Let's (not) escalate this!
Intergroup leadership in a group contest

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February 2021

Abstract

Many social situations are of a competitive kind, in which groups compete for something that not everyone can get. An example for this would be wage increases achieved through the means of a strike. Usually, these benefits will be paid out to workers who have participated in the strike and to those who have not. This creates both a coordination problem within the group, as well as between groups. Empirically, earlier studies on group contests find that groups spend a lot more than what would be socially optimal. Prior studies on social dilemma games studying isolated groups have identified a potentially beneficial role of a leader in coordinating individual behaviour. We investigate if a group leader can help alleviate this coordination problem also in the more complex environment of groups competing for a rent. We conduct a group contest experiment, comparing two levels of leader authority and the effect of communication between leaders, with respect to conflict expenditures and overall welfare. Our results indicate that contest spending in treatments with a leader are higher, unless there is communication. Moreover, leaders with authority fan the flames of between group competition by allocating a relatively larger share of the prize to players that have delivered more input to the competition. When allowing for communication between leaders of competing groups, those who manage to agree on taking turns for delivering input to the contest, exert a mitigating effect on spending levels. We show that having a leader does not automatically improve the over-contribution problem in a group contest game. By contrast, overall social welfare was actually lower in most treatments with a leader.

Keywords: Rent-seeking, Group Contest, Leadership
JEL Classification: C92, D03, D72, D74

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1 Introduction

On various layers of society and with different degrees of hostility, competitive situations are ubiquitous in society. Be it the competition for publishing scientific papers, lobby groups vying for their interests, or rivalry on an inter-country level. What all these examples have in common is the fact that there is a considerable amount of unproductive resources spent in this rat race. Consider for example the global total military budget of $1.822 billion in 2018 (source: Stockholm International Peace Research Institute (SIPRI) Military Expenditure Database), which is equivalent to 2.1 per cent of global gross domestic product (GDP). This enormous sum of money is dedicated solely to being adequately equipped to face outside (or inside) challenges to the national interest.

One of the most widespread models for (group) contests is the lottery game by Tullock (1980) or Katz, Nitzan, and Rosenberg (1990), where the winning probability increases with higher relative spending.[1] The vast majority of experiments on rent-seeking or contest games find contributions that are significantly higher than the Nash equilibrium prediction (Sheremeta, 2018, 2013; Dechenaux, Kovenock, & Sheremeta, 2015; Öncüler & Croson, 2005), causing rent over-dissipation and inefficiency. Sheremeta (2018) reviews the types of explanations that have been offered for this behaviour: Most prominently, there is evidence for a motivational drive for coming out ahead of the other party. Herrmann and Orzen (2008) call this the *homo rivalis* – an agent driven by spiteful, envious or malevolent preferences. Next to costly over-contribution, empirical results commonly show a substantive degree of heterogeneity of behaviour both within and between groups.

In this article we present an experiment designed to examine whether a leader can curtail over-contribution and improve group welfare in a group contest for a group prize. In games where contributing is socially beneficial (like in a public goods game, for example), empirical results often find that leaders help coordinate towards higher contribution levels and earnings (Kosfeld & Rustagi, 2015; Arbak & Villeval, 2013; van der Heijden, Potters, & Sefton, 2009; Potters, Sefton, & Vesterlund, 2007). Rondeau and List (2008) find evidence for this in a field experiment in the context of charitable donations. If a leading donor is mentioned having invested a considerable amount in a given project, following donations from individuals are up to 71 % higher than in control treatments.[2] In a group contest, however, things might very well look different: Pittinsky and Simon (2007), for example, point out that "(t)he very foundations of strong leadership, such as fostering strong group cohesion, can become stepping stones to intergroup conflict." The reason for this is the existence of an ingroup / outgroup leadership trade-off, where strong leadership comes to the detriment of outgroup relations.

There is only little evidence on the effect of leadership in a contest game. Loerakker and van Winden (2017) introduce leading-by-example leaders and emotional leadership. In the former treatment, one player makes her contribution decision before the others. For the latter treatment, leaders choose an emotion to be induced onto their followers by the means of a video clip. Loerakker and van Winden (2017) find no significant treatment effect in terms of contribution levels. A second example of a contest game with some form

[1] See Konrad (2009) for a detailed discussion of this game concept.

[2] There are only a few examples of experimental studies with a group leader, in which individual contributions have negative externalities onto other players, like public bad games and common-pool resource games. Also here, treatments with a leader show a lower degree of negative externalities (Moxnes & van der Heijden, 2003; Vyrastekova & van Soest, 2003).

of leadership is Eisenkopf (2014), who employs a contest game between pairs of two players and an external consultant (manager). In the treatment setup, a manager is added to each pair, who does not contribute herself, but gives advice via free form text messages, individual chat, and typing a number to be displayed on the followers' screen. Eisenkopf (2014) varies the manager's incentives from fixed compensation to being partly contingent on her group's (or the other group's) success in the contest. The author finds no strong effect on behaviour between the incentive schemes.

Our experiment investigates two types of leadership in a group contest. Next to a baseline treatment, which is a symmetric group contest game without leader, we employ four experimental treatments with a group leader, creating a 2×2+1 design. For the experimental treatments, we vary one dimension on whether the leader was only the first mover, versus whether she could also redistribute earnings. On the other dimension we either allow free form text communication between the leaders of competing groups prior to making a decision, or no communication. The results of our study show that leaders tend to increase contest expenditures. This is driven by a strong positive correlation between leaders' and followers' contribution (while theory would predict a negative correlation) and a positive correlation between followers' contribution and the share of the prize allocated to them by the leaders. By contrast, intergroup leadership through free form chat communication between leaders of competing groups can mitigate the contest.

This article is structured as follows: First in Section 2 we explain the setup of our study and give details on the procedures. We discuss equilibrium strategies for the treatments in Section 3, as well as alternative hypotheses. In Section 4, we present the results of this study, which will be followed by this study's implications and conclusion in Section 5.

2 Experimental Design

We employ a design with four experimental treatments and one control benchmark. We will first introduce the *baseline treatment*, followed by each of the other treatments. For each treatment we manipulate one aspect of the game, which makes it possible to make clear inferences. Table 1 provides an overview of the treatments.

Baseline Treatment

Participants are sorted into groups of four, with two groups competing for a fixed prize for 15 periods. They interact with the same other players throughout the experiment (partner matching).

Each period consists of the following stages:

1. Every player receives an endowment of $E = 120$ tokens and decides how much of it to spend on buying lottery tickets, which translate into probabilities of winning the contest. The price for a ticket is one token. Contribution of player k of group K and m of group M are labelled v_k and v_m, respectively. All tokens that a player does not spend on lottery tickets are added to her private account.

2. The winning probability, or contest success function (CSF), is as in Tullock (1980) and Katz et al. (1990) and given by

$$p_K\left(\sum_{k\in K} v_k, \sum_{m\in M} v_m\right) = \begin{cases} \dfrac{\sum\limits_{k\in K} v_k}{\sum\limits_{k\in K} v_k + \sum\limits_{m\in M} v_m} & \text{if } \max\limits_{i\in K\cup M}\{v_i\} > 0 \\ 1/2 & \text{otherwise} \end{cases}$$

where p_K is the probability that group K wins over group M, which is given by the sum of all lottery tickets of group K divided by the total lottery tickets bought by both groups. After the contribution phase, one ticket will be drawn out of a ballot box to determine the winner. Hence, the more tickets a group buys, the higher the chances of winning the lottery, ceteris paribus.

Information of each player's contribution is made available to all members of the same group at the end of a period. Also, information of the opposing group's aggregated contribution will be revealed, as well as the corresponding winning probability. The winning group receives a fixed prize of 1,920, which will be divided equally, such that players of the winning group each receive $z = 480$ tokens as premium – the losing group gets nothing.

2.1 Experimental Treatments

In the experimental treatments, pairs of groups engage in a contest game as in the baseline treatment. What is different here is that there is one player who moves before others in all four experimental treatments. In two of the four experimental treatments, the leader receives the entire prize and may redistribute it among her group mates. Also, in two of the four experimental treatments, the leaders of two competing groups may communicate via a free form chat window in every period, prior to making the contribution decision. This will be explained in detail below.

Ingroup leading-by-example treatment (Ingroup lbe)

Before the first period, one participant in each group is randomly selected to be the leader and stays in this role for the rest of the game. Other players know that there is a leader and that this will be the same person throughout the experiment. Note, though, that we did not use the term "leader" in the instructions, or anywhere else in the experiment. We referred to this participant simply as "member 1". In both groups, the leader buys lottery tickets first and the amount she purchases is made public to the other members of the own group before everyone else decides simultaneously how much to spend. Players of the winning group each receive $z = 480$ tokens as premium, the other group gets nothing.

Ingroup transactional leader treatment (Ingroup trans)

As in the ingroup leading-by-example treatment, a leader is determined at random before the first period. In each period, she buys lottery tickets before everyone else and the amount she purchases is made public to all members of the own group before the followers decide how much to spend, as in the baseline. In contrast to the Ingroup lbe treatment, here the leader of the winning group receives $4z = 1,920$ tokens as premium, nobody else receives anything. However, the leader can redistribute the 1,920 among own group members and herself, as she wishes. The redistribution is made public to other group members but not to the other group.

Intergroup leading-by-example treatment (Intergroup lbe)

This treatment is the same as the ingroup leading-by-example treatment with one adaption: In every period the leaders of competing group pairs now can privately communicate for 45 seconds via a free form chat window prior to their contribution decisions. They both still decide individually about their contribution before everyone else and information on the level of their contribution will be available to the own group.

Intergroup transactional leader treatment (Intergroup trans)

This is a combination of the aforementioned treatments. As in the Intergroup lbe treatment, the two leaders can privately chat before making the contribution. Also in this experimental treatment, the leader makes her contribution decision before the followers do. Lastly, the leader receives $4z = 1,920$ if the own group wins and has the option to redistribute the prize in the same way as in the Ingroup trans treatment.

Table 1: Treatment overview

	Leader moves first	Leader receives prize and may redistribute	Leaders communicate
Baseline			
Ingroup leading-by-example	✓		
Ingroup transactional leader	✓	✓	
Intergroup leading-by-example	✓		✓
Intergroup transactional leader	✓	✓	✓

2.2 Procedures

For this computerised experiment, which was programmed with z-tree by Fischbacher (2007), we use ORSEE (Greiner, 2015) to recruit 360 participants (which is 9 pairs of groups per treatment). Each participant sat in a cubicle, physically and visually separated from other participants. The experiment consisted of 3 parts. Prior to the group contest we measure individual risk preference (called "part 1" in the instructions) using techniques by Eckel and Grossman (2002), and individual social value orientation (SVO) (part 2) by Murphy, Ackermann, and Handgraaf (2011).[3] Towards the participants we refer to the group contest game as "part 3". When entering the laboratory, participants found a printout of both general and part 1 instructions at their seat. Instructions for parts 2 and the main game (part 3) were distributed after the respective previous part has been completed by everyone.[4] After reading the instructions for the main game (part 3), all players encountered three screens presenting the layout of the upcoming part of the experiment. Further, on each of the three said screens, there was one understanding question, which participants had to answer correctly before they could proceed. After part 3, participants filled in a questionnaire on, i.a., demographics, risk preferences (as in Dohmen et al., 2011), and reciprocity (as in the German Socio-Economic Panel (SOEP)).

