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Coopetition in group contest

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Abstract

There are situations in which competitors ally to pursue a common objective. This simultaneous presence of cooperation and competition is called coopetition and we study it theoretically and experimentally in a group contest setup. More concretely, we analyze a group contest with a new sharing rule, that we call inverse proportional. This rule embodies the idea that the more a member of a group contributes to win the contest, the less this member is able to capture the potential posterior prize, introducing thus a competitive element into group decision-making. We compare the effects of this rule with a standard, the egalitarian sharing rule. While in the egalitarian case theoretically the optimal individual contribution is positive, with the inverse proportional rule zero contribution represents the individual (and also the social) optimum. We find that participants in our experiment contribute more with the egalitarian than with the inverse proportional rule. We also document over-expenditure with the inverse proportional sharing rule, suggesting that group contest generates inefficient behavior even when individuals are extremely penalized for their contributions. We also explore the drivers of decision in the group contest, and find that contribution in a public goods game is positively associated with contribution in the group contest and that competitiveness explains part of the behavior with the inverse proportional rule but not with the egalitarian sharing. Neither social value orientation, risk attitudes, nor personal traits appear as significant predictors of behavior.

Keywords: competitiveness, egalitarian sharing rule, group contest, inverse proportional sharing rule, public goods game, risk attitudes, social value orientation

JEL classification: C72, C92, D70; D72, H41

Koopetíció csoportos versenyben

Kiss Hubert János - Alfonso Rosa-Garcia - Vita Zhukova

Összefoglaló

Vannak olyan helyzetek, amelyekben versenytársak összefognak egy közös cél érdekében. Az együttműködés és a verseny egyidejű jelenlétét koopetíciónak hívják. Mi ezt a jelenséget tanulmányozzuk elméletileg és egy kísérlet segítségével csoportos versenykörnyezetben. Pontosabban, csoportos versenyt elemzünk egy új felosztási szabály jelenlétében, amit fordítottan arányosnak nevezünk. Ez a szabály azt az ötletet testesíti meg, hogy minél többel járul hozzá egy csoporttag a verseny megnyeréséhez, annál kisebb szeletet képes megkaparintani a potenciálisan elnyerhető díjból. Összehasonlítjuk ezen szabály hatását a standard egyenlő felosztási szabállyal. Míg az egyenlő felosztás mellett elméletileg az egyéni optimum pozitív hozzájárulási szinttel jár együtt, a fordítottan arányos felosztás mellett a zéró hozzájárulás az egyéni (és egyben a társadalmi) optimum. Azt találjuk, hogy a kísérletben a résztvevők valóban magasabb hozzájárulásokat tesznek az egyenlő felosztás mellett. Azt is látjuk, hogy a fordítottan arányos felosztás mellett is megfigyelhető a túlköltekezés (over-expenditure) jelensége, azt sugallva, hogy a csoportos verseny még akkor sem vezet hatékony viselkedésre, ha az egyéneknek nagyon nem éri meg pozitív hozzájárulásokat tenni. A csoportos versenyben hozott döntések mozgatóira is kíváncsiak vagyunk és azt találjuk, hogy a közjószág-játékban tett hozzájárulások pozitívan korrelálnak a csoportos versenyben tett hozzájárulásokkal, továbbá a versengési hajlamnak is van magyarázó ereje, azonban csak a fordítottan arányos felosztás mellett. Sem a társas érték szerinti orientáció (social value orientation), sem a kockázati attitűdök, sem egyéb személyiségjegyek nem magyarázzák számottevő mértékben a döntéseket.

Tárgyszavak: csoportos verseny, egyenlő felosztás, fordítottan arányos felosztás, kockázati attitűdök, közjószág-játék, társas érték szerinti orientáció, versengési hajlam.

JEL kódok: C72, C92, D70; D72, H41

Coopetition in group contest

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Abstract

There are situations in which competitors ally to pursue a common objective. This simultaneous presence of cooperation and competition is called coopetition and we study it theoretically and experimentally in a group contest setup. More concretely, we analyze a group contest with a new sharing rule, that we call inverse proportional. This rule embodies the idea that the more a member of a group contributes to win the contest, the less this member is able to capture the potential posterior prize, introducing thus a competitive element into group decision-making. We compare the effects of this rule with a standard, the egalitarian sharing rule. While in the egalitarian case theoretically the optimal individual contribution is positive, with the inverse proportional rule zero contribution represents the individual (and also the social) optimum. We find that participants in our experiment contribute more with the egalitarian than with the inverse proportional rule. We also document over-expenditure with the inverse proportional sharing rule, suggesting that group contest generates inefficient behavior even when individuals are extremely penalized for their contributions. We also explore the drivers of decision in the group contest, and find that contribution in a public goods game is positively associated with contribution in the group contest and that competitiveness explains part of the behavior with the inverse proportional rule but not with the egalitarian sharing. Neither social value orientation, risk attitudes, nor personal traits appear as significant predictors of behavior.

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1. Introduction

Group contests are pervasive, including rent-seeking and lobbying, innovation tournaments and R&D races or sports competitions. A recent literature investigates the nature of cooperation among the group members in these contests. However, in many of these situations, members of groups are not just cooperating in order to achieve the common goal, but they are indeed competitors with opposite interests, once the prize is obtained. Cooperation and competition are two of the most studied phenomena in Economics and in many occasions both are present simultaneously, a situation termed as coopetition. In this work, we study for the first time coopetition in the group contest setup.

Consider two examples of coopetition in group contest. In cycling races, in many cases two or more cyclist break away from the peloton. To maintain their distance to the following peloton the cyclists who escaped have to cooperate, meaning that all of them have to be in front and pull (that is, to take the lead) that requires a lot of effort as the leader has to struggle more with air resistance than the followers who are sheltered from wind.[1] On the other hand, these cyclists also compete because each of them wants to win the competition and arrive first at the finish line. To win, they need to economize on efforts so they are interested in less cooperation (that is, less pulling). The more cooperative a cyclist is, the more likely it is that the escape is successful and they arrive first to the finish line, but at the same time more cooperation decreases his chance of winning the race. As a second example, consider a set of firms, that cooperate in R&D to develop some technology, but then compete for customers. The high-definition optical disc format competition is a suitable illustration. As HDTV televisions became popular in the mid-2000s, a need emerged for an inexpensive storage medium capable of holding large amounts of data for HD video. Nine leading electronic companies (e.g. Sony, Panasonic, Samsung) founded Blu-ray Disc Association, an industry consortium with the aim of developing and licensing Blu-ray Disc technology and promoting business opportunities for this standard. A similar associa-

[1] Aerodynamic drag can be reduced up to 50% for cyclist that are not in front (see Blocken et al., 2018, and references therein).

tion arose led by Toshiba (that, for instance, included Sanyo) and which was also supported by Microsoft to promote a competing format called HD DVD. Members of both associations cooperated in the development of the format (the prize being that the format becomes the accepted standard to be used all over the world), but then competed to sell players compatible with the given format to customers. Firms in such consortia dedicate part of their own resources to the development of the standard while they still have to compete for customers against their allies in the consortium. These firms face therefore a trade-off between using their resources to increase the probability of winning the format war or to increase the probability of capturing a larger share of the market. These situations where competitors cooperate to defeat another group of competitors are also present for instance in the case of chambers of commerce and federations of entrepreneurs or enterprises, where firms that cooperate to pursue a common goal are possibly competing for the same customers. Schemes of protected designation of origin which promote and protect names of quality agricultural products of a given region are also examples of coopetition. For instance, producers of gorgonzola or prosciutto cooperate to make the special produce attractive to as many customers as possible, but then the individual producers compete to serve the increased market that has been generated through the cooperation.

All these situations have the common characteristic that a cooperative behavior is needed to achieve a goal as a group but at the same time it lowers the resources / capacity to compete. We explore behavior in these coopetitive environments using the well-studied group contest setup. In group contests several groups compete to obtain a prize. To put simply, the group whose members make the most effort has the greatest probability to win the prize. In the extant literature on group contest, the prize is typically split up either with an egalitarian (everybody in the winning group receiving the same share of the prize) or with a proportional (members of the winner group receiving a share that is proportional to their contribution to the group effort) rule. In this paper, we introduce a new sharing rule that we term *inverse proportional*, expressing the idea that the less a member of the winning group contributed to the group effort to win the prize, the (proportionally) higher share she receives from the prize. Inverse proportionality captures the trade off faced in coopetitive setups: the more an agent spends on cooperation, the less resource she has to obtain a higher share from the prize (if her group wins it). Note that competition is present at two levels. At the group level, each member of the group is interested in defeating the other group, hence in a high overall effort, while at the individual level, each individual is interested in capturing a higher share of the prize, hence in a low individual effort. In our previous examples, cyclists in the leading group are interested that there is always somebody who takes the lead and pulls to maintain the distance to the peloton, while the group of firms favouring a special format is interested to make it dominant in the market, but at the same time cyclists and firms want to defeat also the other members of their group by economizing resources spent on cooperation.[2]

The group contest literature has consistently found overexpenditure in these situations. In particular, it has been found that under the egalitarian rule individuals contribute much more than the positive contribution that the Nash equilibrium of the game predicts. Even though a declining pattern of contributions is observed when the game is repeated, even after several repetitions over-expenditure persists. It suggests that the group contest structure generates this over-expenditure. To test if this is the case, we study how the inverse sharing rule affects behavior. The theoretical analysis of group contest with an inverse proportional sharing rule shows that individuals maximize their payoff making a zero contribution to the group performance. Moreover, zero contribution is also the social optimum. This is a strong prediction that we test in the laboratory, analyzing both if this different sharing rule has an effect on contribution as well as if over-expenditure remains even in the extreme case where zero contribution is always optimal from an individual point of view. In two sessions, both with 14 four-member groups, we investigate behavior in group contest with egalitarian and inverse proportional sharing rule. Moreover, after the group contest we have the participants play additional games to measure their social attitude, risk preferences, cooperativeness and competitiveness, as well as an extensive questionnaire capturing personal traits. Our aim with these games and tasks is to better understand what drives choices in the group contest, and well as what drives differences in behaviors between cooperative and coopetitive environments.

We find a sizable and significant difference in efforts, contributions being much lower under the inverse proportional rule, as expected. We also report over-expenditure with the inverse sharing rule, although zero contribution is

[2]Bouncken et al. (2015) claim that "While coopetition may combine the best of both worlds of cooperation and competition, there is still an inherent paradox, given the possible tension between value creation and capture." Our sharing rules represent different degrees of this inherent tension.

always individually optimal. When relating behavior in contest with other situations, we find that contributions in a public good game are positively associated with contribution in the contest, independently of the sharing rule. Competitiveness, measured á la Niederle and Vesterlund (2007) explains part of the behavior in the coopetitive environment, but not in the cooperative one. Finally, we do not find any effect of neither social value orientation, risk aversion nor personality traits which seem to have no role in explaining behavior in these environments.

1.1. Literature review

In this section, first we briefly speak about the coopetition literature in management, then we review the main findings of the group contest literature that is related to our theoretical predictions and the role of members' heterogeneity in contribution in the framework of group contests.[3]

1.1.1. Coopetition in management

There is a vast literature in management on coopetition, so we briefly review the main findings that are related to our paper.[4] In the management literature, coopetition has been described and analyzed in many industries and services, such as petrochemicals (e.g. Tsai, 2002), retailing (e.g. Kotzab and Teller, 2003; Martinelli and Sparks, 2003), maritime logistics (e.g. Song and Lee, 2012), engineering and technology (e.g. Carayannis and Alexander, 2001; Carfì and Schilirò, 2012; Chin et al., 2008; Gnyawali and Park, 2009; Gueguen, 2009; Quintana-Garcia and Benavides-Velasco, 2004; Shih et al., 2006; Salvetat and Géraudel, 2012), transportation (e.g. Gwynne, 2009; Lin et al., 2017), finance and insurance (e.g. Czakon et al., 2009; Okura, 2007), tourism (e.g. von Friedrichs Grängsjö, 2003; Wang and Krakover, 2008), health care (e.g. Peng and Bourne, 2009).

Bouncken et al. (2015) lists the following motives to pursue coopetition: to gain market power (e.g. Gnyawali and Park, 2011; Ritala et al., 2009; Rusko, 2011), to foster innovation (Brolos, 2009; Ritala and Hurmelinna-Laukkanen, 2009), to promote supply chains (e.g. Bakshi and Kleindorfer, 2009; Wilhelm and Kohlbacher, 2011) and as a strategy in global competition (e.g. Luo, 2007; Gnyawali and Park, 2011). Therefore, these motives can be

[3]Henceforth, we use effort and contribution in an interchangeable manner.

[4]Bengtsson and Kock (2014); Bouncken et al. (2015); Dorn et al. (2016); Walley (2007) are good surveys about this literature.

seen as the goals of the group. The benefit of coopetition may be win-win situations in which the parties involved end up with lower costs. Dorn et al. (2016) find that coopetition is more likely to arise in industries that are at a very early or mature stage of the market lifecycle. The major risk of coopetition according to this literature is opportunistic behavior Levy et al. (2003); Baumard et al. (2009); Bouncken and Kraus (2013); Pellegrin-Boucher et al. (2013); Cassiman et al. (2009).

Related to the benefits and risks of coopetition, a recurring topic in the management literature on coopetition is the inherent tension between cooperation and competiton. The first one requires a friendly mindset, while the latter provokes a hostile attitude, two strongly opposing logics (e.g. Bello et al., 2010; Bunge, 1989; Das and Teng, 2000). Many studies emphasize the importance of balancing competition and cooperation (e.g. Bengtsson and Kock, 2000; Cassiman et al., 2009; Das and Teng, 2000; Osarenkhoe, 2010), but little is known on how an optimal balance can be achieved. Park et al. (2014) find that moderately high competition and high cooperation represents an optimal coopetition balance. Our findings clearly suggest that our setup with the inverse proportional sharing rule generates too much competition that leads to a lower cooperation level than the egalitarian rule.

The management literature distinguishes different levels of coopetition. Thus, coopetition may take place on the individual level (e.g. Enberg, 2012), within the firm (for instance Tsai, 2002; Luo et al., 2006) or on a team level (e.g. Baruch and Lin, 2012; Ghobadi and D'Ambra, 2012), between firms (for example Bouncken and Kraus, 2013; Quintana-Garcia and Benavides-Velasco, 2004) or on a network level (e.g. Peng and Bourne, 2009; Mantena and Saha, 2012). Note that our motivating examples and the idea behind our study is a combination of the different levels. It is not simply that groups compete and cooperate at the same time, but there is also a within-group competition going on. Combining intrafirm coopetition with interfirm competition would yield such a scenario, but we are not aware of any analysis that investigates such a setup.

