Gruppen aus jeweils **4 Teilnehmern** gebildet. Diese Gruppen sind fest für die komplette Periode – d.h. sie werden innerhalb einer Periode nicht mehr durchmischt. Jedes Gruppenmitglied wird entweder als **A, B, C** oder **D** bezeichnet. Für jede neue Periode werden Sie **zufällig einer neuen Gruppe** zugeordnet. Das heißt auch Ihre Bezeichnung (**A, B, C** oder **D**) kann sich ändern.

Die Aufgabe

Zu Beginn jeder Periode sind Sie mit **20 Talern** ausgestattet. Sie können Ihre Ausstattung an Talern in jeder Runde ganz oder teilweise in ein **Gruppenprojekt** investieren (*individueller Beitrag*). Der Teil, den Sie NICHT investieren, wandert in Ihren **Privattopf** und diesen behalten Sie für sich. Die Investitionen **aller 4 Gruppenmitglieder** wandern in einen **Gruppentopf**. Der Inhalt des Gruppentopfs wird danach **um 50 % erhöht** und unter allen Gruppenmitgliedern gleichmäßig verteilt, unabhängig davon wie viel jeder Einzelne dazu beigetragen hat.

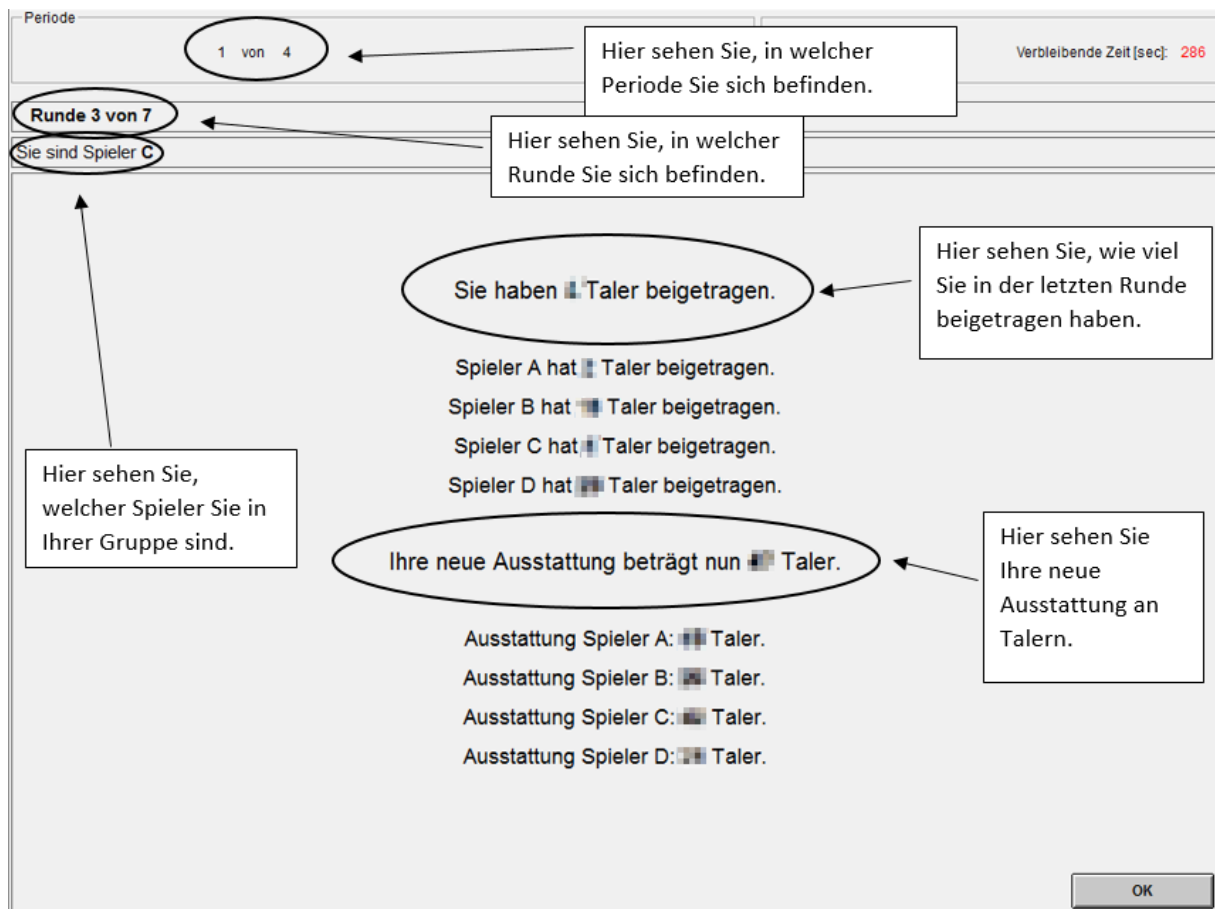
Die neue Ausstattung eines Teilnehmers am Ende einer Runde wird dann folgendermaßen berechnet:

$$\text{Neue Ausstattung} = \underbrace{\text{Alte Ausstattung} - \text{individueller Beitrag}}_{= \text{Privattopf}} + \frac{1.5 \cdot \text{Gruppentopf}}{4}$$

Nach jeder Runde erfahren Sie Ihre neue Ausstattung. **Zusätzlich sehen Sie auch** wie viel die anderen Mitglieder in Ihrer Gruppe beigetragen haben und deren aktuelle Ausstattung (siehe *Screenshot 1*).

Alle Beträge werden immer auf ganze Taler-Beträge gerundet.

Für die weiteren Runden gilt, dass jeder Spieler einen beliebigen individuellen Beitrag zum Gruppentopf wählen kann, welcher jedoch maximal so groß sein kann wie die aktuelle Ausstattung an Talern. Im Gegensatz zu Runde 1 kann die Ausstattung an Talern in den Runden 2 – 7 kleiner oder größer als 20 sein.



Screenshot 1

Die Spieler

In jeder Runde wählen alle Gruppenmitglieder (**A**, **B**, **C** und **D**) ihren individuellen Beitrag simultan. (Ein typischer Entscheidungsbildschirm ist in *Screenshot 2* dargestellt). Das heißt, alle Gruppenmitglieder erfahren immer erst am Ende eine Runde, welches Gruppenmitglied wieviel zum Gruppentopf beigetragen hat.

Ihre aktuelle Ausstattung wird Ihnen oben am Bildschirm angezeigt. Dies ist der Betrag, den Sie maximal wählen können.

Typischer Bildschirm eines Spielers bei der Wahl des individuellen Beitrags

Periode	1 von 4	Verbleibende Zeit [sec]: 288
Runde 1 von 7		
Sie sind Spieler B		
Ihre Ausstattung beträgt 20 Taler.		
<p>Wie viele Ihrer 20 Taler wollen Sie zum Gruppenprojekt beitragen?</p> <p>Eingabe: <input type="text"/></p>		
		OK

Screenshot 2

Ablauf im Experiment

- (i) Zu Beginn werden Sie gebeten eine Reihe von **Kontrollfragen** zu beantworten. Durch die Beantwortung dieser Fragen können Sie kein Geld verdienen. Diese Fragen sind lediglich dazu da, um sicherzugehen, dass Sie das Spiel und die Regeln korrekt verstanden haben.
- (ii) Danach erhalten Sie die Möglichkeit an einem **Beispielrechner** zu testen, welche Ausstattung Sie hätten, wenn Sie und die anderen Mitglieder in Ihrer Gruppe einen bestimmten Beitrag wählen würden (maximal 20 Taler, wie in Runde 1). Ihren Beitrag können Sie unter „Ihr Beitrag“ mithilfe eines Schiebereglers einstellen und den Beitrag der anderen Gruppenmitglieder bei den Schieberegler darunter. Sie können an diesem Beispielrechner verschiedene Kombinationen testen. Auch dieser Beispielrechner ist nur dazu da, sich mit dem Prinzip der Aufgabe vertraut zu machen und Ihre Eingaben hier haben keinerlei Einfluss auf den weiteren Verlauf des Experimentes. Beachten Sie bitte, dass Sie diesen Beispielrechner maximal für 180 Sekunden (= 3 Minuten) nutzen können. Danach geht das Experiment für Sie automatisch weiter (Sie können hier nicht aktiv weiter klicken).
- (iii) Nach der Testphase mit dem Beispielrechner beginnt die **eigentliche Aufgabe** und Sie starten mit der ersten Periode wie oben beschrieben. Jede Periode läuft genau gleich ab, allerdings werden in jeder Periode zufällig neue Gruppen gebildet.

Code für Teil 2: 471