The sessions took place in the BEElab at Maastricht University, between September and November 2015. Each participant received a financial compensation for each part of the game as follows. For the risk elicitation task, we paid out the result of the gamble that the player chose. For the SVO measure, we follow the payment procedures of Murphy et al. (2011)'s "ring matching" procedure. Participants $[i \dots I]$ are ordered on a virtual ring, where i is connected as sender to $i+1$, $i+1$ is connected as sender to $i+2$ etc., which makes everyone a sender *and* a receiver. One choice *per participant* is randomly selected and paid out as a sender. For part 3 the sum of all earnings over all periods was paid out. The payment procedures were public knowledge among the participants. The experiment took about 80 minutes in total.[5] Average earnings were €11.75 across all treatments.[6]

3 Equilibrium Strategies

We start with the *Baseline treatment* and discuss the experimental treatments thereafter. We then provide a general overview of the equilibria in the treatments in Table 2. The sub-game perfect equilibrium of the single-shot game constitutes a natural benchmark to compare our data with. For this, assuming risk-neutrality and that each player $i \in K$ maximises her individual expected earnings, which is

$$\pi_i\left(\sum_{k\in K} v_k, \sum_{m\in M} v_m\right) = E + \frac{v_i + \sum\limits_{k\in K\setminus i} v_k}{v_i + \sum\limits_{k\in K\setminus i} v_k + \sum\limits_{m\in M} v_m} \cdot z - v_i,$$

where E is the initial endowment, v_i is the player's own contribution, $\sum_{k\in K\setminus i} v_k$ is the total contribution of her other three group mates, $\sum_{m\in M} v_m$ is the total contribution of the other group, z is the prize to win.

For this type of group contest game with homogeneous groups, a unique equilibrium only results with regard to the aggregate group contribution. Concerning individual level

[3]See Appendices A.1 and A.2 for more details on the risk preference and SVO measure we employ.

[4]A copy of the instructions is provided in Appendix B. Screen shots from the experiment interface are provided in an online appendix.

[5]Due to technical problems, we shortened the game to eight periods for two group pairs in the *Intergroup lbe* treatment. This has been announced clearly before the start and results are robust to dropping the data of this session.

[6]About \$ 12.80 or £ 8.90 at the exchange rate at the time of the experiment.

contributions, multiple equilibria exist (Abbink, Brandts, Herrmann, & Orzen, 2010; Konrad, 2009). The equilibrium contribution level for each group is $\sum_{k\in K} v_k = \frac{z}{4}$.[7] For this experiment with $z = 480$, this results in 120 tokens per group. All combinations of individual contribution that add up to 120 tokens per group constitute an equilibrium. In the repeated game, the set of equilibria is not only restricted to sequences of single-shot equilibria. For example, the use of grim-trigger strategies would enable off-equilibrium behaviour in particular period. For our analysis, we do not employ these latter equilibrium strategies as benchmarks, as for the immense amount of coordination needed to establish them.

As the game is symmetric, a reasonable selection criterion could be that every player contributes equally (cf. Katz et al., 1990). This would result in an individual contribution of $v_i = \frac{z}{4\cdot K}$ or 30 tokens, given a group size of $K = 4$. So in this case, a risk neutral player would contribute 25% of the endowment $E = 120$ to the project.

When loosening the assumption of risk-neutrality and assuming homogeneity of risk preferences, contribution to the contest decreases with increasing risk-aversion. See Appendix C.2 for a discussion of most conventional functional forms, such as constant absolute risk aversion (CARA) and constant relative risk aversion (CRRA). Katz et al. (1990) also show that for differing levels of risk aversion between the groups, the one with higher risk aversion contributes less. Furthermore they show that for an individual player, the added expected utility gain from an additional unit of contribution decreases with the level of risk aversion. By the nature of this game's equilibrium, players with a relatively lower level of risk aversion would contribute relatively more.

In the experimental treatments, some of the subgame perfect equilibria described above can be excluded. The leader (l) in the *ingroup leading-by-example treatment* would contribute $v_l = 0$ in the subgame perfect Nash equilibrium. She can expect the followers to fully compensate for this and spend $\sum_{i\in K\setminus\{l\}} v_i = \frac{z}{4} - v_l$, which is $\sum_{i\in K\setminus\{l\}} v_i = 120$ under the given parameters of the game. As before, if every follower contributes equally, each would contribute $v_i = \frac{z}{4(K-1)} - v_l$, or $v_i = \frac{120}{3} = 40$.

If the risk-neutral leader is faced with risk averse followers, given (the leader's belief of) the followers' level of risk aversion, she would contribute $v_l = 120 - \sum_{i\in K\setminus\{l\}} v_i$, where $\sum_{i\in K\setminus\{l\}} v_i$ decreases with the level of risk aversion of followers (Appendix C.2; Abbink et al., 2010; Katz et al., 1990). Also, v_l will be lower for higher levels of the leader's risk aversion.

In the *ingroup transactional leader treatment*, a leader motivated by only her own earnings would not redistribute the prize, but keep it for herself. Knowing this, followers would not contribute to the contest. The leader, moving before her group mates contributes $v_l = 120$ tokens. Note that in this treatment, the leader behaves as if she was a one-person competing party, delivering all tokens to the contest by herself and also keeping the prize, if won. As before, under risk aversion, the leader's contribution would decrease with her level of risk aversion. Followers, however, would not chip in for a lowered contribution of the leader, as they would still not expect the leader to redistribute the prize, if won.

In both *intergroup treatments*, communication between leaders is cheap talk and equilibrium predictions are the same as in the treatments without communication.

[7] See Appendix C.1 for the derivation of the equilibrium.

Table 2 illustrates the following: The strategy that would maximise total monetary welfare across groups would be for all parties to contribute nothing and have a 50 % chance of winning (Social Opt.). The reason for this is that contributing in the contest only influences winning probabilities without further productive benefit. Under risk neutrality, the equilibrium contribution on group level stays the same for every treatment (Group level). In the subgame perfect equilibrium of all treatments but the *Baseline*, either of the following situation emerges: *a*) In the leading-by-example treatments, the leader would contribute zero while the followers fully chip in, providing more than they would in the *Baseline* treatment. *b*) In the transactional treatments, by contrast, the leader delivers as much input by herself, as the group would deliver as a whole in the *Baseline* treatment and the followers contribute zero.

Table 2: Overview of Equilibrium predictions

	Group level	Leader	Followers tot.	Followers each if symmetric	Social Opt.
Baseline	120	–	120	30	0
Ingroup leading-by-example	120	0	120	40	0
Ingroup transactional leader	120	120	0	0	0
Intergroup leading-by-example	120	0	120	40	0
Intergroup transactional leader	120	120	0	0	0

(Subgame perfect) Nash equilibria under risk neutrality. The *Baseline treatment* has no leader.

3.1 Alternative Hypotheses

As consequence of the equilibrium strategies under assumptions of selfishness, followers observing a leader who contributes a lot, would only spend a small amount (or nothing) for the contest. Equally, when observing a leader contributing very little, followers would contribute a high amount of points. By contrast, though, as the leader's contribution decision is observed by all others in the group, we expect followers to perceive the leader's contribution as signal or sacrifice and follow her example (cf. Hermalin, 1998; Meidinger & Villeval, 2002; Potters, Sefton, & Vesterlund, 2005). Accordingly, we expect a high leader-contribution to spur followers to contribute as well and a low leader-contribution to dissuade followers from contributing to the contest. What this means for the overall contribution level depends on the leader's motivation.

Hypothesis 1. *In all leader treatments, there exists a positive relationship between leader and follower contribution.*

The leaders may not only care about the monetary value of the prize, but winning as such may be a component in individual utility (Schmitt, Shupp, Swope, & Cadigan, 2004).[8] To increase the chance of winning, a leader might use her contribution as signal

[8] Sheremeta (2010) shows that more than 40% of experiment participants were willing to submit positive contest contributions to a contest with a prize value of $0.

for how followers should behave, rewarding those who do follow. This strategy is viable in the treatments where the leader actually can redistribute the prize won (i.e. *ingroup transactional leader* and *intergroup transactional leader treatment*). In this case, acting in accordance with the leader's contribution level can be in a follower's own economic interest. If this is the case, leaders' prize allocation patterns should deviate significantly from the standard benchmark predictions. Here, a leader would redistribute positive amounts to followers and distribute more to followers who behave according to the leader's benchmark.

Another motivation for prize redistribution would be leaders willing to incur costs in order to reduce inequality.[9] Accordingly, leaders would allocate a larger chunk of the prize to high contributing followers. Because of their high spending levels, this kind of followers is relatively poor and inequality averse leaders would try to close the earnings gap through the prize allocation.

Hypothesis 2. *In the transactional leader treatments, there exists a positive relationship between a follower's contribution and the prize redistributed towards this player.*

There exists a stream of literature showing that communication – even when just "cheap talk" – can improve coordination in experimental games (e.g. Leibbrandt & Sääksvuori, 2012; Sutter & Strassmair, 2009; Blume & Ortmann, 2007; Van Huyck, Battalio, & Beil, 1993). Cason, Sheremeta, and Zhang (2012) present a counterexample using within- and inter-group communication embedded in a weakest-link contest between groups. This experimental design is fairly close to our experiment, as in that there are two groups competing for a prize. The difference between our design and a weakest-link contest, is that in the latter, it is the *lowest* contribution in a group that determines the overall contribution level of the group, while for us, this is defined as the *sum* of all contributions. In Cason et al. (2012), inter-group communication leads to significantly lower efforts and higher payoffs, while within-group communication causes higher efforts and substantially lower payoffs. In our study we only employ inter-group communication, and furthermore only leaders communicate with each other. Evidence from this literature suggests that communication between groups can help mitigate the contest.

Hypothesis 3. *Contributions levels are lower in the intergroup treatments.*

4 Results

This section is divided into four parts. First we present general contribution patterns and corresponding treatment differences, before turning to the leaders' behaviour and the followers' behaviour, respectively. Then in Subsection 4.4 we study leaders' chats and how this communication channel pans out for the between group contest.

We apply non-parametric methods for hypotheses testing: Mann-Whitney U tests (MWU) (Mann & Whitney, 1947) for independent sample tests and Wilcoxon signed-rank test (Wilcoxon, 1945) for paired tests. Furthermore we use the Kruskal-Wallis test (KW test) (Kruskal & Wallis, 1952) and Dunn's test (Dunn, 1964) with a false discovery rate (FDR) adjustment by Benjamini and Hochberg (1995) for tests involving three or more

[9] Bolton and Ockenfels (2000); Fehr and Schmidt (1999) present models of self-centred inequality aversion.

samples. We use a non-parametric test for trend developed by Cuzick (1985). Unless specified differently, we use data on paired group level (eight players) as independent observation and apply two-sided tests. For each treatment we have nine group pairs.

4.1 General Contest expenditures

Figure 1 provides a graphical impression of contest contributions for all treatments. The dashed horizontal line at 120 represents the (risk neutral, standard preferences) Nash equilibrium benchmark as reference. In all treatments we observe strong overcontribution with groups on average contributing almost three times the risk neutral equilibrium prediction (Wilcoxon test: H0: group contr. $= 120$, $N = 45$, $p < 0.001$). However, the results from a KW test indicate that there exists difference between the treatments (KW test: $N = 45$, $p = 0.023$). More specifically, a Dunn's pairwise comparison (see Table 3) finds that contribution levels in the *Baseline* treatment are significantly lower than in the *Ingroup trans* treatment ($p = 0.095$). Furthermore, contribution levels in the *Intergroup lbe* treatment are lower than in all other treatments ($p \leq 0.032$), with the exception of the *Baseline*, which is statistically not different ($p = 0.219$).

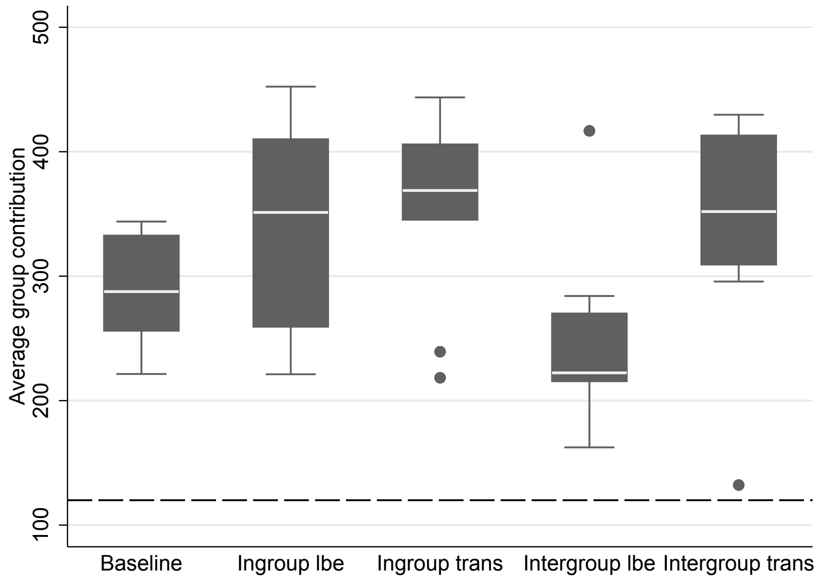

Figure 1: Contribution to the contest. The white horizontal line indicates the median, boxes stretch from upper to lower quartile. Whiskers indicate largest and lowest value, excluding outliers, which are indicated by single dots.