Related to the management literature on coopetition, using classic experimental games Devetag (2009) studies how coordination and trust may affect coopetitive processes, while Rossi and Warglien (2009) investigate how fairness and reciprocity determine coopetition in a firm. Lacomba et al. (2011) study experimentally coopetition on the individual level, using the repeated prisoner's dilemma game. Thus, there is some experimental work on coopetition, but they do not study on a group level and use different games.

1.1.2. Over-expenditure of effort

A general finding in the group contest literature both in the field (e.g. Erev et al., 1993) and in the laboratory (e.g. Nalbantian and Schotter, 1997; Van Dijk et al., 2001) is that with proportional or egalitarian sharing rule contests between groups lead to high individual effort and little free-riding. More recent experimental studies (Abbink et al., 2010; Ahn et al., 2011; Cason et al., 2012, 2017; Leibbrandt and Sääksvuori, 2012; Ke et al., 2013, 2015; Eisenkopf, 2014; Sheremeta, 2011; Brookins et al., 2015; Bhattacharya, 2016; Chowdhury et al., 2016) also consistently find that average effort level (though often showing a declining pattern) is significantly higher than the equilibirum prediction. Sheremeta (2013) reports based on 30 studies that the median over-expenditure is 72%. Several explanations for the over-expenditure of effort have been proposed. Sheremeta (2010); Price and Sheremeta (2011, 2015); Cason et al. (2018) show that the pure joy of winning may explain part of the over-expenditure. Bounded rationality (Fallucchi et al., 2013; Chowdhury et al., 2014; Lim et al., 2014) and relative payoff maximization (Mago et al., 2016) also have some explanatory power when we try to understand over-expenditure. Sheremeta (2018a) shows that individual characteristics (impulsiveness and cognitive abilities) may also affect expenditure on effort.

A different set of explanations involve social preferences. More concretely, in social dilemma and collective action games, participants often contribute more to the public account than predicted by standard game theory based on the idea of *homo economicus*, (see, for instance Chaudhuri, 2011). Theories based on social preferences like altruism (e.g. Andreoni, 1990), fairness (e.g. Rabin, 1993) or inequality aversion (e.g. Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000) offer potential explanation for such behavior and it is natural to think that such social preferences may be at work towards other members of the group.[5] Relatedly, social identity theory (Tajfel and Turner, 1979) that proposes that a strong group identity may blur the differences between individual and group interests is another potential explanation. Chowdhury et al. (2016) provides experimental evidence that social identity is in fact

[5]A related explanation (called parochial altruism) goes further and besides altruism toward in-group members claims the existence of hostility toward members of the rival group. However, such hostility toward out-group subjects is not very common (Halevy et al., 2008; Yamagishi and Mifune, 2016; Abbink et al., 2012).

important to understand the effort level that players choose in group contest.

Our contribution to this issue is to see if over-expenditure holds with the inverse proportional sharing rule.

1.1.3. Heterogeneity in behavior

While the theoretical predictions are based on symmetry, in real life individuals differ in a myriad of ways that may affect their behavior. In most experimental studies on group contest some degree of heterogeneous behavior can be observed. For instance in Abbink et al. (2010), on average, the most contributing group member expends three times more effort than the least contributing member.[6] We do not only observe heterogeneity on the individual level, but also on the group level. In Abbink et al. (2010), for instance, the most competitive group made six times more effort than the least competitive group. Note that this difference is substantially higher than the individual difference, so individual heterogeneity is probably not enough to explain these group-level differences. Parochial altruism and social identity theory are natural candidates for explaining at least partially the differences.

Besides the principal aim to see if behavior is different under the egalitarian and the inverse proportional rule, another objective of this study is to investigate which individual characteristics and to which extent associate with differences in individual behavior. Sheremeta (2018a) pursues the same goal studying individual contests. He elicits loss and risk aversion, cognitive abilities and impulsiveness. He shows that cognitive abilities affect overbidding, but impulsiveness has an even larger predictive power.

2. Model

We present briefly the structure of group contest, relying heavily on the survey by Sheremeta (2018b).[7] There are two groups that compete to win a contest and receive a prize v. There are N_A / N_B players in group A / B. Players in both groups choose simultaneously and independently a level of effort x_{iA} and x_{jB} that is irreversible and the effort entails heterogeneous

[6] Theoretically, the existence of asymmetric equilibria may explain why we observe different levels of effort, (see, for instance Baik, 1993, 1994).

[7] Konrad et al. (2009); Flamand et al. (2015); Gavrilets (2015) also provide a nice introduction to the theory of group contest.

costs $c_{iA}(x_{iA})$ and $c_{jB}(x_{jB})$, for all $i = 1, ..., N_A$ and $j = 1, ..., N_B$. In our experiment groups are composed by four individuals ($N_A = N_B = 4$).

The performance of group A / B, denoted as X_A / X_B is a function of all individual efforts within the given group. For instance, for group A

$$X_A = f_A(x_{1A}, ...x_{1N_A}) \tag{1}$$

The most widely used function in the literature assumes perfect substitution

$$f_A(x_{1A}, ...x_{1N_A}) = \sum_{i=1}^{N_A} x_{iA}. \tag{2}$$

This function describes nicely real-life situations in which the performance of the group hinges on the joint effort of all individuals of the group.[8] We also use this perfect-substitute function in both treatments. As of costs of effort, for simplicity we assume homogeneous linear costs, that is $c_{iA}(x) = c_{jB}(x) = x$ for all $i = 1, ..., N_A$ and $j = 1, ..., N_B$.

The probability of winning the contest depends on the relative performance of the groups. A contest success function (CSF) determines the probability that group A wins the prize:

$$p_A(X_A, X_B) = \frac{(X_A)^r}{(X_A)^r + (X_B)^r} \tag{3}$$

The parameter $r \geq 0$ represents the sensitivity of the probability of winning to the ratio of group performances. One of the most used CSF is when $r = 1$. In this case (often called the lottery case) higher performance implies linearly higher winning probabilities. We use also the lottery CSF in both of our treatments.[9]

Up to this point we follow the literature and use a known performance functions and CSF parameter. Our main modification is in the way the prize is split. In the literature, a general way to capture the division of the prize is the following. In the case group A wins the prize, player i receives a share of the prize which is defined by the following sharing rule (e.g. Nitzan, 1991)

$$s_{iA}(x_{1A}, ...x_{N_AA}) = \frac{\alpha_A}{N_A} + (1 - \alpha_A)\frac{x_{iA}}{\sum_{i=1}^{N_A} x_{iA}}. \tag{4}$$

[8]When group performance depends on the best / worst performer within the group, then other functions are more suitable.

[9]An alternative and often used possibility is the auction case ($r = \infty$), when the group with the highest performance wins the contest with certainty.

In words, share α_A of the prize is split equally among all members of the winning group, and the rest $(1-\alpha_A)$ is divided according to relative effort. Complete egalitarian division occurs if $\alpha_A = 1$, while if $\alpha_A = 0$, then the prize is split completely in proportion to relative effort. In our egalitarian treatment we use the complete egalitarian division, corresponding to $\alpha_A = 1$. For the other treatment, we propose a new sharing rule that states that the share of the prize that a member receives is inversely proportional to relative effort. More concretely, the less effort a member makes, the more she receives proportionally from the prize. We define the inverse proportional share in the following way:

$$s_{iA}(x_{1A}, ...x_{N_A A}) = \frac{\frac{1}{x_{iA}}}{\sum \frac{1}{x_{iA}}} \quad \text{if} \quad x_{iA} > 0,$$

$$\text{s}_{iA}(x_{1A}, ...x_{N_A A}) = \frac{1}{card(x_{iA}=0)} \quad \text{if} \quad x_i = 0 \quad \text{and} \quad \sum \frac{1}{x_{iA}} > 0,$$

(5)

where $card(x_{iA} = 0)$ denotes the cardinality of players in group A who contributed zero. In words, when player i in group A contributes a positive amount then she receives the inverse proportional share. However, for $x_{iA} = 0$ the expression is not well-defined, but by the logic of the sharing rule, in that case player i receives all the prize if the other members of the group contributed a positive amount, and shares the prize equally with those who also contributed zero. If nobody contributes ($\sum \frac{1}{x_{iA}} = 0$) and the group wins the contest (in the very unlikely case when nobody contributes in the rival group either and the prize is allocated randomly to one of the groups), then the prize is split equally.

To illustrate the effect of sharing rules consider the following example. Suppose a group with subjects A,B,C and D who made the following efforts 1,2,4 and 4, respectively. In the egalitarian treatment, upon winning the contest all of the members would receive $\frac{1}{4}$ of the prize. However, the inverse proportional rule gives four / two times as much share from the prize to subject A / B, than to subjects C and D who receive the same share. The formula above yields the following shares: $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$ and $\frac{1}{8}$ respectively to subjects A, B, C and D.

Given perfect substitution in the performance function, homogeneous linear costs, a lottery contest success function ($r = 1$), equal group sizes

($N_A = N_B = N$) and the egalitarian sharing rule, the expected payoff of a risk-neutral player i in group A can be written as:

$$\pi_{iA}(x_{1A}, ...x_{NA}, X_B) = \frac{\sum_{i=1}^{N} x_{iA}}{(\sum_{i=1}^{N} x_{iA} + \sum_{j=1}^{N} x_{jB})} \frac{1}{N} \upsilon - x_{iA} \tag{6}$$

The first term of the expected payoff represents the expected benefit of contributing effort x_{iA}. Higher effort of player i in group A increases the probability of group A winning the contest, but yields the same share of the prize ($\frac{1}{N}$) for all members of group A (if this group wins the contest). Cost is captured by the second term. Hence, there is an inherent tension, because player i has an incentive to cooperate with other members of his group, but given the cost of cooperation, there is also an incentive to free ride.

In the unique symmetric Nash equilibrium with the egalitarian sharing rule,

$$x_{1A}^* = .. = x_{iA}^* = .. = x_{NA}^* = \frac{\upsilon}{4N^2}. \tag{7}$$

Appendix A.1 contains the details of the proof following the line of reasoning by Katz et al. (1990).

If we use the inverse proportional sharing rule, then the expected payoff of a risk-neutral player i in group A can be written as:

$$\pi_{iA}(x_{1A}, ...x_{NA}, X_B) = \frac{\sum_{i=1}^{N} x_{iA}}{(\sum_{i=1}^{N} x_{iA} + \sum_{j=1}^{N} x_{jB})} \frac{\frac{1}{x_{1A}}}{\sum \frac{1}{x_{1A}}} \upsilon - x_{iA} \tag{8}$$

On the other hand, the unique Nash equilibrium under the inverse proportional sharing rule implies:

$$x_{1A}^* = .. = x_{iA}^* = .. = x_{NA}^* = 0. \tag{9}$$

In Appendix A.2 we show that given this rule, zero effort is the dominant strategy for each individual, so in the unique Nash equilibrium members of the group contribute zero. Note that under this rule, the Nash equilibrium in dominant strategies coincides with the socially efficient outcome: since there is a fixed prize in the contest, it is socially efficient not to contribute anything. While this efficient outcome is common in group contests, inverse proportional sharing rule is the only one in which individual and social optima coincide.

The previous predictions are based on the following assumptions: i) players have identical valuations about the payoffs and winning the contest; ii) players maximize their individual utility without regard to the team's interest; and iii) players are risk-neutral. Hence, deviations from the predictions may be due (at least partly) to the fact that these assumptions do not hold.

3. Hypotheses

Over-expenditure of effort and heterogeneity of behavior can be affected by the structure of the game. Therefore, group size, the group performance function or the contest success function can influence how subjects behave in group contest. In this study we focus on the role of the sharing rule and on individual heterogeneity.

Prior to running the experiment, we registered it at the Open Science Foundation (https://osf.io/93aus/). Next, we state the hypotheses as we registered them and provide support for formulating those hypotheses based on the literature. Our hypotheses can be grouped in two sets. Hypothesis 1 refers to the treatment effect and conjectures lower contributions in the inverse proportional treatment than in the egalitarian treatment. The second set of hypotheses refer to how different individual characteristics (measured in phases 2-5 of the experiment) may affect individual contribution in the group contest.

Hypothesis 1 (egalitarian vs. inverse proportional prize sharing): We expect that contributions will be significantly lower in the treatment with the inverse proportional prize sharing than in the treatment with the egalitarian rule.

Most experiments use the egalitarian rule (for instance Nalbantian and Schotter, 1997; Abbink et al., 2010, 2012; Ahn et al., 2011; Sheremeta, 2011; Cason et al., 2012, 2017). Note that even this rule provides incentives for free-riding, because a participant would receive the same share of the prize upon making zero contribution than other members of the group who exerts a positive level of effort. An evidence of such possible free-riding is provided by the comparison of the egalitarian and the proportional sharing rule. Amaldoss et al. (2000); Gunnthorsdottir and Rapoport (2006) and Kugler et al. (2010) compare the effect of egalitarian and proportional sharing rule on behavior in group contest. The general finding is that the proportional sharing rule leads to higher individual efforts than the egalitarian rule. Since the inverse proportional sharing rule provides more incentives to free-ride than the egalitarian rule, we expect that under the former rule individual efforts will be significantly lower than under the latter one as stated in our Hypothesis 1.

Note that hypothesis 1 is silent about over-expenditure because theory does not inform on if participants will contribute more than predicted by the theory. We had no strong conviction based on the literature if over-expenditure would be found in case of the inverse proportional sharing rule, so we did not formulate it as a hypothesis.

Hypothesis 2 (level of contribution and social value orientation): We expect to see correlation between the classification according to social value orientation and contribution in the group contest.

Social value orientation classifies participants into one of the following categories (e.g. Murphy et al., 2011): altruist, prosocial, individualistic or competitive. The nomenclature already suggests that the classification is based on how much a participant cares about others. Often the first two categories are lumped into one called prosocial, while the others two are called proself.

There are many studies showing that the classification correlates with behavior in the expected manner. Balliet et al. (2009) and Bogaert et al. (2008) are two meta-studies that show that social value orientation correlates with cooperation in social dilemmas, altruist and prosocial individuals behaving in a more cooperative manner than individuals classified as individualists or competitors. Importantly, there are several studies indicating that proself individuals are less cooperative in the public goods game (e.g. Parks, 1994; Offerman et al., 1996; De Cremer and Van Vugt, 1999; De Cremer and Van Lange, 2001; De Cremer and Van Dijk, 2002; Smeesters et al., 2003). Field studies also reveal that proself individuals behave differently from prosocial individuals. For instance McClintock and Allison (1989) show that prosocial individuals exhibit more helping behavior than proself ones. The same is found in case of proenvironmental initiatives (Joireman et al., 2001) or choice between public transportation vs. commuting by car (Van Vugt et al., 1995, 1996). Therefore, based on the literature, it is natural to think that altruist and prosocial participants tend to contribute more to the performance of the group than individualistic or competitive subjects.

Hypothesis 3 (level of contribution and risk aversion): We expect that the more risk averse an individual is, the less she contributes in the group contest, *ceteris paribus*.

There are studies showing that risk attitudes correlate with contribution in public goods game (Sabater-Grande and Georgantzis, 2002; Lange et al., 2007; Charness and Villeval, 2009; Gangadharan and Nemes, 2009), more risk averse individuals contributing less. Several studies have shown that risk has many facets and the different aspects affect in different ways contributions in public goods experiments. A basic distinction is often made between strategic uncertainty (sometimes also called social risk) and risk related to random events that are independent of human decisions and is termed as natural risk or environmental uncertainty.[10] Interestingly, Kocher et al. (2015) show that while beliefs about others' cooperation (that is, strategic uncertainty) affects contribution to the linear public good in the expected positive way, risk aversion measured á la Holt and Laury (2002) that captures natural risk does not explain cooperation. However, there are papers (Wit and Wilke, 1998; Au, 2004) studying mainly step-level public goods games that show that both types of risk affect contribution levels. However, in these papers the environment of the decision is varied and the average level of cooperation is investigated. We consider the effect of the environment (notably, the sharing rule), but we focus also on the association between individual-level risk attitudes and contribution.[11]

Contribution to the group performance is risky because winning the prize depends on how much the other members contribute and the total contribution of the other group. These are factors beyond the control of the subjects and represent a source of uncertainty. Not contributing to the group performance lowers the probability of winning the prize but increases the amount of earnings because the money not contributed is a certain earning for the participants. Since due to the contest nature contribution is even more risky than in a simple public goods game, we hypothesize that anything else being equal more risk aversion associates with less contribution.

[10]There is some evidence that individuals' perception of these two types of risk is correlated (e.g. Bohnet et al., 2008).

[11]Wit and Wilke (1998) show that both type of risks and their interaction influence contribution in the public goods game. Moreover, Au (2004) finds that environmental uncertainty also affects contribution: in environments with less uncertainty, contributions were higher. Suleiman et al. (2001) and McBride (2010) show that outcomes in step-level public goods games are sensitive to the threshold and other parameters of the experiment.

Hypothesis 4 (level of contribution and cooperativeness): Contribution in the coopetition task and in the public goods game are expected to correlate positively.

In the group contests that we study there is a tension between individual and group interests. Contributing more to the group performance increases the probability of winning, but lowers the individual earning, *ceteris paribus*. This conflict is more pronounced in the case of the inverse proportional treatment than in the egalitarian case. Contribution to the public account in the public goods game is regarded as a proxy for cooperativeness (e.g. Chaudhuri, 2011). Peysakhovich et al. (2014) show convincingly that on the individual level decisions in different cooperation games are strongly correlated, moreover they find evidence for temporal stability, suggesting that there is a domain-general inclination towards cooperation. Hence, it is natural to think that those participants who are more cooperative in the public goods game, will be more cooperative in the group contests as well, independently of the sharing rule.

Hypothesis 5 (level of contribution and competitiveness): There is competition on two levels. Groups compete against each other, but on the individual level there is a competition between the members of the same group. If the group competition motive dominates, then the individuals who are more competitive are expected to contribute more. If the competition on the individual level is stronger than the group competition, then we expect the opposite to happen. Hence, we expect to see an effect of competitiveness, but we do not have strong expectations on the direction.

The formulation of hypothesis 5 suggests that in terms of competitiveness we carry out a rather exploratory investigation.

4. Experiment

We had two treatments corresponding to the different sharing rules. We ran a session per treatment. In each session, the experiment consisted of five phases plus the questionnaire. In both treatments, phase 1 corresponded to the group contest, while later phases represented experimental games to gather information about the participants' characteristics. More concretely, in phase 2 we measured social attitudes using the social value orientation, in phase 3 we used the public goods game to measure cooperativeness. Phase 4 served to elicit risk preferences and in phase 5 we measured competitiveness á la Niederle and Vesterlund (2007).

We made clear to participants that their final payoff will be the sum of two payoffs plus the show-up fee. We explained that they will be paid for their performance in phase 1 (the group contest) and from the other 4 phases the computer would pick randomly one and that phase will be paid. We also informed the participants that during the phases they will earn tokens that at the end will be converted into Euros and we stated that the exchange rate may change between phases, but in any case more tokens imply more Euros.[12]

We also let subjects know that after the 5 phases there will be a questionnaire and after finishing the questionnaire they would be paid in private.

4.1. Group contest

In this phase, first groups of four subjects were formed randomly and anonymously. There were 14 groups of 4 individuals in each session. This phase consisted of 20 rounds. Groups were fixed for the 20 rounds and each group played against another group, called rival group, such that the pair of rival groups was also fixed across all experimental rounds (as, for instance in (Abbink et al., 2010)).

At the beginning of each round, each subject received 1000 tokens that she could use to buy competition tokens for her group, one competition token costing one token. The tokens not used for buying competition tokens remained on the account of the subject. Subjects knew that the other members of the group started also with the same endowment and could buy competition tokens as well.

After each round, the amount of the competition tokens a group had accumulated determined the chance of winning the contest. More concretely, imagine groups A and B. Suppose that members of group A / B have bought 1000 / 2000 competition tokens. Then, group B had twice as high probability of winning the contest (2/3) than group A (1/3). In other words, the probability of winning the contest was proportional to the total competition tokens of a given group divided by the competition tokens of both groups. A wheel of fortune determined which group won the contest in the following

[12]We changed the exchange rates between tasks in a way that in expected terms the payoffs in the different phases be equal.

way. Following the previous example, two thirds of the wheel would belong to group B and the rest to group A, and after spinning the wheel the winner is the group over whose territory the pointer of the wheel stopped. We made clear that the probability of winning increased in the number of competition tokens.

The group that won the contest received a prize of 4000 tokens. We had two treatments that differed in the way the prize was split within the winning group. In the *egalitarian* treatment, each member of the winning group received the same amount of the prize, that is 1000 tokens. In this treatment the payoff of any member of the winning group is the sum of the tokens that the participant did not use to buy competition tokens and the 1000 tokens won as a prize. The payoff of a subject in the loser group is just the amount of tokens not used to buy competition tokens. For instance, if a participant uses 350 tokens from her initial endowment of 1000 tokens to buy competition tokens and her group wins the contest, then her final payoff is (1000-350)+1000=1650 tokens. If the other group wins, then her payoff is just 1000-350=650. In the *inverse proportional* treatment, the less competition tokens a member of the winning group bought, the higher is her share from the prize. In the instructions we explained the division of the prize in this treatment using the following example. Assume a group that consists of subjects A,B,C and D who have bought 100, 200, 400 and 400 competition tokens, respectively. Suppose that this group wins the contest. Subjects C and D bought the same amount of competition tokens, so their payoff from the prize will be the same. Subject A and B bought just $\frac{1}{4}$ and $\frac{1}{2}$ of the amount bought by subjects C and D, hence their payoff from the prize will be four times and twice as much as the payoff of subjects C and D. That is, A / B / C / D would receive 2000 / 1000 / 500 / 500 tokens from the prize. In turn, it implies that in this round the payoff of A is (1000-100)+2000=2900, the payoff of B is (1000-200)+1000=1800, while C and D would receive (1000-400)+500=1100 tokens, both. As in the other treatment, if the other group wins, then the group receives no prize and the final payoff equals the initial endowment minus the tokens used to buy competition tokens, that is A / B / C / D receives 900 / 800 / 600 / 600 tokens.

In both treatments at the end of each round, each participant obtained the following information

- the number of competition tokens that she bought;

- the total number of competition tokens that the group accumulated;
- the total number of competition tokens that the rival group accumulated;
- whether the group the participant belongs to is the winner group;
- individual's payoff in the round, expressed in tokens.

In both treatments, earnings in this phase consisted of the sum of the payoffs of 5 randomly chosen rounds as, for instance, in Chowdhury et al. (2014, 2016). Subjects knew that their earnings would be converted into euros at the end of the experiment at the following exchange rate: 1000 tokens = 1.2 euros.

At the end of the phase, each participant was provided the information on the five rounds randomly chosen to be paid to the participant and on individual's payoff per phase in tokens and in euros.

4.2. Other phases

The rest of the phases was the same in both treatments. In phase 2 we measured social preferences using the social value orientation. There are various ways to measure social value orientation, we followed Murphy et al. (2011). Participants were randomly paired and each of them had to make 6 decisions. In each decision, subjects saw 9 payoff allocations, each allocation containing a payoff for the decision-maker and a payoff for her co-player. The decision-maker had to choose in all 6 decisions her preferred joint payoff distribution. Choices can be scored to come up with a single score. Social value orientation conceptualizes four idealized orientations:

- altruists maximize the allocation for the other party;
- prosocial individuals tend to maximize their own payoffs, but care also about the other player's payoff;
- subjects with individualistic tendencies are not concerned about the other player, they just maximize their own payoffs;
- competitive individuals attempt to maximize their own payoffs, but at the same time also minimize the other player's payoff.

The score achieved after choosing the 6 allocation allows to classify participants in one of the above categories. Participants knew that if at the end of the experiment this phase would be chosen for payment, then the computer would pick one of the six decisions and would randomly choose one of the participants in each pair (called the elector) and the allocation chosen by the elector in the given decision would be paid. The exchange rate used for payment was 1 token = 0.02 Euros.

Phase 3 consisted of a one-shot play of the public goods game. We aimed to measure cooperativeness with this game. We presented the most widely used format of the public goods game, with four players, each of them endowed with 1000 tokens. Participants had to decide how much of the endowment to assign to a public account, knowing that everybody in the group would receive 40% of the total amount assigned to the public account (that is, marginal per capita return = 40%). The final earning of a subject consisted of the amount not assigned to the public account and the amount received from the public account. The exchange rate used for payment was 1 token = 0.02 Euros.

Phase 4 served to elicit risk attitudes using the bomb risk elicitation task (Crosetto and Filippin, 2013).[13] Participants are presented the following situation. There is a store with 100 boxes, one of them containing a bomb. The bomb can be in any of the boxes with the same probability. Subjects have to decide how many boxes they want to take out of the store. For each box taken out that does not contain the bomb, they receive money (1 token), but if the bomb happens to be in one of the boxes that have been taken out, then their payoff in this task is zero. We explained that if for example they decide to take out 7 boxes and the bomb is in box 42, then they would earn 7 tokens. However, if the decide to remove 56 boxes from the store and the bomb is in box 51, then their earnings is zero. We informed participants that if at the end of the experiment this task is the payoff-relevant task, the the exchange rate would be 1 token = 0.1 Euros.

In phase 5, we measured participants' competitiveness using the Niederle-Vesterlund experimental procedure (Niederle and Vesterlund, 2007). The only modification compared to the original study is that we used the slider

[13] Crosetto and Filippin (2016) compare four risk elicitation methods, among them the bomb risk elicitation task. They show the pros and cons of each method and argue convincingly that the bomb risk elicitation task is appropriate to distinguish between subjects based on their risk attitudes.

task (Gill et al., 2011; Gill and Prowse, 2018) instead of adding up numbers as experimental task. Following Niederle and Vesterlund (2007), this phase consisted of 4 subphases. In subphase 1, subjects performed the slider task (positioning as many sliders on the number 50 as they could in a minute) knowing that they would be paid on a piece-rate basis, earning 1 token for each correctly positioned slider. We also explained that if at the end of the experiment this task would be chosen for payment, then the exchange rate would be 1 token = 0.15 Euros. In subphase 2, before playing again the slider task, groups of 4 members were formed randomly and we informed participants that they would be paid as in a tournament. More concretely, we told them that only the member of the group with the highest number of correctly placed sliders receives a payoff, but she receives 4 tokens for each correctly positioned slider.[14] We used the same exchange rate as before. We also informed subjects that they would not know the result of the tournament until the end of the phase. In subphase 3, we explained that they would perform again the slider task and that they could choose the way to be compensated: piece-rate payment as in subphase 1 or tournament payment as in subphase 2. Hence, we have a binary classification: participants are either competitive (if they choose the tournament) or not competitive (if they choose the piece-rate scheme). As before, we explained that we would not tell them the result of the tournament until the end of the phase. We applied the same exchange rate here as in the previous subphases. In subphase 4, participants were not required to perform the task again, but could earn money by choosing an incentive scheme (piece rate vs. tournament) to be applied to their performance in subphase 1. We reminded participants about the number of correctly positioned sliders in subphase 1. We used the same exchange rate as in the previous subphases. This subphase allows us to see what participants believed about their relative performance. Participants knew that if phase 5 would be paid at the end of the experiment, then one of the subphases would be chosen randomly and earnings in that subphase would be paid.

At the end of the experiment, subjects had to fill in a questionnaire. We elicited socio-demographic information (age, gender, educational attainment, field of study, knowledge of languages, number of siblings, education

[14]We also explained that in case of a tie, the computer randomly would select one of the members with the highest number of sliders correctly positioned.

and employment of the breadwinner in the family, number of persons in the household, factors related to family income), biological features (height, weight, dexterity: left- vs right-handed, and the digit ratio).[15] We also measured cognitive abilities with a 5-item version of the Cognitive Reflection Test (Frederick, 2005; Toplak et al., 2014). We used a 10-item version of the Big Five test (Rammstedt and John, 2007) to elicit personality traits and the Rosenberg test (Rosenberg, 1965) to measure self-esteem . We also asked participants if they were happy in general.

4.3. Procedures

There were two sessions corresponding to the two treatments in July, 2018 in the laboratory of LINEEX (Valencia, Spain). In both sessions, there were 56 individuals. In the egalitarian / inversely proportional treatment 39.3% and 66.1% of the subjects were females.

Sessions lasted about two hours and participants earned on average 18 Euros. There were subjects studying Economics or Business, but 36% studied social sciences, 22% engineering and architecture, 16% health sciences, and 5% arts and humanities.

5. Results

5.1. Descriptive statistics

Figure 1 shows the average effort per period in the two treatments. Visual inspection strongly suggests that there is a treatment effect because in the egalitarian treatment average effort is considerably higher in each period (except period 1) than in the inverse proportional treatment.