Result 1 Leading by example with intergroup communication leads to a decrease in contributions. Other differences are not significant.

Accordingly, our results deliver some evidence in favour of Hypothesis 3 in the *intergroup lbe* treatment only. For the *intergroup trans* treatment, contribution levels are on an equally high level as in the other treatments.

Table 3: Pairwise comparison of group contribution by treatment (Dunn's test with Benjamini-Hochberg FDR correction)

Column mean - row mean z test statistic (p-value)	Baseline	Ingroup lbe	Ingroup trans	Intergroup lbe
Ingroup lbe	-1.364 (0.144)			
Ingroup trans	-1.777^{*} (0.095)	-0.413 (0.425)		
Intergroup lbe	1.023 (0.219)	2.387^{**} (0.028)	2.800^{**} (0.026)	
Intergroup trans	-1.472 (0.141)	-0.108 (0.457)	0.305 (0.422)	-2.495^{**} (0.032)

* p<0.10, ** p<0.05, *** p<0.01

Figure 2 depicts the average group contribution to the contest over the periods per treatment. Again, the risk-neutral Nash equilibrium is indicated at a contribution level of 120. Looking at group contribution levels in period 1, we see that except for the *Intergroup lbe treatment*, which displays a significantly lower contribution in period 1, all treatments start out on a fairly similar level (KW test using group level data: $N = 75,\ p = 0.029$. Dunn's test (see Table 17): H0 rejected for each pairwise comparison iff *Intergroup lbe treatment* involved $p \leq 0.114$, otherwise $p \geq 0.233$). In both *Intergroup treatments* there exists a significant time trend over the course of the game. While there is a positive trend for the *Intergroup trans treatment* (Cuzick test: $N = 9,\ p = 0.072$), *Intergroup lbe* displays a decreasing contribution level over time (Cuzick test: $N = 9,\ p = 0.022$). The other three treatments display no trend (Cuzick tests, $p \geq 0.24$).

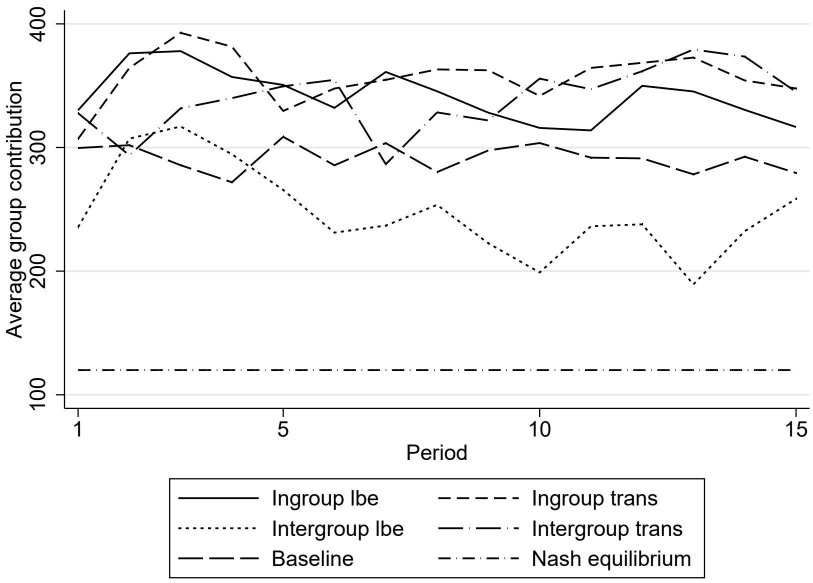

Figure 2: Contribution to the Contest over the Periods

4.2 Leader Behaviour

We start with a look at leaders' contribution levels across all periods. As depicted in Figure 3, leaders contribute at an overall comparable level for almost all treatments (KW test: $N = 36,\ p = 0.126$. All Dunn's pairwise comparisons with $p \geq 0.062$, see Table 18). There exists some weak common directionality for the *Intergroup lbe* treatment being lower than the others at p-values between $6.2 - 15\%$.

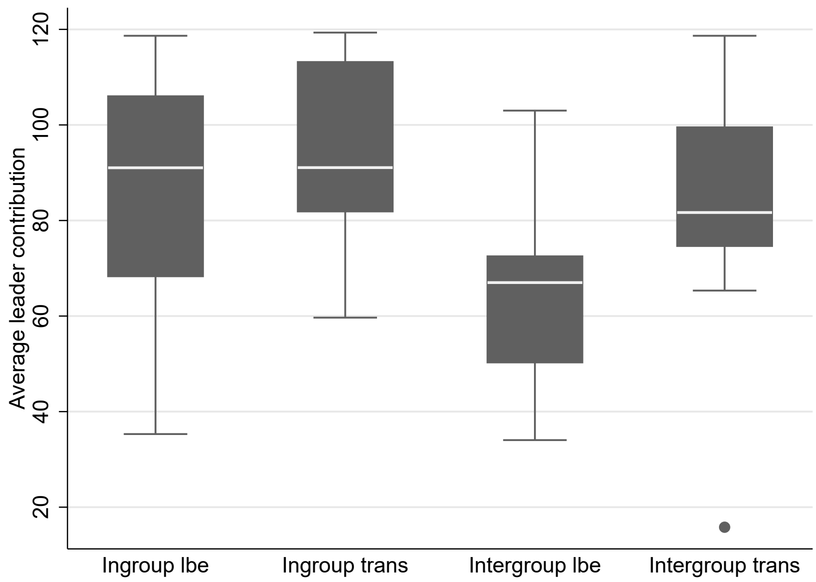

Figure 3: Leader contribution to the contest. The white horizontal line indicates the median, boxes stretch from upper to lower quartile. Whiskers indicate largest and lowest value, excluding outliers, which are indicated by single dots.

Figure 4 depicts average leader contribution levels per period for each treatment with a leader. On the left hand side we have the *leading by example* treatments, in which the leader is merely a first mover in the game, and on the right hand side we group the *transactional leader* treatments, in which the leader can redistribute the prize, if won. As reference, the dashed straight line represents the respective Nash equilibrium. Notice the difference in subgame perfect Nash equilibria for leaders (cf. Table 2), which do not seem to have any effect on behaviour. While it seems that *Ingroup* leaders contribute more than *Intergroup* leaders, pairwise tests fail to support this (see KW and Dunn's tests above). In terms of period trend, however, we find some evidence for a difference between leading-by-example and transactional leaders. While leader contribution levels for both transactional treatments display a significant positive trend (Cuzick tests at group pair level: *Ingroup trans* $N = 9,\ p = 0.063$, *Intergroup trans* $N = 9,\ p = 0.076$), among the two other treatments with a leader, only *Intergroup lbe* has a significant and negative trend (Cuzick test at group pair level: *Ingroup lbe* $N = 9,\ p = 0.378$, *Intergroup lbe* $N = 9,\ p = 0.083$).

This paragraph needs updating towards new regression results Table 4 presents results of OLS individual fixed-effects models with error terms clustered at group-pair level (two competing groups), regressing a leader's contribution in period t on a number of factors.[10]

[10] A Hausman specification test (Hausman, 1978) rejects GLS random effects model as inconsistent with

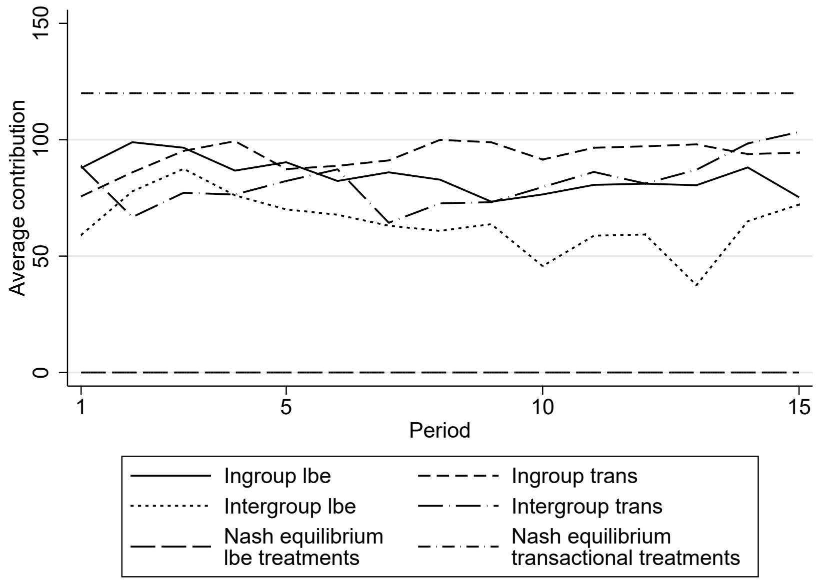

Figure 4: Contribution to the Contest by Leaders only

This panel data regression method allows us to investigate how leaders' contribution decisions are influenced by other players' behaviour in this game and whether this differs between treatments. These only include data from treatments with a leader, hence omitting the *baseline treatment*. Our results indicate that the autoregressive factors "Contribution $t-1$" and "... $t-2$" barely carry any significance. By contrast, there indeed exists a positive relationship between leader and follower contribution levels in two of the four regressions (the *intergroup* treatments) and a common directionality in all four regressions. This delivers evidence in favour of Hypothesis 1. Furthermore, the competing group's contribution level in $t-1$ positively influences a leader's contribution in t for two of the four treatments (*Ingroup lbe* and *Intergroup trans* treatments). In the other two treatments, however, this effect seems to be very close to zero. As it concerns the two orthogonal experimental treatments, interpretation of this effect, or the lack thereof in particular treatments, is not obvious. Lastly, lagged earnings from the contest only have some small negative effect in the *Intergroup trans* treatment.

Result 2 We find some weak evidence for lower contribution levels of leaders in the *intergroup lbe* treatment. Furthermore, follower contribution levels have a positive effect on their leader's contribution.

In the transactional treatments, leaders can redistribute the prize. If this instrument is used to incentivise a reduction in contest spending, resources would need to be distributed towards those followers that adhere to low contribution levels. Using a density-distribution sunflower plot (Dupont & Plummer, 2003), Figure 5 depicts the relationship between the prize received from the leader and a player's contribution relative to the leader in the same period. Circles represent individual observations, light sunflowers are accumulations of

$p < 0.001$. To assess the effect of the time invariant factors social value orientation and risk aversion, see Appendix D.

Table 4: Leader contribution – OLS individual fixed-effects model using treatments with leaders only.

VARIABLES	(1) Ingroup lbe	(2) Ingroup trans	(3) Intergroup lbe	(4) Intergroup trans
	Leader contribution in period t			
Contribution $t-1$	0.145	0.428***	0.053	−0.167
	(0.17)	(0.07)	(0.09)	(0.11)
Average follower	0.234	0.296**	0.119	0.214**
contribution $t-1$	(0.22)	(0.11)	(0.12)	(0.11)
Other group's	0.055	−0.011	0.011	0.045**
contribution $t-1$	(0.04)	(0.02)	(0.03)	(0.02)
Group won in $t-1$	−4.305	−1.524	−3.228	−17.537**
	(3.06)	(1.90)	(4.62)	(8.65)
Constant	34.965*	32.841**	53.668***	69.644***
	(21.19)	(14.34)	(14.78)	(15.09)
Number of observations	252	252	224	252
Number of individuals	18	18	18	18
Within model R-squared	0.131	0.453	0.020	0.099
Between model R-squared	0.778	0.907	0.742	0.148
Overall R-squared	0.475	0.715	0.173	0.101

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses. *Baseline* treatment omitted.

entries within a bin of 8.571,[11] where each petal stands for one observation, dark sunflowers constitute a further aggregation, with a petal for each 13 observations, using the same bin size. We add two reference lines: *1*) a horizontal line at 480, which represents an equal redistribution of the prize among all group members and *2*) a vertical line at 0, where a follower contributes at the same level as her leader does.