The average effort in the egalitarian / inverse proportional treatment is 332.3 / 124.8, efforts being more than 2.5 times larger in the egalitarian treatment than in the inverse proportional one, on average. The same averages over the first / second / third and last 5 rounds are 353.3 / 183.8 (92% more effort in the egalitarian treatment) for the first, 371 / 129.5 (186% more

[15]We gathered information on participants' digit ratio since we believed that there might be some relationship between digit ratio and decisions in the group contest. There is a growing literature indicating that digit ratio associates with several individual characteristics, such as competitiveness, social preferences, and risk aversion among other domains of economic interest (Brañas-Garza et al., 2013, 2018; Garbarino et al., 2011; Millet and Dewitte, 2006; Pearson and Schipper, 2012)

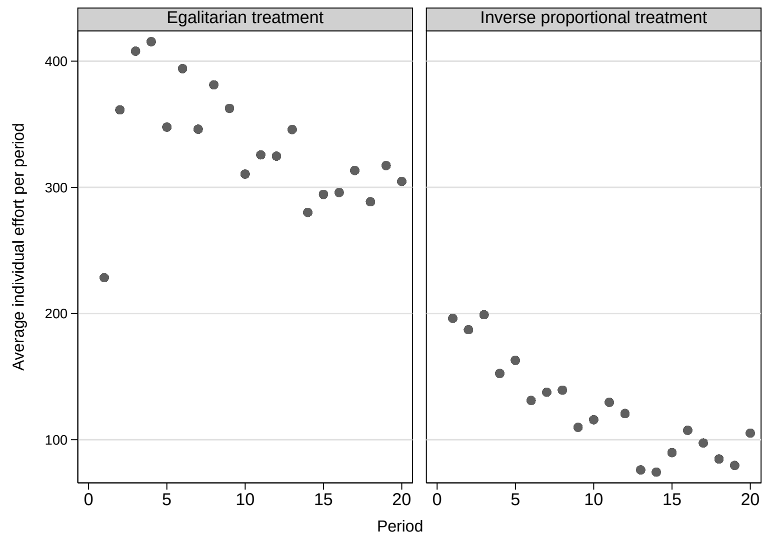

Figure 1: Average effort per period

effort in the egalitarian treatment) for the second, 319.1 / 100.2 (218% more effort in the egalitarian treatment) for the third and 303.8 / 92.3 (229% more effort in the egalitarian treatment) for the last 5 rounds.

The two-sample Wilcoxon ranksum test confirms what we see, as for all periods except period 1 there is a significant difference in the effort made between the two treatments ($p<0.001$ in all cases). If we do not distinguish between periods and pool all the efforts together, we observe a significant difference using the same test ($p<0.001$). In both treatments we observe a marked downward trend. However, even in the last 5 periods in the egalitarian treatment efforts are higher than in the first 5 periods in the inverse proportional treatment, the difference being significant (two-sample Wilcoxon ranksum test, $p<0.001$).

We also carry out within-subject tests to compare decisions in the first and last five rounds to see if there is indeed a downward trend. In fact, there is statistically significantly lower effort in the last 5 rounds relative to the first 5 rounds in both treatments (Wilcoxon signed-rank test, p-value$= 0.085$ in the egalitarian treatment and p-value<0.001 in the inverse proportional treatment).

Remember that the theoretical symmetric prediction for the egalitarian treatment is $\frac{v}{4N^2}$, that for $v = 4000$ and $N = 4$ implies a predicted individual effort of 62.5. Given average efforts of 332.2, we have an 431.5% over-expenditure in the egalitarian treatment, on average. Similarly, the average effort of 124.8 tokens in the inverse proportional treatment is much higher than the predicted zero contribution. Hence, although contributions in the inverse proportional treatment are significantly lower, than in the egalitarian treatment, we observe over-expenditure even in the inverse proportional treatment. Moreover, observing a decrease in the effort across rounds in each experimental treatment, we look for differences between predicted and actual effort exerted by participants in the last 5 rounds, which is 303.9 and 94.9 in egalitarian and inverse proportional treatment respectively. *t*-test shows statistically significant differences in average effort with respect to predicted effort of 62.5 in egalitarian and 0 in inverse proportional treatment ($p<0.001$ in both treatments), suggesting the presence of the over-expenditure in both treatments even at the end of the group contest phase. Figure 2 provides further support to the treatment effect, indicating the histograms of efforts in the two treatments. Efforts in the inverse proportional treatment are clearly more skewed to the left than in the egalitarian treatment, resulting in overall less effort. The Kolmogorov-Smirnov test rejects clearly ($p<0.001$) the equality of the effort distributions in the two treatments.

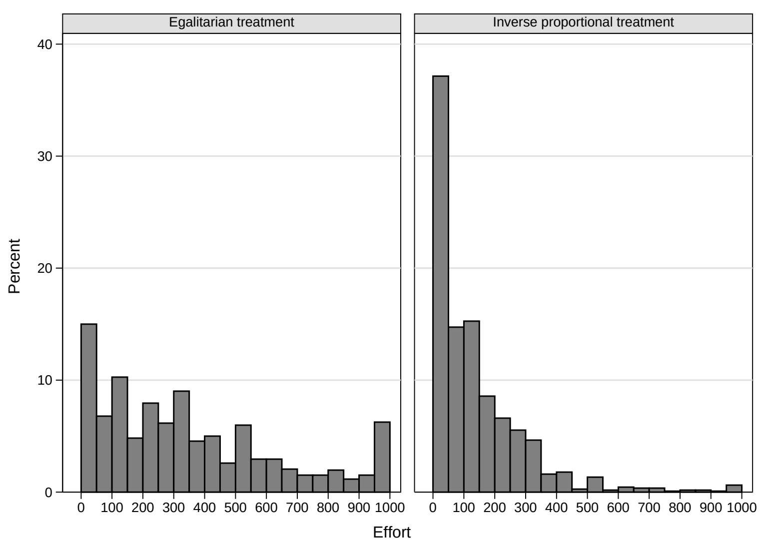

Figure 2: Histogram of efforts in the treatments

The above descriptive statistics and tests strongly suggest that there is a difference in the behavior of participants between treatments. Subjects in the egalitarian treatment on average made considerably more effort than participants in the inverse proportional treatment.[16]

In Table 1 we represent the choices of the subject in the other tasks. In the social value orientation, 59% of the participants were classified as prosocial, that is very similar to other studies (e.g. Murphy et al., 2011).[17] In the bomb risk elicitation task the mean / median / standard deviation of the boxes is 45.9 / 47 / 15.2 which is in line with results found in other experiments (e.g. Crosetto and Filippin, 2013, 2016). Moreover, we do not see any gender differences when we consider treatments together or separately (Wilcoxon ranksum test, p>0.17 always), similarly to other studies that use this risk elicitation method, (see Crosetto and Filippin, 2013, 2016). Contribution in the public goods game is generally in the range of 40-60% in the literature, (see, for instance Chaudhuri, 2011). In our experiment, contribution levels are considerably lower. However, note that in our case participants played the public goods game after the 20-period group contest game in which they experienced a declining pattern of effort that might have affected their contribution in the public goods game. A main finding of the competition experiment by Niederle and Vesterlund (2007) is that men are more likely to enter tournaments than women, a pattern that we observe in our data as well.[18] Overall, we believe that the behavior that we observe in these games and tasks is in line with what has been found in the literature.

Table 1 also reveals that while in the case of social value orientation and risk tolerance we do not observe a marked difference between treatments, cooperativeness (captured by contribution in the public goods game) and competitiveness vary considerably between treatments.

In Table 2 we depict the pairwise correlations between the individual

[16]As a further evidence, consider the share of zero contributions in the different treatments. This share is 5.18% in the egalitarian and 5.27% in the inverse proportional treatment, the difference is not significant (according to the two-sample Wilcoxon ranksum test and the test of proportions). However, the share of zeros increases more quickly over time in the inverse proportional treatment (see Appendix C.1).

[17]Anderl et al. (2015) show that social value orientation fluctuates with the menstrual cycle, so the gender breakdown may be not very informative since we do not know anything about the participants' menstrual cycle.

[18]Despite the considerable difference in competitiveness between males and females, neither the Wilcoxon ranksum test, nor the test of proportions do reveal a significant difference.

	Social Value Orientation (% of prosocial)	Risk tolerance (# of boxes)	Contribution in PGG (% of endowment)	Competitiveness (% of competitive)
Overall	58.9 (52.5 / 66)	45.9 (46.7 / 45)	27.6 (20.9 / 35)	48.2 (54.2 / 41.5)
Egalitarian	58.9 (45.5 / 67.6)	46.9 (45.9 / 47.5)	35.2 (24.6 / 42)	44.6 (50 / 41.2)
Inverse proportional	58.9 (56.8 / 63.2)	44.9 (47.2 / 40.5)	20 (18.7 / 22.4)	51.8 (56.8 / 42.1)

Table 1: Performance in the other tasks. In brackets the first number corresponds to males and the second to females.

choices in the group contest, treatment and choices in the social value orientation (SVO), bomb risk elicitation task (BRET), public goods game (PGG) and the competitiveness task. For social value orientation we classify participants either as prosocial or as individualistic, by employing a dummy that is 1 if the participant is prosocial. In the bomb risk elicitation task we measure risk tolerance, so larger values here denote less risk aversion. In the public goods game the contribution to the common project is our measure of cooperativeness, higher values representing more cooperative individuals. To measure competitive behavior, we have a dummy that takes on the value of 1 if the subjects chooses to compete in subphase 3 of the competition task. In order not to inflate the number of observations, we only consider the average effort over the 20 rounds.[19]

Variables	Average Effort	Treatment (=1 if inverse prop.)	Prosocial (SVO)	Risk attitudes (BRET)	Contribution (PGG)	Competitiveness (=1 if competitive)
Average Effort	1.000					
Treatment (=1 if inverse prop.)	-0.562*** (0.000)	1.000				
Prosocial (SVO)	-0.065 (0.493)	0.018 (0.852)	1.000			
Risk attitudes (BRET)	0.096* (0.315)	-0.065 (0.497)	0.016 (0.864)	1.000		
Contribution (PGG)	0.404*** (0.000)	-0.318*** (0.001)	-0.149 (0.117)	0.169* (0.074)	1.000	
Competitiveness (=1 if competitive)	-0.077 (0.418)	0.071 (0.454)	-0.019 (0.846)	0.271** (0.004)	0.112 (0.240)	1.000
Observations	112	112	112	112	112	

P-values in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Pairwise correlations between behavior in the group contest, treatment and the subsequent games and tasks.

Table 2 also indicates that there is a treatment effect as being in the

[19]If we carry out the same exercise over the first / last five periods in the group contest, we obtain qualitatively the same pattern, see section Appendix C.2.

inverse proportional treatment is associated with significantly lower efforts. Prosociality as measured by the Social Value Orientation does not seem to be correlated with effort. More risk-tolerant participants tend to make more effort in the experiment, though the effect is only marginally significant. Cooperativeness measured as contribution in the public goods game is highly correlated with the average effort made by the subjects. Those who contributed more in the public goods game, made also more effort in the group contest. Treatment is also correlated with contribution in the public goods game, the contributions being lower in the inversely proportional case. At first sight, competitive behavior as measured by the Niederle-Vesterlund task is not associated with effort made in the group contest. Note also that there is some significant positive correlation between risk tolerance and contribution in the public goods game and risk tolerance and competitive behavior.

This correlation analysis gives some support to Hypothesis 1, 3 and 4. Hence, there seems to be a treatment effect; more risk averse subjects contribute less and contribution in the public goods game is positively correlated with contribution in the group contest. However, behavior in the Social Value Orientation and competitiveness measured á la Niederle-Vesterlund do not seem to be associated with behavior in the group contest.

5.2. Regression analysis

Correlations are informative, but not enough to disentangle the effects, so we proceed with a regression analysis.

The variable *Treatment* is a dummy with value equal to 1 if the observation comes from the inverse proportional treatment. *Prosocial (SVO)* is also a binary variable equal to 1 if the individual is classified prosocial.[20] Risk attitude is represented by the variable *Risk preferences (Bomb task)* that measures the number of boxes the participant decided to take out of the store. The higher this number, the more risk-tolerant a subject is. *Contribution (PGG)* indicates the amount of tokens contributed to the common project and is a natural measure of cooperativeness: the higher is the amount, the more cooperative is the participant. *Competitiveness (Niederle et. al. 2007)* is a dummy variable with value 1 if the subject chose the tournament payment instead of the piece-rate payment in phase 3 of the competition task.

[20]We note that no individual in our experiments was classified either as altruistic or competitive.

In Figure 1 we see a clear declining pattern of effort, so we control for that by introducing the variable *Period* indicating the period that the decision was made in. To account for past experience we include the variables *Group's total effort (t-1)* and *Rival group's total effort (t-1)* that indicate the total effort of the participant's group and the total effort of the rival group in the previous period. These variables also control then for the probability of having won the contest in the last period. To reveal potential interactions between treatment and the previous variables, we created a set of interaction terms.

We also consider a wide range of controls related to socio-demographic variables as female, age, body mass index, digit ratio (see footnote 12), and academic degree that measures participant's education level corresponding to the following categories: no formal education, secondary school, bachelor, master, and doctorate degree. We also gathered information regarding the participant's household like number of siblings, breadwinner, breadwinner's education and employment.[21] Breadwinner's employment provides the information on whether the breadwinner is a student, without employment, but currently searching for it, employed, self-employed, or others. Work measures the hours worked by participant per week: zero hour, less than 5 hours, from 5 to 10 hours, from 10 to 15 hours, from 15 to 30 hours, and more than 30 hours.

We also include in some specifications variables related to linguistic and cognitive abilities. More concretely, we take into account the number of languages that indicates the number of languages spoken by the participant.[22] To measure participants' cognitive ability we use the Cognitive Reflection Test (Frederick, 2005) and borrow the definition of the variables reflective and irreflective from Cueva et al. (2016). Reflective measures the number of correct answers, while irreflective measures the number of answers provided by the participant impulsively, which are wrong, in the test.

With a final set of variables, we also control for the personality of the participants. The short BIG Five test allows us to assess the agreeableness, conscientiousness, extraversion, neuroticism, openness of the subjects.

[21]Breadwinner indicates the person who is in charge of the main financial responsibilities in the household: the participant, her father/mother, her spouse, absence of breadwinner.

[22]Since the participants of our study come from a bilingual region of Spain, we wanted to investigate to what extent being fluent in Catalan and other languages (in addition to Spanish) explains their decisions.