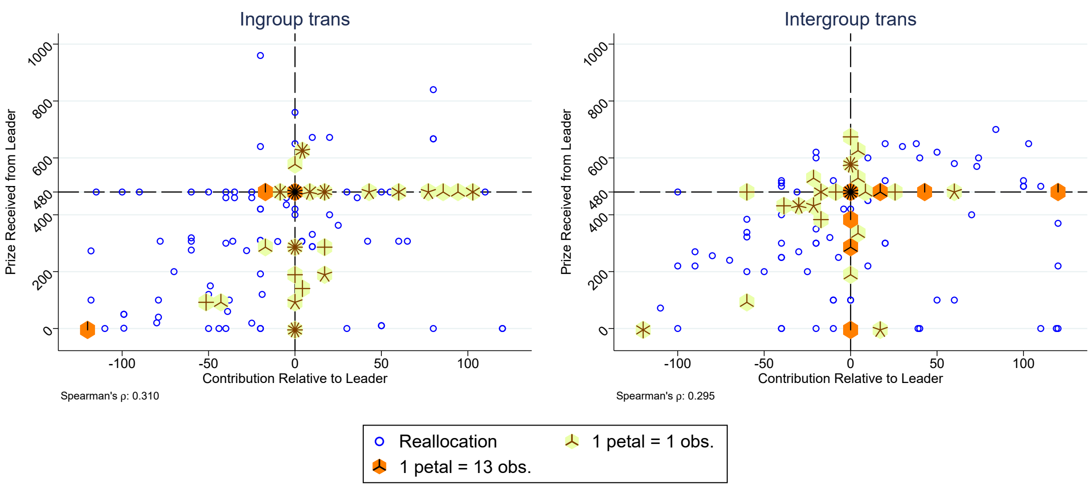

Figure 5: Reallocation of Prize by Transactional Leaders

[11]For our x-axis $[-120, 120]$, this creates exactly 28 bin ranges. See Dupont and Plummer (2003) for details on the determination of bin sizes.

In Figure 5 two dominant strategical patterns can be recognised: *First*, followers tend to contribute at the same level as the leader, which is illustrated by the high density of observations along a relative contribution of 0. *Second*, leaders reallocate an equal share of the prize, which can be seen by the accumulation of observations on the horizontal line of 480. This creates a cross, establishing four domains. The north-western and north-eastern domains contain only a few observations. This means that leaders tend to not reallocate more than the equal share, even to those that contribute more than the leader. By contrast, it is in the south-western domain where by far the most observations lie. This area represents the situation where leaders reallocate less than the equal share to followers with a negative relative contribution. Furthermore, for an extremely low level of relative contribution (-120), we observe a high clustering on zero redistribution. This means that followers who fall far below their leader's benchmark do not receive anything from the leader.

This paragraph needs to be adjusted to new results, now using bootstrapped error terms In addition, consider Regressions (1) and (2) in Table 5, which zoom in on the reallocation behaviour of leaders. Using fixed-effects models we regress a leader's reallocation on how the recipient's contribution compares to the leader's contribution, controlling for the general contribution level in the group ("Other followers' contribution") and the leader's contribution level in t. Note that in this set of regressions, a leader forms a panel with three allocation decisions directed at other players per period. Only for Regression (1) we find a positive relationship between followers' individual contribution levels and the share in the prize the leader allocates. Table 12 in Appendix D.1 presents results from similar GLS random effects regressions, in which we control for risk aversion and social value orientation. Here we find evidence for a positive relationship for leaders from both transactional treatments. Together with the common directionality with Regression (2) in Table 5, this delivers some evidence that leaders tend to allocate more to high contributors, which supports Hypothesis 2. Accordingly, we find some evidence that leaders incentivise higher follower contribution by allocating more to high contributors. The fact that the level of other group members' contribution has no significant effect suggests that leaders do look at individual contribution levels when deciding on the prize allocation within a group. With a similar degree of significance as the result on relative follower contribution, there is some evidence from the results in Tables 5 and 12 that leaders who contribute more themselves, also tend to allocate more of the prize to their followers.

Result 3 In transactional treatments, many leaders reallocate an equal share of the prize, 480. Furthermore, we find evidence for a positive relationship between follower contribution levels and prize reallocation.

4.3 Follower Behaviour

We start with a look at overall follower contribution levels in Figure 6. Similar to results discussed in previous subsections, behaviour in the *intergroup lbe* treatment stands out from the other treatments with lower contribution levels than each of the other treatments. A KW test indicates that at least one treatment is different from the other ones (KW test: $N = 36,\ p = 0.047$). Dunn's pairwise comparisons show that follower contributions in the *intergroup lbe* treatment are indeed lower than any of the other treatments with a leader ($p \leq 0.039$, see Table 20). All other pairwise comparisons display no evidence for

Table 5: Transactional Leadership – OLS individual fixed-effects models using data from followers in groups that have won in a given period.

VARIABLES	(1) Ingroup trans	(2) Intergroup trans
	Prize Allocated by Leader	
Contribution	1.779***	1.245*
relative to leader	(0.46)	(0.65)
Other followers'	−0.115	−0.247
contribution	(0.30)	(0.30)
Leader contribution	1.330***	0.991**
	(0.36)	(0.50)
Constant	282.237***	358.121***
	(56.75)	(68.63)
Number of observations	405	405
Number of individuals	18	18
Within model R-squared	0.183	0.078
Between model R-squared	0.387	0.057
Overall R-squared	0.241	0.063

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses.

significant difference ($p \geq 0.473$). This confirms Hypothesis 3 partially. We find evidence in favour of said hypothesis for the *Intergroup lbe*, but not the *Intergroup trans* treatment.

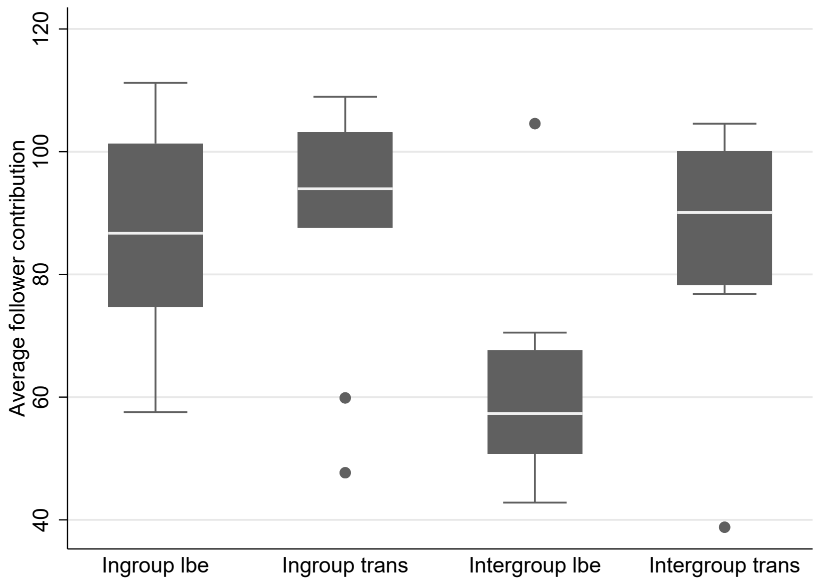

Figure 6: Follower contribution to the contest. The white horizontal line indicates the median, boxes stretch from upper to lower quartile. Whiskers indicate largest and lowest value, excluding outliers, which are indicated by single dots.

In Figure 7 we depict average group contribution for followers per period for each treatment with a leader. As before, with *leading by example* treatments on the left and *transactional leader* treatments on the right hand side. The dashed straight lines represent the respective Nash equilibria at follower level. This image visually illustrates that the Nash equilibrium does not have any bearing on the contribution levels of the treatments. Most notably, contribution levels in the *intergroup lbe* treatment are lower than for the other treatments, despite having a higher Nash equilibrium than both transactional leader treatments. For the followers, we only find a significant trend for both intergroup treatments. While this trend is negative for the *intergroup lbe* treatment (Cuzick test at group pair level, $N = 9,\ p = 0.020$), it is positive for the *intergroup trans* treatment (Cuzick test at group pair level, $N = 9,\ p = 0.092$). For both ingroup treatments, follower contributions do not seem to systematically change over time (Cuzick tests at group pair level, $N = 9,\ p \geq 0.299$).

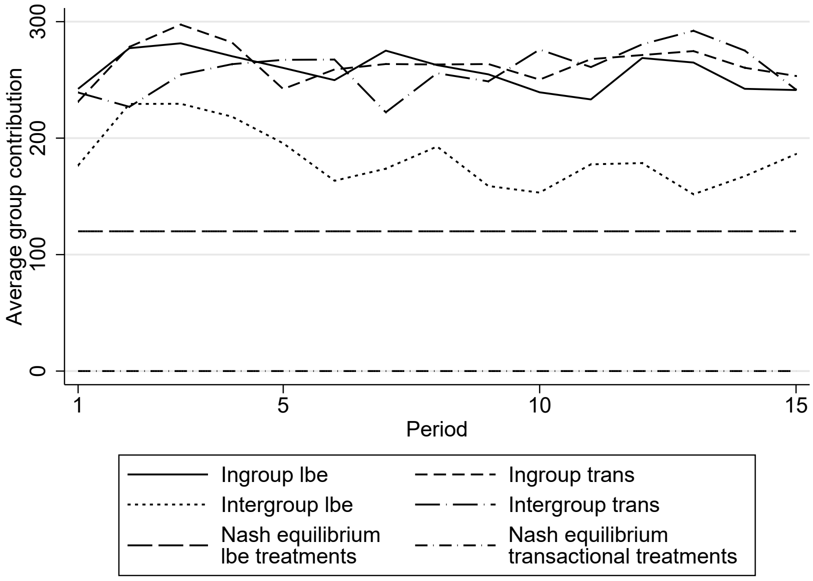

Figure 7: Contribution to the Contest by Followers only.

In Table 6 we presents results of an OLS individual fixed-effects model with error terms clustered at group-pair level (two competing groups), regressing a follower's contribution in period t on a number of factors. For this we omit data from the *baseline treatment*, focussing on treatments with a leader only. We use this panel data analysis method to look into which dynamics of the game have an effect on followers' contribution behaviour and whether this differs between treatments. Again, like in the regressions on leader behaviour in Table 4, the lagged own contributions are not significant. There exists, however, a robust positive relationship between leader and follower contribution levels in all four treatments. Indeed, in all four treatments, the leader's contribution level is perceived as a signal and followers tend to follow her example. This result delivers additional evidence in support of Hypothesis 1. Other factors of the game have only minor or no influence on follower contribution levels. The lagged contribution level of the other group has no significant effect for all four treatments. The lagged contribution level of other fellow followers and the prize received in the previous period both have a small positive effect in the *ingroup trans* treatment, but not in the other three treatments. This latter factor ("Prize received from contest $t-1$") is zero for groups that have lost in $t-1$ and either 480 in the two lbe treatments or whatever the leader reallocated to the follower in the two trans treatments. From this analysis it appears that the leader's contribution level is the strongest and most robust factor influencing followers' behaviour.

Table 6: Follower contribution – OLS individual fixed-effects model using treatments with leaders only.