Moreover, using the Rosenberg-test we have a measure of their self-esteem as well. We include also their self-reported happiness in this set of personality variables.

In all specifications except 4 and 8, we see a clear treatment effect (significant at 1 %), indicating that in the inverse proportional treatment participants contribute less. Prosociality as captured by the social value orientation is not associated with the efforts of the individuals, even the sign of the coefficient is changing. If we interact this variable with treatment, we do not see any significant effect either. Risk tolerance exhibits a consistent positive association with effort, more risk-tolerant subjects contributing more, but the effect is only marginally significant in only one specification. The interaction between risk attitudes and treatment does not reveal any significant association. Cooperativeness proxied by contribution in the public goods game has a consistent and significant positive effect in all specifications, indicating that more cooperative individuals tend to make more effort in group contest, *ceteris paribus*. The effect of cooperativeness is not contingent on treatment, as indicated by the interaction term. The effect of competitiveness is less clear. Even though it associates negatively with effort in a consistent manner, it is significant only in one specification. However, in specification 4 we see a weak interaction effect, indicating that in the inverse proportional treatment competitive participants tended to make more effort. The negative and always significant effect of period reflects just the declining pattern that we observed in Figure 1 and the lack of significance in the interaction term reveals that this effect is not substantially different between treatments. The group's total effort and the rival group' total effort have very similar effects that are consistently and significantly positive throughout the specifications: the higher is (own or rival group's) total effort in the last period, the higher is the effort made by the individual. The interaction terms show that these effects do not differ between treatments.[23] In specifications 4 and 8, the variable *Treatment* is not significant, suggesting the lack of treatment effect. However, note that through the interaction terms involving treatment we control for the treatment effect and those interaction terms capture the effect of the treatment.[24]

[23]We re-run the regressions including the variable on whether the group won the contest in the previous period. It does not affect decision in the current period.

[24]From the rest of the variables that we used as controls none shows a consistently significant pattern. For details, see Appendix E.

Table 3: Effort (Linear model)

	est1	est2	est3	est4	est5	est6	est7	est8
Treatment (=1 if inverse)	-207.470***	-174.360***	-115.141***	-45.286	-113.833***	-109.147***	-103.638***	-51.748
	(29.096)	(29.998)	(30.357)	(101.882)	(31.686)	(30.995)	(30.481)	(109.019)
Prosocial(SVO)		-7.978	-3.751	19.190	0.348	-5.331	-12.736	15.118
		(28.583)	(27.089)	(39.255)	(29.467)	(27.502)	(28.328)	(47.553)
Risk preferences (Bomb task)		0.556	0.805	2.508*	1.061	0.754	0.505	1.904
		(0.979)	(0.927)	(1.407)	(0.954)	(0.937)	(0.947)	(1.582)
Contribution (PGG)		0.195***	0.182***	0.204***	0.161**	0.180***	0.174***	0.190**
		(0.064)	(0.061)	(0.072)	(0.064)	(0.062)	(0.064)	(0.083)
Competitiveness (Niederle et. al. 2007)		-31.252	-30.550	-92.325**	-8.735	-26.776	-34.127	-56.054
		(29.623)	(28.020)	(41.599)	(30.328)	(28.516)	(28.798)	(46.615)
Period			-4.005***	-4.736***	-3.990***	-4.009***	-3.991***	-4.725***
			(0.729)	(0.985)	(0.729)	(0.729)	(0.728)	(0.984)
Group's total effort (t-1)			0.046***	0.046***	0.046***	0.046***	0.045***	0.044***
			(0.010)	(0.012)	(0.010)	(0.010)	(0.010)	(0.013)
Rival group's total effort (t-1)			0.038***	0.034***	0.039***	0.038***	0.040***	0.037***
			(0.010)	(0.012)	(0.010)	(0.010)	(0.010)	(0.013)
Tr.*Prosocial				-19.905				-26.863
				(56.213)				(64.850)
Tr.*Risk preferences				-2.842				-1.992
				(1.919)				(2.120)
Tr.*Contribution				-0.052				-0.075
				(0.137)				(0.150)
Tr.*Competitiveness				109.603*				83.816
				(57.229)				(62.676)
Tr.*Period				1.759				1.776
				(1.526)				(1.525)
Tr.*Group's effort				0.001				0.003
				(0.023)				(0.023)
Tr.*Rival group's effort				0.017				0.016
				(0.023)				(0.023)
Socio-demographics (9 variables)	NO	NO	NO	NO	YES	NO	NO	YES
Linguistic and cogn. ability (3 var.s)	NO	NO	NO	NO	NO	YES	NO	YES
Personality charact.s (7 variables)	NO	NO	NO	NO	NO	NO	YES	YES
Constant	332.305***	255.457***	182.981***	125.841*	-166.340	138.749*	522.524**	312.247
	(20.574)	(52.736)	(54.789)	(76.141)	(436.257)	(79.504)	(214.301)	(581.125)
Observations	2240	2240	2128	2128	2128	2128	2128	2128

Standard errors in parentheses.Rnd Eff. Panel Linear Model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Socio-demographics: Female, Age, Body Mass Index, Academic degree, 2-4DR(left hand), Number of siblings, Breadwinner, Breadwin.'s employm., Work (hrs/week).

Cognitive ability: Reflective, (Ir)reflecitve, Number of languages

Personality characteristics:Agreeableness, Conscientiousness, Extraversion, Neuroticism, Openness, Happiness (degree), Self-esteem

In section Appendix D we carry out the same analysis, but separately for each treatment. This analysis reveals that cooperativeness has a markedly lower effect in the egalitarian treatment than in the inverse proportional treatment. Prosociality, risk attitudes and competitiveness do not show a significant association with effort in these regressions. The group's and the rival group's total effort have the same effect as before.

6. Conclusion

In many instances, cooperation and competition is present at the same time, a situation named coopetition. We study coopetition on the group level. Groups compete for a prize and cooperation between the members of the group increases the probability of winning the contest. More concretely, the more overall effort a group makes in the form of contributions, the proportionally higher is the chance of obtaining the prize. Within the group we introduce a second layer of competition as the prize is split up as a function of individual contributions. In the egalitarian treatment, the prize is divided equally among the members of the group, while in the inverse proportional treatment those who contribute less, receive a proportionally larger share. Such sharing rules represent incentives to make less contributions as the earnings in case of winning are then higher. In the inverse proportional treatment such incentives are arguably stronger as supported by our theoretical predictions.

In coopetitive situations, the tension between cooperation and competition is a central topic in the management literature. The inverse proportional treatment clearly represents a case of more intense tension. Our paper is the first attempt to see how increasing the tension this way affect the level of effort that members of a group make. We motivate this stark contrast between cooperation and competition by a resource constraint argument: agents have some level of resources that they can either dedicate to cooperation or competition. The more they dedicate to cooperation, the less resource they will have for competition.

We find that indeed the level of effort is significantly higher in the egalitarian treatment than in the inverse proportional treatment. In line with the literature, we document overexpenditure in the egalitarian treatment, and interestingly we observe overexpenditure also in the inverse proportional treatment. In the experiment we measured economic preferences to see if they affect the choice of contribution. We see that more cooperative participants choose a higher level of effort in both treatments. Competitive preferences have some effect in the inverse proportional treatment: more competitive participants contributing larger amounts from their endowment. Social and risk preferences do not seem to have any effect.

Our results are in line with findings in the management literature in the sense that when forces conducive to competition dominate, then cooperation is harmed. Future research will tell if this finding holds also for other group contest setups where the performance of the group or the contest success function are different from ours. Another interesting question is how our findings change if the prize is a function of the effort made by the members of the groups.

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Appendix A. Theoretical predictions

In this section we derive the theoretical predictions of the model.

Appendix A.1. Egalitarian case

Given perfect substitution in the performance function, homogeneous linear costs, a lottery contest success function ($r = 1$), equal group sizes ($N_A = N_B = N$) and the egalitarian sharing rule, the expected payoff of a risk-neutral player i in group A can be written as:

$$\pi_{iA}(x_{1A}, ...x_{NA}, X_B) = \frac{\sum_{i=1}^{N} x_{iA}}{(\sum_{i=1}^{N} x_{iA} + \sum_{j=1}^{N} x_{jB})} \frac{1}{N} \upsilon - x_{iA} \tag{A.1}$$

As in Katz et al. (1990), we use the Nash equilibrium to find the solution. Assuming a regular interior solution, the first-order condition for members of group A is

$$\frac{\partial \pi_{iA}}{\partial x_{iA}} = \frac{\sum_{j=1}^{N} x_{jB}}{(\sum_{i=1}^{N} x_{iA} + \sum_{j=1}^{N} x_{jB})^2} \frac{1}{N} \upsilon - 1 = 0 \tag{A.2}$$

Similarly, for group B

$$\frac{\partial \pi_{jB}}{\partial x_{jB}} = \frac{\sum_{j=1}^{N} x_{iA}}{(\sum_{i=1}^{N} x_{iA} + \sum_{j=1}^{N} x_{jB})^2} \frac{1}{N} \upsilon - 1 = 0 \tag{A.3}$$

In a symmetric equilibrium, $x_{1A} = x_{2A}.. = x_{iA} = .. = x_{NA}$ and $x_{1B} = x_{2B}.. = x_{jB} = .. = x_{NB}$, the previous conditions become

$$\frac{\partial \pi_{iA}}{\partial x_{iA}} = \frac{x_{jB}}{N^2(x_{iA}^2 + 2x_{iA}x_{jB} + x_{jB}^2)} \upsilon - 1 = 0 \tag{A.4}$$

and

$$\frac{\partial \pi_{jB}}{\partial x_{jB}} = \frac{x_{iA}}{N^2(x_{iA}^2 + 2x_{iA}x_{jB} + x_{jB}^2)} \upsilon - 1 = 0 \tag{A.5}$$

These first-order conditions imply that in equilibrium $x_{iA}^* = x_{jB}^*$. As a consequence, we obtain that

$$x_{1A}^* = .. = x_{iA}^* = .. = x_{NA}^* = \frac{v}{4N^2} \tag{A.6}$$

Appendix A.2. Inverse proportional case

In the proof, we will use the following additional notation:

$X_{A-i} = \sum_{j\epsilon A, j\neq i} x_j$

By our defintion the inverse proportional rule implies the following expected payoffs:

$$\pi_i\left(x_{i,A}, X_{A-i}, X_B\right) = \frac{X_A}{X_A + X_B} \frac{x_{i,A}^{-1}}{\sum_{j\epsilon A} x_j^{-1}} v - x_{i,A} \tag{A.7}$$

$$\pi_i\left(0, X_{A-i}, X_B\right) = \frac{X_{A-i}}{X_{A-i} + X_B} v \quad \text{for} \quad \forall x_{j\neq i, j\in A} > 0 \tag{A.8}$$

The second line specifies that if all other members of group A contribute a positive amount while member i's contribution is zero, then in case group A wins the contest, member i will receive the whole prize.

Next, we prove that the individual payoff upon contributing a positive amount is less than the payoff related to zero contribution, conditional on all the other members of the group contributing a positive amount:

$$\pi_i\left(x_{i,A} X_{A-i}, X_B\right) - \pi_i\left(0, X_{A-i}, X_B\right) = \frac{X_A}{X_A + X_B} \frac{x_{i,A}^{-1}}{\sum_{j\epsilon A} x_j^{-1}} v - x_{i,A} - \frac{X_{A-i}}{X_{A-i} + X_B} v =$$

$$= \left[\frac{X_A}{(X_A+X_B)} \frac{x_{i,A}^{-1}}{\left(\sum_{j\epsilon A} x_j^{-1}\right)} - \frac{X_{A-i}}{(X_{A-i}+X_B)}\right] v - x_{i,A} =$$
$$= \left[\frac{X_A \cdot x_{i,A}^{-1} \cdot (X_{A-i}+X_B) - X_{A-i} \cdot (X_A+X_B)\left(\sum_{j\epsilon A} x_j^{-1}\right)}{(X_A+X_B)\left(\sum_{j\epsilon A} x_j^{-1}\right)(X_{A-i}+X_B)}\right] v - x_{i,A} =$$
$$= \left[\frac{X_A \cdot x_{i,A}^{-1} \cdot X_{A-i} + X_A \cdot x_{i,A}^{-1} \cdot X_B - X_{A-i} \cdot X_A \cdot \left(\sum_{j\epsilon A} x_j^{-1}\right) - X_{A-i} \cdot X_B \cdot \left(\sum_{j\epsilon A} x_j^{-1}\right)}{(X_A+X_B)\left(\sum_{j\epsilon A} x_j^{-1}\right)(X_{A-i}+X_B)}\right] v - x_{i,A} =$$
$$= \left[\frac{X_B - X_{A-i} \cdot X_A \cdot \left(\sum_{j\epsilon A, j\neq i} x_j^{-1}\right) - X_{A-i} \cdot X_B \cdot \left(\sum_{j\epsilon A, j\neq i} x_j^{-1}\right)}{(X_A+X_B)\left(\sum_{j\epsilon A} x_j^{-1}\right)(X_{A-i}+X_B)}\right] v - x_{i,A} =$$
$$= \left[\frac{\left[1 - X_{A-i} \cdot \left(\sum_{j\epsilon A, j\neq i} x_j^{-1}\right)\right] X_B - X_{A-i} \cdot X_A \cdot \left(\sum_{j\epsilon A, j\neq i} x_j^{-1}\right)}{(X_A+X_B)\left(\sum_{j\epsilon A} x_j^{-1}\right)(X_{A-i}+X_B)}\right] v - x_{i,A} =$$
$$= \left[\frac{\left[1 - \left(\sum_{j\epsilon A, j\neq i} x_j\right) \cdot \left(\sum_{j\epsilon A, j\neq i} x_j^{-1}\right)\right] X_B - X_{A-i} \cdot X_A \cdot \left(\sum_{j\epsilon A, j\neq i} x_j^{-1}\right)}{(X_A+X_B)\left(\sum_{j\epsilon A} x_j^{-1}\right)(X_{A-i}+X_B)}\right] v - x_{i,A} < 0$$

(A.9)

since $\left(\sum_{j\epsilon A,j\neq i} x_j\right) \cdot \left(\sum_{j\epsilon A,j\neq i} x_j^{-1}\right) > 1$ always.

Hence, we proved that

$\pi_i\left(x_{i,A} X_{A-i}, X_B\right) - \pi_i\left(0, X_{A-i}, X_B\right) < 0,$

so contributing zero yields always a higher payoff than contributing a positive amount if the other members of the group contribute a positive amount.

We turn now to the case when another member of the group contributes zero. In this case, contributing a positive amount would yield the loss of the contribution, because if the group wins the contest, then the member with zero contribution obtains the whole prize, while in case of losing the contest the contribution is lost anyway. Therefore, if another member of the group contributes zero, then contributing zero yields a payoff that is higher than the payoff related to a positive contribution.

Thus, we have shown that to contribute zero leads always to higher payoffs than to contribute a positive amount in the case of the inverse proportional sharing rule.

Appendix B. Online Appendix - Instructions

The language of the instruction was Spanish as we ran the experiment in Spain. Here we present the English version of the instructions.

Welcome to the experiment

Welcome and thanks for participating in this experiment! Please, read carefully these instructions. The instructions are the same for all participants with whom you are going to interact during the experiment.

This is an experiment to study how individuals make decisions. We are interested in what individuals do on average.

Do not think that we expect any particular behavior from you. However, keep in mind that your behavior affects the amount of money that you may earn.

Next, you will see a series of instructions explaining how the experiment works and how you can use the computer during the experiment.

Please, do not either speak to or disturb the other participants during the experiment. If you need help, raise your hand and wait quietly. You will be attended as soon as possible. From now on, no type of communication is allowed with other participants. Please, switch off your mobile phone. If you do not comply with the rules, you will be dismissed and you will not receive any compensation for your participation.

The structure of the experiment is the following:

- PHASE 1
- PHASE 2
- PHASE 3
- PHASE 4
- PHASE 5
- QUESTIONNAIRE

You will have to make decisions in all phases as we will explain during the experiment. All your decisions will be treated confidentially.

The final payoffs will be the sum of two payoffs. The first payoff is the one that you obtain in Phase 1 and the second payoff is the one that is picked randomly from the payoffs related to the rest of the phases.

We record the earnings during the experiment as tokens that will be converted into euros at an exchange rate that we specify in each phase. In all cases, more tokens imply more euros.

After finishing the 5 phases, you will be asked to fill in a questionnaire and then we will pay your earnings in euros in private.

(Treatments varied only in Phase 1. Next we report the instructions for phase 1 for both treatments. First, we do it for the egalitarian treatment and then for the inverse proportional treatment.)

Phase 1 - egalitarian treatment

Read carefully the following instructions in order to know what are the decisions that you are going to make and how you can earn money.

In this phase of the experiment you will be a member of a group composed of 4 persons in the room. These 4-person groups will be formed randomly by the computer. You will not know the identities of the persons who are in your group, neither will they know your identity. Hence, identity of all members of the groups will remain anonymous. From the 56 individuals in the room, 14 4-person groups will be formed.

This phase consists of 20 rounds.

Throughout this phase, your group will play against another group, so your group and the other group will form a pair of rival groups. You will be member of the same group during the 20 rounds and you will play against the same rival group in each of the 20 rounds. The game consists in that the rival groups compete for a prize, as we will explain it in detail now.

At the beginning of each round you will receive an individual endowment of 1000 tokens. You can use this individual endowment of 1000 tokens to buy 'competition tokens' for the public account of your 4-person group. Each competition token costs 1 token of your individual endowment, hence you may buy at most 1000 competition tokens. The tokens of your individual endowment that you do not spend on buying competition tokens for the public account, will remain on your individual account. Similarly, the other 3 members of your group will have an endowment of 1000 tokens that they can use to buy competition tokens for the public account of your 4-person group.

At the end of each round, when each individual in the room has chosen how many competition tokens to buy, a random process similar to a wheel of fortune determines which group (the group that you belong to or the rival group with whom your group competes) wins the prize. The prize is 4000 tokens. The probability of winning the prize depends on the amount of competition tokens that your group has and on the amount of competition tokens acquired by the rival group. More concretely, the following happens.

The 'wheel of fortune' will be divided in two parts with different colors. One part of the wheel belongs to your group and the other part to the rival group. The size of the parts of the wheel represent exactly in a proportional way the amount of competition tokens acquired by your group and the rival group. For example, if your group and the rival group have acquired the same amount of tokens, then each group has 50% of the 'wheel of fortune'. If your group has acquired twice as many tokens as the rival group, then your group has two thirds of the wheel and the rival group has the remaining one third. Once the division of the wheel is determined by the competition tokens of the groups, the wheel starts to spin and stops randomly after a while. The wheel has an indicator in the position of 12 hours of a clock. The prize will be won by the group above whose color the indicator of the wheel is. Imagine that your group has acquired twice as many competition tokens than the other group and the color of your group is red, while the color of the rival group is blue. In this case, two thirds of the wheel will be red and one third blue. If after stopping the wheel the indicator is above a part of the wheel that is red, then your group wins the prize. However, if the indicator is above the blue part, then the prize goes to the rival group.

Therefore, the probability that your group wins the prize increases in the amount of competition tokens acquired by your group. In the same vein, the more tokens the rival group acquires, the higher is the probability that the rival group wins the prize. If one of the group does not acquire competition tokens, while the other group acquires tokens, then the group with the tokens wins with certainty. If none of the groups acquires tokens, the prize will be assigned randomly to one of the groups.

If your group wins the prize, then the 4000 tokens will be divided equally among the members of the group, independently of how many competition tokens each member of the group bought. That is, if a group wins the prize, the members of the group will receive 1000 tokens. In this case, the total amount of tokens obtained in the round would be the tokens of your initial endowment not used to buy competition tokens and your share of the prize, 1000 tokens.

If your group does not win the contest, you will not receive anything from the prize. In this case, your payoff in the round would be the initial endowment minus the tokens used to buy competition tokens.

Imagine that you use 350 tokens from your initial endowment of 1000 tokens to buy competition tokens. Suppose that your group wins the contest and obtains the prize. In this case, your payoff is (1000-350)+1000=1650 tokens in that round. Now assume that the other group wins the contest. Then your payoff in that round would be 1000-350=650 tokens. The numbers used in this example are fictitious.

The earnings will depend always on the amount of competition tokens that the members of the groups buy and on the result of spinning the wheel of fortune.

At the end of each round, after determing the winner of the contest, the earnings of the round will be computed.

Moreover, at the end of each round you will receive the following information:

• your contribution to the common cause (that is, how many competition tokens you have bought);

• the total contribution of your group (that is, the total number of competition tokens bought by the members of your group) ;

• the total contribution of the rival group (that is, the total number of competition tokens bought by the members of the rival group);

• if your group has won the contest or not;

• your individual earning in the given round.

Your final earning in this phase of the experiment will be the sum of the earnings obtained in 5 randomly chosen rounds from the 20 rounds that you play in this phase.

The exchange rate in this phase of the experiment is the following:

1000 tokens = 1.2 Euros (that is, 1 token = 0.12 Euro cents).

For example, if you earn 5000 tokens then you will receive 6 Euros.

Phase 1 - inverse proportional treatment

Read carefully the following instructions in order to know what are the decisions that you are going to make and how you can earn money.

In this phase of the experiment you will be a member of a group composed of 4 persons in the room. These 4-person groups will be formed randomly by the computer. You will not know the identities of the persons who are in your group, neither will they know your identity. Hence, identity of all members of the groups will remain anonymous. From the 56 individuals in the room, 14 4-person groups will be formed.

This phase consists of 20 rounds.

Throughout this phase, your group will play against another group, so your group and the other group will form a pair of rival groups. You will be member of the same group during the 20 rounds and you will play against the same rival group in each of the 20 rounds. The game consists in that the rival groups compete for a prize, as we will explain it in detail now.

At the beginning of each round you will receive an individual endowment of 1000 tokens. You can use this individual endowment of 1000 tokens to buy 'competition tokens' for the public account of your 4-person group. Each competition token costs 1 token of your individual endowment, hence you may buy at most 1000 competition tokens. The tokens of your individual endowment that you do not spend on buying competition tokens for the public account, will remain on your individual account. Similarly, the other 3 members of your group will have an endowment of 1000 tokens that they can use to buy competition tokens for the public account of your 4-person group.

At the end of each round, when each individual in the room has chosen how many competition tokens to buy, a random process similar to a wheel of fortune determines which group (the group that you belong to or the rival group with whom your group competes) wins the prize. The prize is 4000 tokens. The probability of winning the prize depends on the amount of competition tokens that your group has and on the amount of competition tokens acquired by the rival group. More concretely, the following happens.

The 'wheel of fortune' will be divided in two parts with different colors. One part of the wheel belongs to your group and the other part to the rival group. The size of the parts of the wheel represent exactly in a proportional way the amount of competition tokens acquired by your group and the rival group. For example, if your group and the rival group have acquired the same amount of tokens, then each group has 50% of the 'wheel of fortune'. If your group has acquired twice as many tokens as the rival group, then your group has two thirds of the wheel and the rival group has the remaining one third. Once the division of the wheel is determined by the competition tokens of the groups, the wheel starts to spin and stops randomly after a while. The wheel has an indicator in the position of 12 hours of a clock. The prize will be won by the group above whose color the indicator of the wheel is. Imagine that your group has acquired twice as many competition tokens than the other group and the color of your group is red, while the color of the rival group is blue. In this case, two thirds of the wheel will be red and one third blue. If after stopping the wheel the indicator is above a part of the wheel that is red, then your group wins the prize. However, if the indicator is above the blue part, then the prize goes to the rival group.

Therefore, the probability that your group wins the prize increases in the amount of competition tokens acquired by your group. In the same vein, the more tokens the rival group acquires, the higher is the probability that the rival group wins the prize. If one of the group does not acquire competition tokens, while the other group acquires tokens, then the group with the tokens wins with certainty. If none of the groups acquires tokens, the prize will be assigned randomly to one of the groups.

If your group wins the prize, then the 4000 tokens will be divided among the members of the group in the following way. In the winner group, the member that has bought the least number of competition tokens obtains the highest share of the prize, followed by the member who bought the second lowest amount of competition tokens and so on. That is, the member that bought the largest quantity of competition tokens, receives the lowest share of the 4000-token prize. The difference in the quantities that the members receive is inversely proportional to the competition tokens that the members of the group acquired.

The next example will help you understand better how the prize is divided. Assume that the members of a group, for instance A,B,C and D buy 100, 200, 400 and 400 competition tokens, respectively. In total, the group has 1100 tokens. Suppose that the group wins the prize and obtains the 4000 tokens. As you see, members C and D bought the same amount of tokens, while member A bought one quarter of the amount bought by members C and D, and member B bought half of the quantity acquired by members C and D.

Members C and D will receive the same amount from the prize since they bought the same quantity of competition tokens. Member A will receive four times as much as member C (and D), because she bought only one quarter of what member C (and D) bought. Member B bought only half of what member C (and D) bought, so she will receive the double of tokens from the prize as members C (and D). For the same reason, since member A bought only half the competition tokens that member B bought, she will obtain twice as many tokens from the prize as member B. That is, from the 4000 tokens of the prize, members A,B, C and D will receive 2000, 1000, 500 and 500 tokens, respectively.

Using the previous numbers and assuming that the group wins the prize, the payoff of member A would be (1000-100)+2000=2900, the payoff of member B would be (1000-200)+1000=1800, the payoff of member C would be (1000-400)+500=1100 and the payoff of member D would be (1000-400)+500=1100.

If your group does not win the contest, you will not receive anything from the prize. In this case, your payoff in the round would be the initial endowment minus the tokens used to buy competition tokens. Using the previous example and assuming that the rival group wins the prize the payoffs of group members A,B,C and D would be 1000-100=900, 1000-200=800, 1000-400=600 and 1000-400=600 tokens, respectively.

The numbers used in this example are fictitious and the earnings will depend always on the amount of competition tokens that the members of the groups buy and on the result of spinning the wheel of fortune.

At the end of each round, after determining the winner of the contest, the earnings of the round will be computed.

Moreover, at the end of each round you will receive the following information:

- your contribution to the common cause (that is, how many competition tokens you have bought);
- the total contribution of your group (that is, the total number of competition tokens bought by the members of your group) ;
- the total contribution of the rival group (that is, the total number of competition tokens bought by the members of the rival group);
- if your group has won the contest or not;
- your individual earning in the given round.

Your final earning in this phase of the experiment will be the sum of the earnings obtained in 5 randomly chosen rounds from the 20 rounds that you play in this phase.

The exchange rate in this phase of the experiment is the following:

1000 tokens = 1.2 Euros (that is, 1 token = 0.12 Euro cents).

For example, if you earn 5000 tokens, then you will receive 6 Euros.

(Phases 2-5 are the same in both treatments.)

Phase 2

Read carefully the following instructions in order to know what are the decisions that you are going to make and how you can earn money.

In this phase of the experiment you will be paired with another person in the room, that is, you will be part of a two-person group. The two-person groups are formed randomly by the computer. You will not know the identity of the other person who will be in your group, neither will she / he know that you are the other member of the group. Hence, anonymity is maintained. The decisions that any individual of this room makes are anonymous as well.

This phase consists of 6 experimental rounds.

In each round you will see on the screen a sequence of 9 pairs of numbers. In each pair of numbers, one of the numbers is your payoff and the other number is the payoff of the other person of your group. Your task in this phase is to choose the pair of numbers that you prefer in each round.

Once everybody in the room has decided in each of the six rounds, we will proceed with the calculation of the payoffs of this phase of the experiment.

First, the computer chooses randomly one of the 6 rounds that we will use for the payoffs.

Once the payoff-relevant round is selected, the computer will pick randomly one of the persons in each group who will be the Elector.

There is a 50% chance that you will be the Elector and and a 50% chance that the other person in your group will be the Elector.

In this phase, the payoff of each person in the room will be the decision made by the Elector in the group in the round that has been selected for payoff.

The exchange rate in this phase of the experiment is the following:

1 token = 0.02 Euros (that is, 1 token = 2 Euro cents).

For example, if you earn 100 tokens, then you will receive 2 Euros.

Phase 3

Read carefully the following instructions in order to know what are the decisions that you are going to make and how you can earn money.

In this phase of the experiment you will be part of a 4-person group. The four-person groups are formed randomly by the computer. You will not know the identity of the other persons who will be in your group, neither will they know that you are a member of the group. Hence, anonymity is maintained. The decisions that any individual of this room makes when interacting with the other members of the her / his group are anonymous as well.

This phase consists of 1 experimental round.

At the beginning of the round everybody in the room will receive an endowment of 1000 tokens. Your task is to decide how much of your endowment to assign to the common account of the group. That is, you have to decide how many tokens of the 1000 that you have you want to contribute to an account that you share with the other members of your group. The other members of your group will make the same decision, that is how many tokens from the initial endowment they assign to the common account of your group.

Once everybody in the room has decided, we will proceed with the calculation of the payoffs of this phase of the experiment.