VARIABLES	(1) Ingroup lbe	(2) Ingroup trans	(3) Intergroup lbe	(4) Intergroup trans
	Follower contribution in period t			
Contribution $t-1$	0.250***	0.372***	0.181***	0.211***
	(0.06)	(0.10)	(0.04)	(0.04)
Leader Contribution	0.392**	0.280**	0.450***	0.540***
	(0.17)	(0.12)	(0.08)	(0.07)
Other group's	0.007	0.003	0.011	−0.003
contribution $t-1$	(0.02)	(0.02)	(0.01)	(0.01)
Other followers'	−0.050	−0.024	−0.016	−0.067**
contribution $t-1$	(0.04)	(0.05)	(0.03)	(0.03)
Group won in $t-1$	−0.031	−1.530	−6.250*	−1.377
	(2.12)	(3.37)	(3.68)	(3.23)
Constant	37.808***	33.404**	23.846***	37.692***
	(14.22)	(14.11)	(6.38)	(10.79)
Number of observations	756	756	672	756
Number of individuals	18	18	18	18
Within model R-squared	0.200	0.217	0.216	0.333
Between model R-squared	0.743	0.852	0.515	0.649
Overall R-squared	0.425	0.470	0.291	0.416

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Bootstrapped standard errors in parentheses. *Baseline* treatment omitted.

Result 4 We find robust evidence for lower contribution levels of followers in the *intergroup lbe* treatment. Furthermore, the leader's contribution has a positive effect on her followers' contribution levels.

Next we focus on groups that have won in $t-1$. Figure 8 uses a density-distribution sunflower plot to illustrate how a follower's willingness to contribute (relative to the leader) relates to the leader's prize reallocation in the previous period. For this analysis we focus on groups in the transactional treatments that have won in the previous period.[12] It illustrates the relationship between a follower's relative contribution and the prize received from the leader in the previous period. We use the same reference lines as before. We observe that followers frequently contribute at the same level as the leader. These dominant behaviour patterns serve as boundary for creating four domains in the graph, as in the earlier analysis. The south-eastern domain remains nearly empty, and if there are entries, they lie very close to the delimiters. Accordingly, individuals who receive more than the equal split of the prize tend to not contribute less than the leader in the subsequent period. The vast majority of observations off the cross fall into the south-western domain: Followers who have received less than the equal share in the preceding period, tend to display a lower contribution than the leader. The two northern domains display a few entries, any behaviour off the cross does not seem to be very widespread here.

[12]For groups that have lost in the period before, there is no prize to reallocate. Also, this part only includes data from 14 periods, dropping period 1 contribution data.

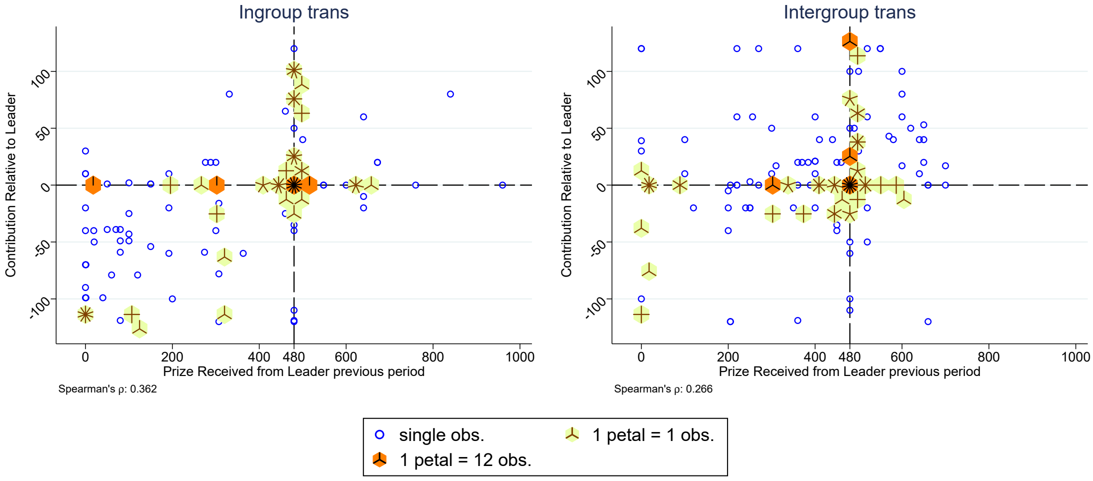

Figure 8: Followers' Relative Contribution in Relation to the Prize they Received from the Leader in the Previous Period

Update to new regression table Consider also Table 7, in which we quantify the behaviour of followers in groups that have won in $t-1$. Using individual fixed-effects models we find that for both *transactional* treatments, followers who receive a larger piece from the prize also display higher contribution levels in the subsequent period. Only in the leading-by-example treatments there is some evidence for a positive effect from other fellow followers' contribution, as can be observed in Regressions (1) and (3). Further, there appears to be a robust positive relationship between leader and follower contribution for all treatments.

Table 7: Transactional Leadership – OLS individual fixed-effects models using data from followers in groups that have won the period before (in $t-1$).

VARIABLES	(1) Ingroup trans Contribution in period t	(2) Intergroup trans
Prize received from leader $t-1$	0.074***	0.062***
	(0.02)	(0.02)
Other followers' contribution $t-1$	−0.058	−0.054
	(0.10)	(0.05)
Leader contribution t	0.346**	0.525***
	(0.14)	(0.10)
Constant	44.355**	30.850**
	(20.58)	(14.20)
Number of observations	378	378
Number of individuals	18	18
Within model R-squared	0.168	0.308
Between model R-squared	0.667	0.669
Overall R-squared	0.331	0.402

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses.

Result 5 The relationship discussed under Hypothesis 2 seems to also hold in the inverse: Redistribution from the leader has a positive effect on followers' subsequent contribution levels.

4.4 Intergroup Leadership: The chat contents

Prior to deciding on her contribution level, each leader in the *intergroup* treatments has the opportunity to communicate with the leader of the competing group via a chat window for 45 seconds each period. These conversations have been documented by the software and categorised by a research assistant who is not involved with this project in any other way. The assistant was not informed about the research question or about the hypotheses of this study. She read the entire chat history of all groups and sorted the messages according to categories, provided by us. Table 8 gives an overview of all categories we employ for this. Some messages fall into multiple categories at a time. Figure 9 depicts the prevalence of messages fitting into the chat categories per treatment. We see that "low contribution" messages are being sent more frequently in the *Intergroup lbe* treatment than in the *Intergroup trans* treatment, while "bonding" or "small talk" are relatively less commonly used here.

Table 8: Chat categories employed

Category	Criterion, i.e. "Conversation about..."
Low contribution	Contributing an amount between 0-40 points
Medium contribution	Contributing an amount between 41-80 points
High contribution	Contributing an amount between 81-120 points
Alternate	Taking alternating turns in contributing
Bonding	Creating an emotional bond with each other
Small Talk	Non-game related casual conversations
Understanding	The rules of the game, clarifications
Efficiency	Deliberations about what would be the most "efficient" way to play
Followers' behaviour	What the followers do / what they contribute
Give much to followers	Redistributing a significant sum of points to followers
Give little to followers	Redistributing only a minor sum of points to followers
Other	Any message that does not fall into any of the categories above

Check if results are still the same now with bootstrap Using a GLS random effects model with error terms clustered for intra-pair correlation, we regress a leader's contribution level on the number of messages sent in a given period, which fall into one of the categories, as discussed below. Furthermore, we use lagged values for own contribution and a lagged group win term as controls. Table 9 contains the regression results for the *Intergroup lbe* treatment in Regression (1) and for *Intergroup trans* in Regression (2). This analysis has a somewhat exploratory character, which connotes a caveat when interpreting the results. As participants usually send multiple messages in a given period, different messages from the same participant could fall into multiple categories in the same period, which in theory may cancel out effects in the analysis.

First of all, sending messages discussing low contribution levels (e.g. between 0 - 40 points), has a reducing effect on contribution levels. Inversely, leaders discussing high contribution levels (e.g. between 81 - 120 points) contribute more to the contest, subsequently.

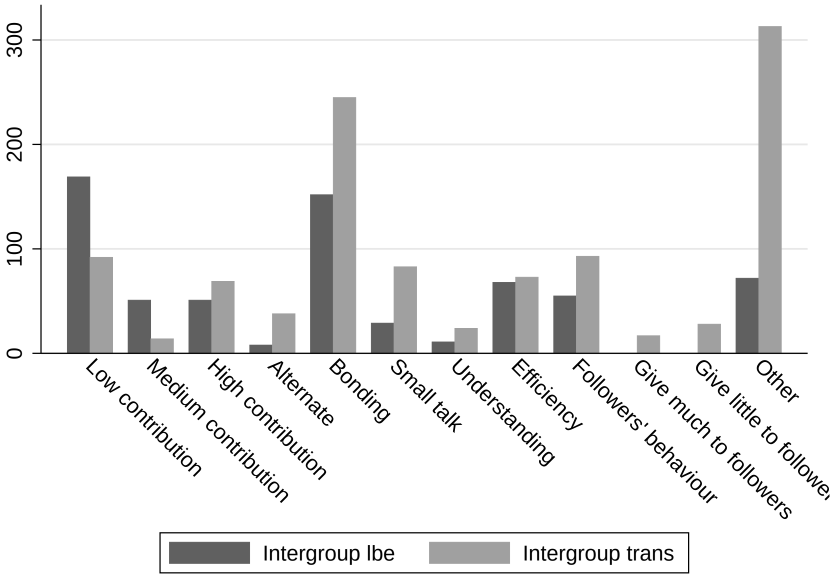

Figure 9: Prevalence of Chat Messages per Treatment

This is true for both treatments with chat function. As expected, discussing a medium level of contest spending has neither a lowering nor increasing effect in this regard. Furthermore, transactional leaders who discuss coordinating on taking alternating turns, manage to alleviate the between-group contest. We do not find the same significant effect for leaders in the *intergroup lbe* treatment, which may in part be attributable to the low number of observation for this chat message type in the *intergroup lbe* treatment. Somewhat surprisingly, bonding or small talk messages incite a higher spending level in Regression (15). By creating an emotional tie with the other group representative, we would have expected a degree of mitigation towards the inter-group contest. Furthermore, while bonding messages indeed feature an escalating character towards leaders in the *Intergroup lbe* treatment, this effect appears to be non-existent in the *Intergroup trans* treatment.

Understanding has a weak positive effect in Regression (2), delivering some suggestive evidence that leaders in the *intergroup trans* treatment, who had understanding questions, tended to contribute a little more. This effect is not significant for the other intergroup treatment and has a comparably high p-value of 0.094. Further, efficiency concerns do not seem to be a driving factor for leaders' decision making. While this could have been expected to have an abating effect on contest expenditures, discussing this topic had no influence on their contribution behaviour. General conversation on the followers' behaviour, by contrast, constitutes a subject matter with escalating influence on leader contribution decisions in both treatments. Concerning the reallocation of the prize, leaders who articulate their intention to allocate open-handedly towards followers ("Give much to followers"), are also the ones who spend more resources to the contest, i.e. displaying prosocial behaviour. The inverse is also true, leaders talking about giving only little to their followers, also spend little in the contest.

Apart from the chat categories, there is some difference in leaders' reaction on having won in the previous period. While a transactional leader whose group won the preceding period drastically reduces her contributions, this is not the case for leaders in the *Intergroup*

Table 9: Leader Contribution as Function of Chat Contents – GLS random effects models.

VARIABLES	(1) Intergroup lbe	(2) Intergroup trans
	Leader Contribution	
Low contribution	-14.009^{***}	-22.113^{***}
	(3.91)	(5.61)
Medium contribution	3.521	4.452
	(3.66)	(7.58)
High contribution	17.715^{***}	12.550^{**}
	(3.50)	(4.98)
Alternate	-0.059	-11.494^{**}
	(12.03)	(4.94)
Bonding	10.037^{***}	0.683
	(2.33)	(1.81)
Small talk	10.619^{***}	4.019
	(2.47)	(3.60)
Understanding	2.234	8.452
	(21.22)	(6.05)
Efficiency	-0.522	-3.645
	(3.02)	(6.10)
Followers' behaviour	6.101^{*}	5.562^{**}
	(3.64)	(2.22)
Give much to followers		12.773
		(7.86)
Give little to followers		-15.280^{*}
		(8.20)
Other		0.997
	(5.13)	(2.78)
Contribution $t-1$	0.279^{***}	0.298^{***}
	(0.09)	(0.09)
Group won $t-1$	-4.782	-23.154^{***}
	(4.98)	(5.80)
Constant	44.592^{***}	70.737^{***}
	(7.22)	(11.55)
Number of observations	224	252
Number of individuals	18	18
Within model R-squared	0.177	0.151
Between model R-squared	0.807	0.858
Overall R-squared	0.397	0.360

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses.

lbe treatment. This result reproduces the results from Regressions (3) and (4) from Table 4, which also showcase no significant and a negative effect, respectively. The difference between the two treatments in this regard could have to do with the fact that alternating seems to work a lot better in the *Intergroup trans* treatment.

5 Conclusion

This study provides one of the first (experimental) study on leaders in a group contest, complementing studies by Loerakker and van Winden (2017); Eisenkopf (2014). In a $2 \times 2 + 1$ setup, we investigate leaders who are either mere first movers (as in Loerakker & van Winden, 2017), or who have large financial authority over followers. Furthermore, we explore the effect of communication between leaders via free form chats. Hence, we explore the effect of having the institution of a central authority entrusted with setting a benchmark or with pecuniary say. Does this lead to mitigation of wasteful contest spending and lead to a de-escalation?

Our results substantiate a considerably pessimist view overall: Most leadership types actually prompt an escalation of the contest and leaders tend to incentivise their group mates to chip in resources to the competition, confirming Hypothesis 2. While the establishment of intergroup leadership through free form text communication between leaders of competing groups can contribute at abating the rat race – which confirms Hypothesis 3 – general spending levels do not constitute a significant improvement from the baseline level. Leaders who manage to coordinate through the chat on taking turns at chipping in resources are most successful in guiding their groups towards more efficient play.

In contrast to the set of risk-neutral subgame perfect equilibria, outlined in Section 3, we find followers' contribution levels to be depending positively on the leader's spending level. This confirms Hypothesis 1. A leader's spending pattern serves as benchmark / signal towards her followers.

The primary application for these results are twofold: *First*, there is scope for operationalisation in the context of socio-economic conflict or between-country struggles for a natural resource. *Second*, in a corporate context, commercial tenders are of widespread use for the procurement of public projects, like major or medium-sized construction ventures. In fact, public procurement represents more than 10 % of EU GDP as of 2007 (Bovis, 2012). Given the starkly contrasting nature of these two fields of application, policy recommendations, based on insights gained in this article, would fundamentally differ with respect to which goal is considered achievable. While in the former scenario, a de-escalation of conflict expenditures would be desirable, firms in the latter scenario might wish to increase engagement into the procurement tender. The hierarchical nature of the group setup in this experiment has potential for a closer resemblance to group structures which are characterised by having a superordinate leader. Examples for this are most businesses, political parties or sports teams. In a competitive scenario, a proper understanding of the role of managers in a firm or commanders in a military platoon, can be of utmost importance for a smooth functioning of the group as a whole.

We see a couple of fruitful opportunities for future research. In our study we allow for communication between leaders of competing parties. One conceivable extension would be to consider one-sided text messages from the leader towards her followers, or even an interactive chat between leader and followers. Further, side-payments (as in Kimbrough & Sheremeta, 2013, 2014) or costly commitment (e.g. Kimbrough, Rubin, Sheremeta, & Shields, 2015) could constitute a promising vehicle for coordination between the groups. Prior research has employed these latter conflict resolution mechanisms for contests or other conflict models between individuals, only. The richer dynamics of a group setting with a leader could be an interesting litmus test for their robustness.

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Appendix A Further Information on Parts 1 and 2

A.1 Measuring Risk Aversion

Prior to the group contest we take an individual risk preference measure. To this end we use an extended version of the method designed by Eckel and Grossman (2002). Players are confronted with a gamble choice as in Dave, Eckel, Johnson, and Rojas (2010). They opt for one out of 11 gambles as presented in Table 10.[13] Each gamble has a 50:50 chance to either receive a low or a high payoff, respectively. While for Gamble 1 both payoffs are identical (representing the safe option), the alternatives gradually become more risky towards Gamble 11. At the same time, expected returns gradually increase from Gamble 1 to Gamble 9, with Gambles 9, 10 and 11 having an identical expected return. The gamble choice is designed such that risk averse players would choose a Gamble 1-8, a risk neutral player would go for Gamble 9 and a risk seeking player would opt for Gambles 10 or 11.

Table 10: Gamble choices

	Low Payoff	High Payoff	Expected Return	Standard Deviation	Implied CRRA Range
Option 1	28	28	28	0	$0.99 < r$
Option 2	26	32	29	3	$0.99 < r$
Option 3	24	36	30	6	$0.99 < r$
Option 4	22	40	31	9	$0.99 < r$
Option 5	20	44	32	12	$0.78 < r \leq 0.99$
Option 6	18	48	33	15	$0.64 < r \leq 0.78$
Option 7	16	52	34	18	$0.54 < r \leq 0.64$
Option 8	14	56	35	21	$0.46 < r \leq 0.54$
Option 9	12	60	36	24	$0 \leq r \leq 0.46$
Option 10	7	65	36	29	$r < 0$
Option 11	2	70	36	34	$r < 0$

This gamble choice method allows to elicit risk preferences in one step that is easy to understand and easy to implement. Furthermore, it allows for a parameter estimation giving an interval for the player's constant relative risk aversion (CRRA) of the form $u(x) = x^{1-r}$ with x being the wealth and r the coefficient of relative risk aversion (where $r < 0$ is risk seeking, $r = 0$ risk neutral and $r > 0$ risk averse). Dave et al. (2010) compare this method with other, more complex elicitation methods and find that it delivers a less noisy estimate for risk preferences.

A.2 Measuring Social Value Orientation

We take measures of individual social preferences. For this we make use of the SVO slider measure by Murphy et al. (2011).[14] Individuals set 15 sliders determining how to allocate tokens between themselves and another player, some of which are represented in Figure 10. This provides us with a measure for the most commonplace social orientations (for example

[13] The gambles were called "Option" in the experiment.

[14] Crosetto, Weisel, and Winter (2019) provide a helpful tool for implementation.

altruistic, prosocial, individualistic, and competitive) and their relative weighing for the player.

The SVO slider measure constitutes a simplification and adjustment of the circle test employed by Brandts, Riedl, and van Winden (2009); Sonnemans, van Dijk, and van Winden (2006); Van Lange, De Bruin, Otten, and Joireman (1997). It has demonstrated reliable psychometric properties, yields scores for individuals at the ratio level and is quick and easy to implement (cf. Murphy & Ackermann, 2014).

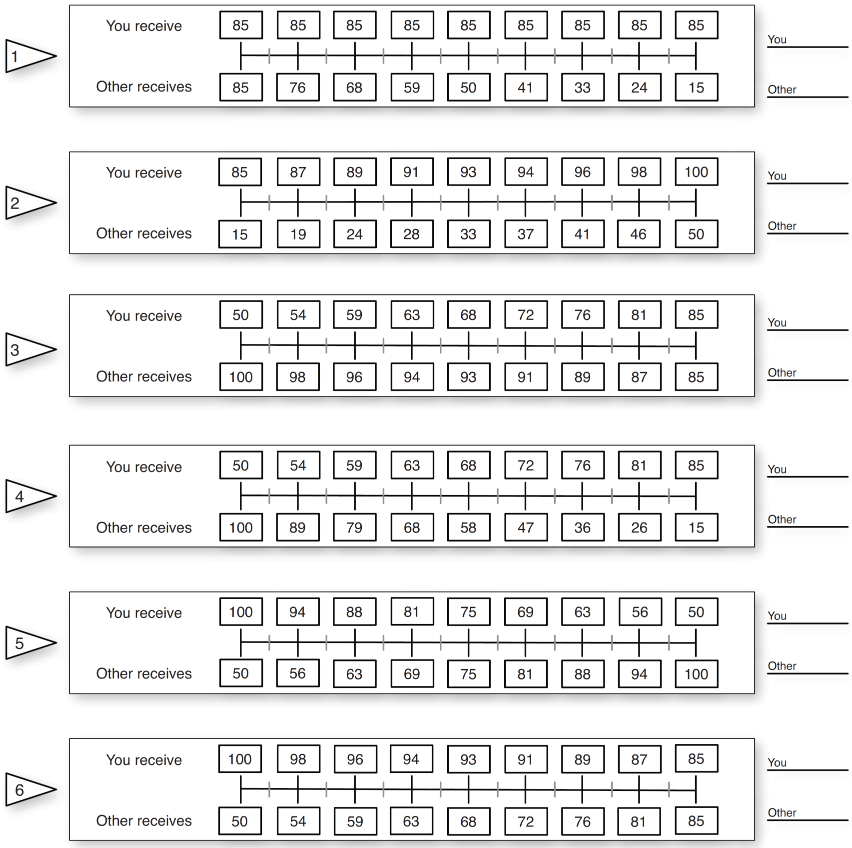

Figure 10: Examples for the slider questions as seen by the participants to measure Social Value Orientation.

Appendix B Instructions

The instructions consisted of three parts. Participants found part 1 with general information and introductions for the risk aversion measure[15] at their place when entering the laboratory. Once everyone was finished with this part of the experiment, the following set of instructions were distributed, which outlined the measurement of individual social value orientation.[16] After this part, participants received instructions for the main part of the experiment, which differed somewhat between the treatments, as outlined below. Paragraphs beginning with a treatment name in square brackets were only given to participants of that particular treatment.

[15]Find details in Appendix A.1

[16]see Appendix A.2

General Instructions

Welcome and thank you for participating in this experiment. In the experiment you can earn money with the decisions you make. Please read these instructions carefully. If you have any questions, please raise your hand and one of the experimenters will come to your cubicle to answer your question.

Talking or using mobile phones or any other electronic devices is strictly prohibited. Mobile phones and other electronic devices should be switched off. If you are found violating these rules, you will both forfeit any earnings from this experiment, and may be excluded from future experiments as well.

This is an experiment about decision making. The instructions are simple and if you follow them carefully you can earn a considerable amount of money which will be paid to you privately and in cash at the end of the experiment. The amount of money you earn will depend on your decisions, on other participants' decisions and on random events. You will never be asked to reveal your identity to anyone during the course of the experiment. Your name will never be associated with any of your decisions.

During the experiment you can earn points (the experimental money unit), which will be converted into cash at the end of the experiment, using an exchange rate of

40 points = 10 cent.

Thus, the more points you earn, the more cash you will receive at the end of the session.

This experiment consists of three parts. The following instructions explain part 1. After finishing that part, you will receive instructions for part 2 and after the end of part 2 you will receive instructions for part 3. None of your (or anyone else's) decisions for one part are affecting your (or anyone else's) earnings in the other parts.

All of your choices are completely confidential. You will learn your results of part 1 and part 2 after part 3 has finished. Points earned in each of the three parts will be added up to determine your total earnings.

Instructions part 1

This is an individual decision task and your choice will only affect you. You will be presented with six payoff options, of which you will have to choose one. Each option is associated with a low and a high payoff and both the high and low payoff are equally likely. At the end, after part 3 the computer will randomly pick either the low or the high payoff of the option you chose.

Instructions part 2

In this task you will be randomly paired with one other person in this room. You will make a series of decisions about allocating points between you and this other person.

One of your decisions will be picked randomly and you receive what you allocated to yourself and the other person receives what you allocated to her in this decision. Note that any of your decisions is equally likely to be chosen. Therefore you should treat each decision as if it is the one that counts.

One other person in the room will make such decision towards you. This is not the person you are randomly paired with.

Instructions part 3

In part 3, all participants are assigned to teams of four and your team will be randomly matched with another team. None of you will learn the identities of own team members or other team members. Part 3 will consist of 15 periods, and in each period you and the other participants can obtain a prize in the following way:

At the beginning of each period you will receive an endowment of 120 points. Then you can use none, parts or all of these points to buy lottery tickets for your team. Each lottery ticket costs 1 point. Any of your points not spent on lottery tickets will be accumulated in your private point balance. Likewise, each of your team members receives 120 points which they may use to buy lottery tickets for your team. Similarly, each member of the other team will receive 120 points and may buy tickets for their team in exactly the same way.