In this phase, the individual payoff of each member of the group depends on her / his decision, on the decisions of the other members of the group and on a multiplier. We will explain the payoff in detail:

Your earning = initial endowment - contribution to the common account + 0.4* (common account of the group)

$P_i = 1000 - x_i + 0.4(x_1 + x_2 + x_3 + x_4)$, where

- P_i is the individual earning
- 1000 is the initial endowment
- x_i is your contribution to the common account

- 0.4 is the multiplier
- $x_1 + x_2 + x_3 + x_4$ is the sum of the contributions of each member of the group, that is the total of tokens accummulated in the common account of your group

For example, if you contribute 250 tokens to the common account, while the total contribution is 800, then you earn (1000-250)+0.4*800=1070 tokens.

The exchange rate in this phase of the experiment is the following:

1 token = 0.002 Euros (that is, 1 token = 0.2 Euro cents).

For example, if you earn 500 tokens, then you will receive 1 Euro.

Phase 4

Read carefully the following instructions in order to know what are the decisions that you are going to make and how you can earn money.

In a store there are 100 boxes, numbered from 1 to 100. In one of the boxes there is a bomb. In the other 99 boxes there is money (each of them contains money). You do not know which box contains the bomb, but you know that it could be in any of the boxes with the same probability.

Your task in this phase is to choose how many boxes wou would take out from the store. The boxes are numbered and will be taken out in numerical order (starting with box 1). That is, if you want to take out 20 boxes, then the boxes numbered from 1 to 20 will be collected. If you want to take out 57 boxes, then the boxes from 1 to 57 will be collected.

Once everybody in the room has decided, we will proceed with the calculation of the payoffs of this phase of the experiment.

At the end of this phase, the computer will choose randomly a number between 1 and 100 to determine in which box the bomb is. If the bomb is in one of the boxes that you collected from the store, then you will earn nothing in this phase of the experiment. However, if the bomb is not in the boxes that you took out of the store, then you may open the boxes and you will receive a token for each box.

Next, we will show some examples to illustrate how you can earn money in this phase:

Case A) Imagine that you decide to collect 7 boxes and the bomb is in the box 42. Since you did not collect the box with the bomb, you earn a token for each of the 7 boxes that you collected, that is your earnings will be 7 x 1 token = 7 tokens.

Case B) Imagine that you decide to collect 35 boxes and the bomb is in the box 42. Since you did not collect the box with the bomb, you earn a token for each of the 35 boxes that you collected, that is your earnings will be 35 x 1 token = 35 tokens.

Case C) Imagine that you decide to collect 52 boxes and the bomb is in the box 42. Since you did collect the box with the bomb, you earn zero token in this phase.

Case D) Imagine that you decide to collect 68 boxes and the bomb is in the box 73. Since you did not collect the box with the bomb, you earn a token for each of the 68 boxes that you collected, that is your earnings will be 68 x 1 token = 68 tokens.

Case E) Imagine that you decide to collect 10 boxes and the bomb is in the box 7. Since you did collect the box with the bomb, you earn zero token in this phase.

The exchange rate in this phase of the experiment is the following:

1 token = 0.1 Euros (that is, 1 token = 10 Euro cents).

For example, if you earn 50 tokens, then you will receive 5 Euro.

Phase 5

Read carefully the following instructions in order to know what are the decisions that you are going to make and how you can earn money.

In this phase you will have to complete 4 tasks. None of these tasks will take more than 5 minutes. At the end of this phase, the computer will choose randomly one of the 4 tasks and you will receive your earnings based on your performance in that task. The computation of the earnings varies between tasks as we will inform you before starting each of the tasks.

Task 1

In Task 1, you will see on the screen a series of sliders that you have to work with during a minute. Each slider can be moved along the integer numbers going from 0 to 100. At the beginning of the task each slider is positioned at 0. Your task consists in moving as many sliders as you can in a minute to the number 50 with the help of the mouse. On the right hand side of each slider you will see the number at which the slider is positioned. You can use the mouse to readjust the position of the sliders as many times as you need.

If Task 1 is chosen for payment in this phase of the experiment, then you will receive 1 token for each slider positioned at the number 50. Your payoff will not decrease in the number of sliders not positioned at the number 50. That is, the payment depends on the number of sliders positioned at the number 50.

The exchange rate in this phase of the experiment is the following:
1 token = 0.15 Euros (that is, 1 token = 15 Euro cents).
For example, 20 tokens = 3 Euro.

Task 2

In this task you will have 1 minute to work with a set of sliders. This task, as the previous one, consists in positioning sliders at the number 50. However, in this task your earning depends on your performance in relation to the performance of the members of the group that you belong to. That is, your earning depends on the number of sliders positioned at the number 50 and the quantity of sliders that the other members of your group positioned at the number 50. Each group in the room will be formed by 4 individuals, so you will be in a group with 3 other persons in the room. The person of the group that has the highest number of sliders positioned at the number 50 in a minute, will receive 4 tokens for each slider at the number 50, while the other members of the group will receive 0 token.

You will not be informed about your performance in this tournament until the end of this phase of the experiment. If there is a tie, the winner will be chosen randomly by the computer.

Remember that in this task the only one to win tokens and hence money is the one that positions the highest number of sliders correctly at the number 50.

The exchange rate in this phase of the experiment is the following:
1 token = 0.15 Euros (that is, 1 token = 15 Euro cents).
For example, 20 tokens = 3 Euro.

Task 3

In this task, you will have 1 minute to work with sliders. This task, as the previous ones, consists in positioning the sliders at the number 50. However, at the beginning of this task you will have to decide the way that you want to be paid, that is the way that we compute your earning.

If you choose piece-rate payment, then you will earn 1 token for each slider positioned at the number 50.

If you choose the tournament payment, then your performance in this task will be compared with the performance of the other members of your group in task 2. If the amount of sliders positioned at the number 50 is larger than that of the other members of your group, then you will receive 4 times more tokens per slider than in the piece-rate payment, that is 4 tokens for each slider positioned at the number 50. If in this task the number of sliders positioned at the number 50 is less than that of any of the members in your group in task 2, then you will earn 0 token. We will not inform you about your performance in the tournament until the end of this phase. In case of a tie, the winner will be chosen randomly by the computer.

If you are the person in your group with the highest number of sliders positioned at the number 50, you will receive 4 tokens for each slider at the number 50, otherwise you will earn 0 token.

The exchange rate in this phase of the experiment is the following:

1 token = 0.15 Euros (that is, 1 token = 15 Euro cents).

For example, 20 tokens = 3 Euro.

Task 4

In this task you will not have to work with the sliders. Notwithstanding, you can obtain some additional earning for the amount of sliders positioned at the number 50 in task 1. You have to choose the way of payment that you would like to be applied to compute your earnings in task 1. You can choose the piece-rate payment or the tournament payment.

If this task, that is task 4, is chosen for payment in this phase of the experiment, then your earnings will be the following. If you chose the piece-rate payment, then you will earn 1 token for each slider positioned at the number 50 in task 1.

If you chose the tournament payment, then your earnings are determined in relation to the performance of the other members in your group in task 1. Each group in the room will be formed by 4 individuals, so you will be in a group with 3 other persons in the room. If the amount of sliders positioned at the number 50 in task 1 is larger than that of the other members of your group, then you will receive 4 times more tokens than in the piece-rate payment, that is, 4 tokens for each slider positioned at the number 50. If the number of sliders positioned above the number 50 in task 1 is less than that of any of the members of your group in task 1, then you will receive 0 token. Hence, if you choose the tournament payment and you are the one in the group with the highest number of sliders positioned at the number 50, then you will earn 4 tokens for each slider at the number 50, otherwise you will earn 0 token.

In this task, you will see on the screen the amount of sliders that you positioned at the number 50 in task 1 and next you will have to select the way of payment.

The exchange rate in this phase of the experiment is the following:
1 token = 0.15 Euros (that is, 1 token = 15 Euro cents).
For example, 20 tokens = 3 Euro.

Additional questions

If you answer the next questions correctly, you can earn extra payment. These questions refer to your performance in the previous tasks, compared to those of the other participants.

In task 1, with the piece-rate payment, what do you think your performance was in relation to the other members in your group.

- The best
- The second best
- The third best
- The fourth

In task 2, with the tournament payment, what do you think your performance was in relation to the other members in your group.

- The best
- The second best
- The third best
- The fourth

For each correct answer, you will receive 7 tokens.
1 token = 0.15 Euros (that is, 1 token = 15 Euro cents).

Questionnaire

(The questionnaire contained questions about the sociodemographics of the participants. The questionnaire is available upon request.)

Appendix C. Online Appendix - Descriptive statistics

Appendix C.1. Share of zero contributions

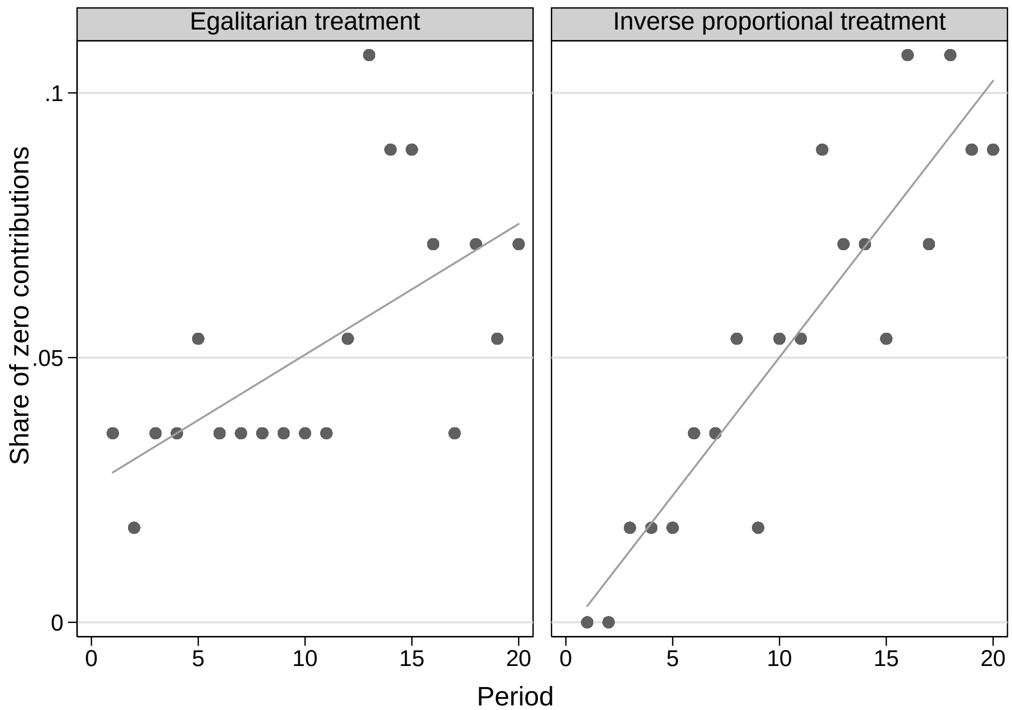

Figure C.3: Share of zero contributions in the treatments

Figure Appendix C.1 illustrates the proportion of participants in a session contributing nothing for each payment treatment. We observe an increase in the share of participants with zero effort in time in both treatments, but the increase is clearly more pronounced in the inverse proportional treatment.

Appendix C.2. Correlations

The following correlation tables show the pairwise correlations between our main variables. There is a negative and statistically significant correlation between the average effort and the treatment, which indicates that individuals contribute less in terms of effort in the inverse proportional treatment of the group contest and whose contributions are much lower at the end of the experimental task (-0.502*** for Round 16-20) rather than at its beginning (-0.435*** for Round 1-5).

We also observe, that there is a strong positive correlation between individual's risk attitudes and the competitiveness showing that individuals with risk acceptant preferences compete more. Moreover, there is a positive correlation between individuals contributions in terms of effort in the group contest game and in the Public Good Game, such that those individuals who put more effort in the Group contest, either at the beginning (Round 1-5) or at the end of the task (Round 16-20), are more cooperative in the Public Goods Game.

Variables	Average Effort	Treatment (=1 if inverse prop.)	Prosocial (SVO)	Risk attitudes (BRET)	Contribution (PGG)	Competitiveness (=1 if competitive)
Average Effort	1.000					
Treatment	-0.435***	1.000				
(=1 if inverse prop.)	(0.000)					
Prosocial(SVO)	0.013	0.018	1.000			
	(0.894)	(0.852)				
Risk attitudes (BRET)	0.048	-0.065	0.016	1.000		
	(0.619)	(0.497)	(0.864)			
Contribution (PGG)	0.248*	-0.318***	-0.149	0.169	1.000	
	(0.008)	(0.001)	(0.117)	(0.074)		
Competitiveness	-0.056	0.071	-0.019	0.271**	0.112	1.000
(=1 if competitive)	(0.558)	(0.454)	(0.846)	(0.004)	(0.240)	

Table C.4: Pairwise correlations between behavior in the group contest, treatment and the subsequent games and tasks. Round 1-5)

Variables	Average Effort	Treatment	Prosocial (SVO)	Risk attitudes (BRET)	Contribution (PGG)	Competitiveness (=1 if competitive)
Average Effort	1.000					
Treatment	-0.502***	1.000				
(=1 if inverse prop.)	(0.000)					
Prosocial(SVO)	-0.096	0.018	1.000			
	(0.312)	(0.852)				
Risk attitudes (BRET)	0.112	-0.065	0.016	1.000		
	(0.239)	(0.497)	(0.864)			
Contribution (PGG)	0.473***	-0.318***	-0.149	0.169	1.000	
	(0.000)	(0.001)	(0.117)	(0.074)		
Competitiveness	-0.114	0.071	-0.019	0.271**	0.112	1.000
(=1 if competitive)	(0.230)	(0.454)	(0.846)	(0.004)	(0.240)	

Table C.5: Pairwise correlations between behavior in the group contest, treatment and the subsequent games and tasks. Round 16-20)

Appendix D. Online Appendix - Regressions per treatment

Here we consider very similar specifications to those in section 5.2, the main difference being that here we carry them out separately for the different treatments. First, we do this analysis for the egalitarian treatment and then for the inverse proportional treatment.