[Ingroup leading-by-example & Ingroup transactional leader] In your and the other group, one participant – member 1 – makes her / his decision before the others. Own team members will see, how many tickets this participant bought, before they make their decisions.

[Intergroup leading-by-example & Intergroup transactional leader] In your and the other group, one participant – member 1 – has been randomly selected to be able to communicate with one participant of the other group in private, via a chat window. This communication possibility will automatically expire after 45 seconds. Unless you are member 1, neither you nor any other participant will ever learn the contents of this communication. After that chat window has been closed, member 1 makes her / his decision. Own team members will see, how many tickets this participant bought, before they make their decisions.

After everybody has made the decision, a lottery will determine whether your team, or the team you are matched with, wins. The likelihood that a team wins depends in a proportional way on the total number of tickets, the team bought and on the total number of tickets, the other team bought. That is, if you and your team members bought in total X tickets, and the team members of the other team bought in total Y tickets, the likelihood that your team wins is $\frac{X}{X+Y}$ and the likelihood that the other team wins is $\frac{Y}{X+Y}$. Hence, the more tickets your (the other) team has, the higher is your (the other) team's chance of winning.

Examples: If your team and the other team have bought the same amount of tickets then each team is equally likely to win. If your team has bought three times as many tickets as the other team, then your team is three times more likely to win than the other team. If only one of the teams has bought tickets, then this team wins for sure. If neither your team nor the other team has bought any tickets, then each team is equally likely to win.

[Baseline, Ingroup leading-by-example & Intergroup leading-by-example] The winning team will receive a prize of 1,920 points in total, which will be split equally among group members. This delivers 480 points for each player of the winning group.

[Ingroup transactional leader & Intergroup transactional leader] The winning team will receive a prize of 1,920 points in total and member 1 will determine how the prize will be split among the group members. The losing team will receive nothing.

Summary: In part 3, your earnings in each period are determined as follows:

Winning team:

	Your Endowment (= 120)
-	Your tickets bought (between 0 and 120)
[Baseline, Ingroup leading-by-example & Intergroup leading-by-example]	
+	Prize (480)
[Ingroup transactional leader & Intergroup transactional leader]	
+	Share of the prize allocated by member 1 (between 0 and 1,920)
=	Your earnings

Losing team:

	Your Endowment (= 120)
-	Your tickets bought (between 0 and 120)
=	Your earnings

The points you earn in each period accumulate and your earnings in part 3 will be the total point earning from all 15 periods.

This part starts with a trial period in which you will be asked to answer some questions in order to check your understanding and to give you the opportunity to get acquainted with the setup. Points earned in this trial period will not be paid out.

Appendix C Standard Theoretical Predictions

C.1 Risk Neutral Equilibrium

Player i maximises expected profit π_i by setting own contribution $v_i = (v_i)_{i \in K}$. Contribution of players $k \in K$ of own group K is labelled $\sum_{k \in K} v_k$, while players $m \in M$ in the other disjoint group M contribute $\sum_{m \in M} v_m$. Individual prize for winning a period is z. Solve individual optimisation problem for any period t, time indices are omitted.

$$\pi_i\Big(\sum_{k \in K} v_k, \sum_{m \in M} v_m\Big) = \frac{v_i + \sum\limits_{k \in K \setminus \{i\}} v_k}{v_i + \sum\limits_{k \in K \setminus \{i\}} v_k + \sum\limits_{m \in M} v_m} \cdot z - v_i$$

Deriving with respect to v_i delivers the best response function for any player i of group K:

$$\frac{\partial \pi_i\big(\sum_{k \in K} v_k, \sum_{m \in M} v_m\big)}{\partial v_i} = 0 \quad \Leftrightarrow \quad v_i = \sqrt{\sum_{m \in M} v_m \cdot z} - \sum_{m \in M} v_m - \sum_{k \in K \setminus \{i\}} v_k$$

Checking the second order condition confirms that we find a maximum:

$$\frac{\partial^2 \pi_i}{\partial v_i^2} = \frac{-2 \sum\limits_{m \in M} v_m \cdot z}{\left(\sum\limits_{k \in K} v_k + \sum\limits_{m \in M} v_m\right)^3} < 0$$

Using the first order condition of group M, we find a multiplicity of equilibria, characterised by $\sum_{m \in M} v_m = \frac{z}{4}$ and $\sum_{k \in K} v_k = \frac{z}{4}$. If we assume symmetry in own group: $v_i = \frac{z}{16}$.

C.2 Equilibrium with Risk Aversion

In this analysis we use techniques presented in Abbink et al. (2010); Katz et al. (1990). Let every agent maximise her individual concave utility function $u(\cdot)$, being identical for all players. For brevity, let $X = \sum_{k \in K} v_k$ and $Y = \sum_{m \in M} v_m$.

$$\frac{X}{X+Y} u(z + E - v_i) + \frac{Y}{X+Y} u(E - v_i) \tag{C.1}$$

As before, z is the individual prize to win, E is the individual endowment and v_i is a player's own contribution. Differentiating (C.1) with respect to v_i and setting equal to zero:

$$\frac{Y}{X+Y}\big(u(z + E - v_i) - u(E - v_i)\big) = X u'(z + E - v_i) + Y u'(E - v_i) \tag{C.2}$$

For symmetric equilibria $X = Y$, so

$$\frac{u(z + E - v_i) - u(E - v_i)}{u'(z + E - v_i) + u'(E - v_i)} = 2X \tag{C.3}$$

CARA Under constant absolute risk aversion (i.e. exponential utility), let $u(\pi_i) = -e^{-\alpha\pi_i}$, with α being the measure of risk aversion. Set in to (C.3):

$$\frac{-e^{-\alpha(z+E-v_i)} + e^{-\alpha(E-v_i)}}{\alpha e^{-\alpha(z+E-v_i)} + \alpha e^{-\alpha(E-v_i)}} = 2X \tag{C.4}$$

We divide both numerator and denominator by $e^{-\alpha(E-v_i)}$ and rearrange:

$$X = \frac{1}{2\alpha} \cdot \frac{1-e^{-\alpha z}}{1+e^{-\alpha z}} \tag{C.5}$$

As shown in Abbink et al. (2010), $X = \frac{z}{4}$ if $\lim_{\alpha\to 0}$, which is the risk-neutral equilibrium. Deriving with respect to α delivers the slope of the function:

$$\frac{\partial X}{\partial \alpha} = \frac{ze^{-\alpha z}\left(2\alpha + 2\alpha e^{-\alpha z}\right) - \left(1-e^{-\alpha z}\right)\left(2 + 2e^{-\alpha z} - 2\alpha z e^{-\alpha z}\right)}{4\alpha\left(1+e^{\alpha z}\right)^2},$$

which simplifies to:

$$\frac{\partial X}{\partial \alpha} = \frac{e^{-2\alpha z} + 2\alpha z e^{-\alpha z} - 1}{2\alpha\left(1+e^{\alpha z}\right)^2} \tag{C.6}$$

Abbink et al. (2010) show that the slope is negative for all $\alpha > 0$ and $z > 0$. This means that departing from the risk neutral equilibrium at $\alpha = 0$ towards a higher level of risk aversion, equilibrium group contribution decreases. To illustrate, Figure 11 depicts equilibrium group contributions for specific α-values and $z = 480$.

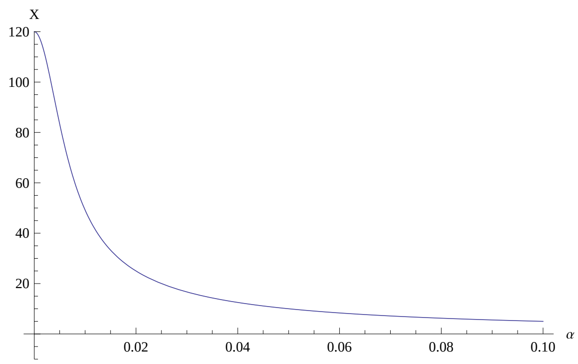

Figure 11: Equilibrium Contributions per contest group under CARA

CRRA We consider constant relative risk aversion, specified as $u(\pi_i) = \frac{\pi^{1-\rho}}{1-\rho}$, with ρ being the risk parameter. Set in to (C.3):

$$\frac{1}{1-\rho} \cdot \frac{(z+E-v_i)^{1-\rho} - (E-v_i)^{1-\rho}}{(z+E-v_i)^{-\rho} - (E-v_i)^{-\rho}} = 2X \tag{C.7}$$

Consider Figure 12 to see that contribution for the contest decreases with risk aversion, under the assumption of symmetric behaviour ($v_i = \frac{X}{4}$) and the parameters of the game ($z = 480, E = 120$).

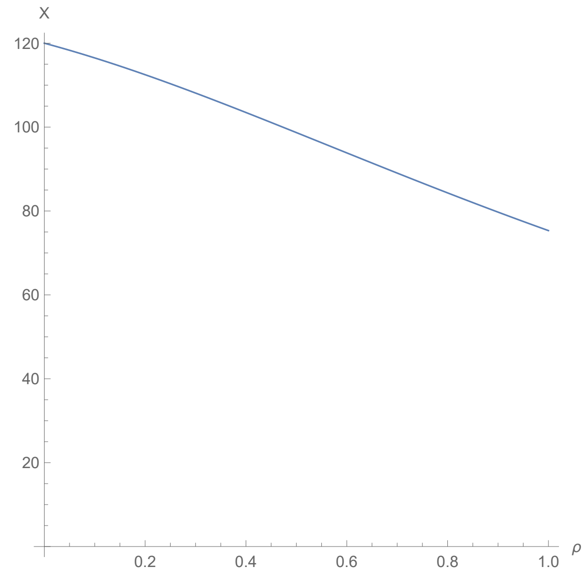

Figure 12: Equilibrium Contributions per contest group under CRRA

Appendix D GLS Random Effects Models, Randomisation Check, Dunn's Test Matrices

D.1 GLS Random Effects Models with Risk Aversion and Social Value Orientation

In this section we present regression results for robustness checks pertaining to the analyses presented in the main part of the article. We run GLS random-effects analyses controlling for risk aversion and social value orientation. The data for these two control variables were collected in Parts 1 and 2 of the experiment and incentivised. More details on the risk aversion task and social value orientation measure are in Appendix A.

Entire Section: Double check if it needs updating, given new regression tables (now bootstrap instead of clustered). Table 11 presents results from GLS random-effects model regressions equivalent to the ones presented in Table 4, now controlling for risk aversion ("Riskiness of Gamble Choice") and social value orientation ("SVO angle") measured in respectively Part 1 and 2 of the experiment. Comparing regressions from Table 4 and 11, the latter regressions indicate a much higher degree of autocorrelation in leader contribution behaviour. For the other factors, the directionality remains the same for the two regression methods, yet for a few cases, the level of significance differs between the two regression methods. We observe no significant effect in leader contribution behaviour attributable to individual risk aversion measures. Lastly, there exists a weak common directionality across all four regressions of a negative relationship between risk aversion and contribution levels of leaders. This negative effect is only significant for leaders in the *Intergroup trans* treatment, though. This weak negative factor aligns with the characterisation of the social optimum being at the lower end of participants' decision space, as discussed in Section 3.

The regressions in Table 12 show the results of similar regressions as in Table 5, now as GLS random effects models including controls for risk aversion and social value orientation

Table 11: Leader contribution – GLS random-effects model using treatments with leaders only.

VARIABLES	(1) Ingroup lbe	(2) Ingroup trans	(3) Intergroup lbe	(4) Intergroup trans
	Leader contribution in period t			
Contribution $t-1$	0.583^{***}	0.719^{***}	0.336^{***}	0.201^{*}
	(0.19)	(0.10)	(0.12)	(0.12)
Average follower	0.280	0.211	0.102	0.113
contribution $t-1$	(0.25)	(0.13)	(0.10)	(0.14)
Other group's	0.022	−0.015	0.031	0.119^{***}
contribution $t-1$	(0.02)	(0.02)	(0.02)	(0.03)
Group won in $t-1$	−6.695	−0.814	−6.579	-16.346^{**}
	(4.32)	(2.16)	(5.40)	(7.96)
SVO angle	−0.107	−0.176	−0.203	−0.241
	(0.36)	(0.24)	(0.50)	(0.17)
Riskiness of Gamble	0.446	−1.006	1.026	−1.523
Choice	(1.17)	(1.31)	(1.75)	(1.97)
Constant	5.331	24.902	29.935	34.787^{*}
	(23.29)	(17.70)	(19.84)	(20.10)
Number of observations	252	252	224	252
Number of individuals	18	18	18	18
Within model R-squared	0.109	0.441	0.017	0.046
Between model R-squared	0.970	0.972	0.884	0.868
Overall R-squared	0.560	0.748	0.213	0.303

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses. *Baseline* treatment omitted.

from Parts 1 and 2 of the experiment. Adding to the discussion from Subsection 4.2, we see that while risk aversion does not seem to have a significant influence on leaders' prize allocation decision, the positive coefficients for the social value orientation measure suggest that leaders with a more prosocial orientation also allocate a higher share of the prize to their followers.

Table 13 shows regression results from GLS individual random-effects models similar to those presented in Table 6. What is different in the regressions presented here is that we employ GLS random-effects with risk aversion and social value orientation. As in Table 11 above, the results from this appendix relate to those in the main text in that they show a considerable degree of autocorrelation. Further, the results do not qualitatively differ a lot from the results in Table 6. The results confirm the robust positive relationship between leader and follower contribution. Risk aversion and SVO do not seem to have a strong effect on followers' contribution decisions. Only Regression (3) shows some weak positive effect for risk aversion, meaning that more risk averse participants would contribute more to the contest. While the other regressions indicate the same directionality, this is not significantly different from zero. Higher contribution levels for risk averse players would in fact be the *opposite* of what our equilibrium predictions under standard risk aversion models would predict (as derived in Appendix C.2).

Table 14 is the equivalent of Table 7, differing by that we use GLS individual random-

Table 12: Transactional Leadership – GLS fixed-effects models using data groups that have won.

VARIABLES	(1) Ingroup trans	(2) Intergroup trans
	Prize Allocated by Leader	
Contribution	1.844^{***}	1.305^{***}
relative to leader	(0.50)	(0.47)
Other followers'	-0.045	-0.259
contribution	(0.36)	(0.24)
Leader contribution	1.426^{***}	1.001^{**}
	(0.51)	(0.45)
Riskiness of Gamble	1.198	-3.972^{*}
Choice	(2.72)	(2.23)
SVO angle	0.989	1.332^{***}
	(1.07)	(0.42)
Constant	214.397^{***}	360.852^{***}
	(56.32)	(40.50)
Number of observations	405	405
Number of individuals	18	18
Within model R-squared	0.192	0.094
Between model R-squared	0.281	0.043
Overall R-squared	0.217	0.076

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses.

effects models employing risk aversion and SVO controls here. Results stay qualitatively similar, save for the effect of leader contribution in t for Regressions (2) and (4), which here display a significant *negative* effect. This may be a regression to the mean effect, stemming from an interplay with the factor "Price received from leader $t-1$." Tables 5 and 12 have identified a positive relationship between leader contribution and their reallocation rates.

Table 15 adds risk aversion and SVO controls to the analyses carried out in Table 9. Effects from the chat categories remain qualitatively unchanged. As in Table 11, risk aversion does not influence leader contribution levels, while SVO has a negative effect on leader contribution levels for the *Intergroup trans* treatment only.

D.2 Randomisation Check

Table 16 depicts general background characteristics of the experiment participants. For general demographics, social value orientation, or risk aversion measure, χ^2 or F-statistics show no significant systematic difference between the treatments.

Table 13: Follower contribution – GLS individual random-effects model using treatments with leaders only.

VARIABLES	(1) Ingroup lbe	(2) Ingroup trans	(3) Intergroup lbe	(4) Intergroup trans
	Follower contribution in period t			
Contribution $t-1$	0.363^{***}	0.506^{***}	0.254^{***}	0.254^{***}
	(0.07)	(0.08)	(0.05)	(0.06)
Leader Contribution	0.324^{**}	0.180^{**}	0.395^{***}	0.515^{***}
	(0.15)	(0.08)	(0.08)	(0.07)
Other group's	-0.017	-0.003	-0.003	-0.009
contribution $t-1$	(0.01)	(0.02)	(0.02)	(0.01)
Other followers'	0.065	0.109^{***}	0.058^{*}	-0.014
contribution $t-1$	(0.06)	(0.04)	(0.03)	(0.04)
Group won in $t-1$	1.836	-2.537	-6.050	-1.819
	(2.41)	(2.61)	(4.10)	(3.01)
Riskiness of Gamble	0.049	0.349	1.622^{**}	0.894
Choice	(0.44)	(0.47)	(0.75)	(0.92)
SVO angle	-0.036	-0.055	-0.000	0.136
	(0.11)	(0.14)	(0.15)	(0.13)
Constant	21.836^{**}	8.852	7.500	21.349^{**}
	(9.57)	(10.86)	(7.89)	(9.46)
Number of observations	756	756	672	756
Number of individuals	18	18	18	18
Within model R-squared	0.169	0.197	0.187	0.318
Between model R-squared	0.914	0.976	0.786	0.768
Overall R-squared	0.477	0.514	0.334	0.437

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Bootstrapped standard errors in parentheses. *Baseline* treatment omitted.

Table 14: Transactional Leadership – GLS individual random-effects models using data from followers in groups that have won the period before (in $t-1$).

	(1)	(2)
	Ingroup trans	Intergroup trans
VARIABLES	Contribution in period t	
Prize received from	0.098^{***}	0.067^{***}
leader $t-1$	(0.02)	(0.02)
Other followers'	0.029	-0.007
contribution $t-1$	(0.09)	(0.05)
Leader contribution	-0.722^{***}	-0.465^{***}
t	(0.12)	(0.11)
SVO angle	-0.068	-0.273
	(0.23)	(0.29)
Riskiness of Gamble	-0.066	1.947
Choice	(0.87)	(1.61)
Constant	25.408^{*}	9.874
	(14.81)	(14.57)
Number of observations	378	378
Number of individuals	18	18
Within model R-squared	0.329	0.280
Between model R-squared	0.741	0.454
Overall R-squared	0.545	0.346

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Bootstrapped standard errors in parentheses.

Table 15: Leader Contribution as Function of Chat Contents – GLS random effects models.

VARIABLES	(1) Contribution Intergroup lbe	(2) Contribution Intergroup trans
Low contribution	-13.579^{***}	-21.431^{***}
	(4.78)	(4.51)
Medium contribution	4.159	6.184
	(4.17)	(6.48)
High contribution	19.000^{***}	12.809^{***}
	(5.70)	(4.25)
Alternate	-2.695	-11.283^{**}
	(12.77)	(5.20)
Bonding	9.635^{***}	1.403
	(2.37)	(2.21)
Small talk	10.012^{***}	3.410
	(3.73)	(3.78)
Understanding	-0.007	7.106^{*}
	(20.94)	(4.13)
Efficiency	-1.540	-3.861
	(2.51)	(5.76)
Followers' behaviour	5.348	5.110^{**}
	(3.37)	(2.37)
Give much to followers	0.000	11.839
	(0.00)	(7.76)
Give little to followers	0.000	-15.922^{**}
	(0.00)	(6.27)
Other	4.434	0.092
	(4.28)	(2.51)
Contribution $t-1$	0.275^{***}	0.286^{**}
	(0.09)	(0.11)
Group won $t-1$	-6.016	-23.104^{***}
	(5.49)	(7.21)
Riskiness of Gamble Choice	1.130	-1.163
	(1.43)	(1.88)
SVO angle	0.039	-0.294
	(0.41)	(0.36)
Constant	38.272^{**}	82.265^{***}
	(16.68)	(20.13)
Number of observations	224	252
Number of individuals	18	18
Within model R-squared	0.179	0.154
Between model R-squared	0.824	0.842
Overall R-squared	0.402	0.369

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Clustered standard errors in parentheses. Standard errors clustered to allow for intra-pair correlation.

Treatment	Baseline ($n = 72$)	Ingroup lbe ($n = 72$)	Ingroup trans ($n = 72$)	Intergroup lbe ($n = 72$)	Intergroup trans ($n = 72$)	χ^2 or F
Age (mean years)	21.08	20.89	21.43	20.57	20.94	1.02
Female	0.58	0.63	0.57	0.63	0.6	1.00
Riskiness of Gamble Choice	6.07	6.38	6.57	5.90	6.15	0.53
SVO angle	16.51	20.10	16.61	15.43	14.69	1.87

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

χ^2 statistic reported for difference in categorical variable between treatments; F-statistic for difference in continuous variable.

Table 16: Individual Background Characteristics

D.3 Dunn's Test Matrices

Table 17: Pairwise comparison of group contribution in period 1 by treatment (Dunn's test with Benjamini-Hochberg FDR correction). Test at individual group level

Column mean - row mean z test statistic (p-value)	Baseline	Ingroup lbe	Ingroup trans	Intergroup lbe
Ingroup lbe	-1.082 (0.233)			
Ingroup trans	-0.399 (0.383)	0.683 (0.309)		
Intergroup lbe	1.691 (0.114)	2.773^{**} (0.014)	2.09^{*} (0.061)	
Intergroup trans	-1.184 (0.237)	-0.102 (0.459)	-0.785 (0.309)	-2.875^{**} (0.02)

* p<0.10, ** p<0.05, *** p<0.01

Table 18: Pairwise comparison of leader contribution by treatment (Dunn's test with Benjamini-Hochberg FDR correction). Test at group pair level.

Column mean - row mean z test statistic (p-value)	Ingroup lbe	Ingroup trans	Intergroup lbe
Ingroup trans	-0.671 (0.301)		
Intergroup lbe	1.645 (0.15)	2.316^{*} (0.062)	
Intergroup trans	0.145 (0.442)	0.817 (0.311)	-1.499 (0.134)

* p<0.10, ** p<0.05, *** p<0.01

Table 19: Pairwise comparison of leader contribution by treatment in period 1 (Dunn's test with Benjamini-Hochberg FDR correction). Test at individual group level.

Column mean - row mean z test statistic (p-value)	Ingroup lbe	Ingroup trans	Intergroup lbe
Ingroup trans	1.132 (0.193)		
Intergroup lbe	1.778 (0.113)	0.645^{*} (0.3112)	
Intergroup trans	-0.057 (0.477)	-1.189 (0.234)	-1.834 (0.2)

* p<0.10, ** p<0.05, *** p<0.01

Table 20: Pairwise comparison of follower contribution by treatment (Dunn's test with Benjamini-Hochberg FDR correction). Test at group pair level.

Column mean - row mean z test statistic (p-value)	Ingroup lbe	Ingroup trans	Intergroup lbe
Ingroup trans	−0.268		
	(0.473)		
Intergroup lbe	2.215**	2.483**	
	(0.04)	(0.039)	
Intergroup trans	0.067	0.336	−2.148**
	(0.473)	(0.553)	(0.032)

* p<0.10, ** p<0.05, *** p<0.01

Table 21: Pairwise comparison of follower contribution by treatment in period 1 (Dunn's test with Benjamini-Hochberg FDR correction). Test at individual group level.

Column mean - row mean z test statistic (p-value)	Ingroup lbe	Ingroup trans	Intergroup lbe
Ingroup trans	0.068		
	(0.473)		
Intergroup lbe	4.683***	4.615***	
	(0.000)	(0.000)	
Intergroup trans	−0.226	−0.294	−4.909***
	(0.493)	(0.577)	(0.000)

* p<0.10, ** p<0.05, *** p<0.01