Table D.6: Effort (Linear model: Egalitarian tr.)

	est1	est2	est3	est4	est5	est6
Prosocial(SVO)	14.538	18.886	21.142	1.064	6.994	-22.301
	(53.250)	(52.039)	(56.693)	(54.433)	(54.024)	(70.179)
Risk preferences (Bomb task)	2.272	2.513	3.641*	2.658	1.474	1.874
	(1.912)	(1.866)	(1.886)	(1.910)	(1.934)	(2.222)
Contribution (PGG)	0.214**	0.203**	0.130	0.208**	0.206*	0.180
	(0.098)	(0.096)	(0.104)	(0.098)	(0.105)	(0.122)
Competitiveness (Niederle et. al. 2007)	-90.686	-92.320*	-42.011	-83.069	-83.490	-49.753
	(56.533)	(55.162)	(57.168)	(55.848)	(58.801)	(65.763)
Period		-4.737***	-4.734***	-4.737***	-4.728***	-4.723***
		(1.201)	(1.200)	(1.201)	(1.199)	(1.198)
Group's total effort (t-1)		0.045***	0.044***	0.045***	0.043***	0.041***
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Rival group's total effort (t-1)		0.035**	0.036**	0.035**	0.038**	0.039**
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Socio-demographics (9 var.s)	NO	NO	YES	NO	NO	YES
Linguistic and cogn. ability (3 var.s)	NO	NO	NO	YES	NO	YES
Personality traits (7 var.s)	NO	NO	NO	NO	YES	YES
Constant	183.955*	126.035	-512.636	66.296	767.594*	819.887
	(97.639)	(100.110)	(814.750)	(141.081)	(413.176)	(1255.076)
Observations	1120	1064	1064	1064	1064	1064

Standard errors in parentheses. Random Effects Panel Linear Model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Similarly to the regression in Table 3 prosociality proxied by social value orientation does not correlate with effort in the egalitarian treatment. Risk attitudes have the same effect as in the regression in Table 3. Interestingly, the effect of cooperativeness as captured by contribution in the public goods game is considerably lower in the egalitarian treatment than in Table 3. Competitiveness exhibits a consistent negative effect that is marginally significant in one specification, indicating that competitive individuals tend to make less effort in the egalitarian treatment. The effect of period, group's total effort, rival group's total effort is very similar to what we have seen in Table 3.

As in the egalitarian treatment and overall, prosociality does not associate with effort made in the group contest in the inverse proportional treatment. The effect of risk attitudes vanishes as in this treatment we do not observe a consistent positive (and sometimes significant) effect of risk tolerance on

Table D.7: Effort(Linear model: Inverse payment tr.)

	est1	est2	est3	est4	est5	est6
Prosocial(SVO)	-6.262	0.263	-4.784	2.640	-5.371	-6.752
	(24.061)	(19.804)	(21.052)	(21.104)	(24.030)	(29.834)
Risk preferences (Bomb task)	-0.623	-0.310	-0.070	-0.393	0.115	0.239
	(0.781)	(0.642)	(0.672)	(0.682)	(0.734)	(0.811)
Contribution (PGG)	0.168**	0.150***	0.210***	0.156***	0.137**	0.166**
	(0.070)	(0.057)	(0.066)	(0.060)	(0.064)	(0.083)
Competitiveness (Niederle et. al. 2007)	14.812	17.208	-6.470	19.604	29.428	8.763
	(23.542)	(19.311)	(21.626)	(20.391)	(22.383)	(27.011)
Period		-2.731***	-2.772***	-2.761***	-2.878***	-2.873***
		(0.829)	(0.831)	(0.830)	(0.831)	(0.834)
Group's total effort (t-1)		0.055***	0.054***	0.054***	0.050***	0.050***
		(0.013)	(0.013)	(0.013)	(0.014)	(0.014)
Rival group's total effort (t-1)		0.053***	0.052***	0.053***	0.052***	0.052***
		(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
Socio-demographics (9 var.s)	NO	NO	YES	NO	NO	YES
Linguistic and cogn. ability (3 var.s)	NO	NO	NO	YES	NO	YES
Personality traits (7 var.s)	NO	NO	NO	NO	YES	YES
Constant	114.791***	71.792**	-314.673	68.252	-7.698	-390.727
	(37.604)	(35.592)	(329.742)	(58.003)	(170.420)	(454.581)
Observations	1120	1064	1064	1064	1064	1064

Standard errors in parentheses. Random Effect Panel Linear Model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

the effort made. However, the effect of cooperativeness is very strong in this treatment, while competitiveness fails to exhibit a consistent pattern. Period has a significant negative effect, but the coefficient is considerably lower in this treatment than on the egalitarian treatment. This may be due to the fact that effort starts out at a lower level so it cannot decline as fast as in the egalitarian treatment. Group's total effort and rival group's total effort has a similar effect as in the egalitarian treatment and overall.

Appendix E. Online Appendix - Complete regressions

In this section we report the complete regressions so that the coefficients of all variables used can be appreciated.

Table E.8: Effort (Linear model)

	est1	est2	est3	est4	est5	est6	est7	est8
Treatment (Inverse vs. egalit.)	-207.470***	-174.360***	-115.141***	-45.286	-113.833***	-109.147***	-103.638***	-51.748
	(29.096)	(29.998)	(30.357)	(101.882)	(31.686)	(30.995)	(30.481)	(109.019)
Prosocial(SVO)		-7.978	-3.751	19.190	0.348	-5.331	-12.736	15.118
		(28.583)	(27.089)	(39.255)	(29.467)	(27.502)	(28.328)	(47.553)
Risk pref.s (Bomb task)		0.556	0.805	2.508*	1.061	0.754	0.505	1.904
		(0.979)	(0.927)	(1.407)	(0.954)	(0.937)	(0.947)	(1.582)
Contribution (PGG)		0.195***	0.182***	0.204***	0.161**	0.180***	0.174***	0.190**
		(0.064)	(0.061)	(0.072)	(0.064)	(0.062)	(0.064)	(0.083)
Competitiveness (Niederle et. al. 2007)		-31.252	-30.550	-92.325**	-8.735	-26.776	-34.127	-56.054
		(29.623)	(28.020)	(41.599)	(30.328)	(28.516)	(28.798)	(46.615)
Period			-4.005***	-4.736***	-3.990***	-4.009***	-3.991***	-4.725***
			(0.729)	(0.985)	(0.729)	(0.729)	(0.728)	(0.984)
Group's tot. effor (t-1)			0.046***	0.046***	0.046***	0.046***	0.045***	0.044***
			(0.010)	(0.012)	(0.010)	(0.010)	(0.010)	(0.013)
Rival's group tot. effor (t-1)			0.038***	0.034***	0.039***	0.038***	0.040***	0.037***
			(0.010)	(0.012)	(0.010)	(0.010)	(0.010)	(0.013)
Tr.*Prosocial				-19.905				-26.863
				(56.213)				(64.850)
Tr.*Risk pref.s				-2.842				-1.992
				(1.919)				(2.120)
Tr.*Contibution				-0.052				-0.075
				(0.137)				(0.150)
Tr.*Competitiveness				109.603*				83.816
				(57.229)				(62.676)
Tr.*Period				1.759				1.776
				(1.526)				(1.525)
Tr.*Group's effort				0.001				0.003
				(0.023)				(0.023)
Tr.*Rival's group effort				0.017				0.016
				(0.023)				(0.023)
Female					16.890			14.427
					(31.511)			(35.932)
Age					-0.087			0.418
					(2.069)			(2.425)
Body Mass Index					-1.008			-1.680
					(0.991)			(1.158)
Academ. degree					13.013			8.881
					(17.822)			(21.765)
2-4(left hand)					306.485			75.144
					(404.384)			(443.898)
Breadwinner					56.093*			48.261
					(30.232)			(32.961)
Breadwin.'s employm.					-1.948			-8.978
					(15.968)			(17.419)
Num. siblings					-20.335*			-14.601
					(10.908)			(12.523)
Work (hrs/week)					-0.494			4.723
					(9.060)			(9.806)
Reflective						18.838		8.143
						(42.316)		(48.684)
(Ir)reflective						45.997		13.711
						(34.983)		(41.523)
Num. of lang.s						5.066		-1.371
						(19.888)		(22.876)
Agreeableness							-21.062	-20.733
							(12.902)	(15.979)
Conscientiousness							-20.334*	-25.617*
							(11.719)	(13.410)
Extraversion							-18.024	-8.579
							(16.270)	(18.568)
Neuroticism							19.107*	10.614
							(10.360)	(11.255)
Openness							-8.603	-1.424
							(13.347)	(14.800)
Happiness (degree)							7.701	24.259
							(25.054)	(28.904)
Self esteem							-5.406	-2.858
							(4.060)	(4.798)
Constant	332.305***	255.457***	182.981***	125.841*	-166.340	138.749*	522.524**	312.247
	(20.574)	(52.736)	(54.789)	(76.141)	(436.257)	(79.504)	(214.301)	(581.125)
Observations	2240	2240	2128	2128	2128	2128	2128	2128

Standard errors in parentheses. Random Effect Panel Linear Model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.9: Effort (Linear model: Egalitarian tr.)

	est1	est2	est3	est4	est5	est6
Prosocial(SVO)	14.538	18.886	21.142	1.064	6.994	-22.301
	(53.250)	(52.039)	(56.693)	(54.433)	(54.024)	(70.179)
Risk pref.s (Bomb task)	2.272	2.513	3.641*	2.658	1.474	1.874
	(1.912)	(1.866)	(1.886)	(1.910)	(1.934)	(2.222)
Contribution (PGG)	0.214**	0.203**	0.130	0.208**	0.206*	0.180
	(0.098)	(0.096)	(0.104)	(0.098)	(0.105)	(0.122)
Competitiveness (Niederle et. al. 2007)	-90.686	-92.320*	-42.011	-83.069	-83.490	-49.753
	(56.533)	(55.162)	(57.168)	(55.848)	(58.801)	(65.763)
Period		-4.737***	-4.734***	-4.737***	-4.728***	-4.723***
		(1.201)	(1.200)	(1.201)	(1.199)	(1.198)
Group's tot. effor (t-1)		0.045***	0.044***	0.045***	0.043***	0.041***
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Rival's group tot. effor (t-1)		0.035**	0.036**	0.035**	0.038**	0.039**
		(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
Female			3.336			5.909
			(60.957)			(83.293)
Age			4.281			1.702
			(3.823)			(4.828)
Body Mass Index			-1.481			-3.141
			(1.671)			(2.001)
Academ. degree			31.006			36.416
			(36.645)			(47.001)
2-4(left hand)			314.875			-128.833
			(714.065)			(829.690)
Breadwinner			154.756**			127.390
			(76.436)			(96.664)
Breadwin.'s employm.			-1.382			11.502
			(31.060)			(36.950)
Num. siblings			-55.958***			-32.617
			(21.652)			(25.538)
Work (hrs/week)			6.813			19.659
			(17.916)			(19.567)
Reflective				77.050		-94.639
				(90.133)		(118.715)
(Ir)reflective				129.926		-62.796
				(79.225)		(125.344)
Num. of lang.s				-15.785		-21.842
				(37.258)		(43.325)
Agreeableness					-40.063*	-63.556*
					(24.154)	(35.805)
Conscientiousness					-27.729	-35.627
					(22.416)	(25.278)
Extraversion					-15.859	2.564
					(32.585)	(35.424)
Neuroticism					38.515*	17.974
					(22.264)	(25.687)
Openness					-4.896	-5.325
					(28.250)	(29.419)
Happiness (degree)					-12.373	5.556
					(52.517)	(58.136)
Self esteem					-15.432**	-8.928
					(7.539)	(11.359)
Constant	183.955*	126.035	-512.636	66.296	767.594*	819.887
	(97.639)	(100.110)	(814.750)	(141.081)	(413.176)	(1255.076)
Observations	1120	1064	1064	1064	1064	1064

Standard errors in parentheses. Random Effect Panel Linear Model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table E.10: Effort(Linear model: Inverse payment tr.)

	est1	est2	est3	est4	est5	est6
Prosocial(SVO)	-6.262	0.263	-4.784	2.640	-5.371	-6.752
	(24.061)	(19.804)	(21.052)	(21.104)	(24.030)	(29.834)
Risk pref.s (Bomb task)	-0.623	-0.310	-0.070	-0.393	0.115	0.239
	(0.781)	(0.642)	(0.672)	(0.682)	(0.734)	(0.811)
Contribution (PGG)	0.168**	0.150***	0.210***	0.156***	0.137**	0.166**
	(0.070)	(0.057)	(0.066)	(0.060)	(0.064)	(0.083)
Competitiveness (Niederle et. al. 2007)	14.812	17.208	-6.470	19.604	29.428	8.763
	(23.542)	(19.311)	(21.626)	(20.391)	(22.383)	(27.011)
Period		-2.731***	-2.772***	-2.761***	-2.878***	-2.873***
		(0.829)	(0.831)	(0.830)	(0.831)	(0.834)
Group's tot. effor (t-1)		0.055***	0.054***	0.054***	0.050***	0.050***
		(0.013)	(0.013)	(0.013)	(0.014)	(0.014)
Rival's group tot. effor (t-1)		0.053***	0.052***	0.053***	0.052***	0.052***
		(0.013)	(0.013)	(0.013)	(0.013)	(0.014)
Female			-11.143			-5.526
			(21.821)			(25.951)
Age			-1.179			-0.093
			(1.814)			(2.280)
Body Mass Index			2.538***			3.046***
			(0.939)			(1.161)
Academ. degree			6.488			-4.374
			(14.759)			(19.799)
2-4(left hand)			216.367			182.446
			(310.559)			(369.976)
Breadwinner			-4.944			-10.281
			(18.708)			(23.355)
Breadwin.'s employm.			-0.244			2.899
			(11.326)			(14.648)
Num. siblings			19.924**			18.093*
			(8.049)			(9.698)
Work (hrs/week)			0.962			3.984
			(6.517)			(8.443)
Reflective				18.034		7.521
				(29.032)		(36.703)
(Ir)reflective				4.395		16.094
				(23.065)		(26.999)
Num. of lang.s				-0.586		-6.896
				(16.379)		(19.332)
Agreeableness					7.938	10.424
					(10.681)	(12.793)
Conscientiousness					-14.047	-5.606
					(10.062)	(12.207)
Extraversion					-10.059	-17.212
					(13.436)	(17.036)
Neuroticism					0.180	3.644
					(7.165)	(7.728)
Openness					1.411	-3.687
					(9.890)	(11.951)
Happiness (degree)					23.645	27.409
					(19.777)	(22.953)
Self esteem					3.546	2.349
					(3.109)	(3.777)
Constant	114.791***	71.792**	-314.673	68.252	-7.698	-390.727
	(37.604)	(35.592)	(329.742)	(58.003)	(170.420)	(454.581)
Observations	1120	1064	1064	1064	1064	1064

Standard errors in parentheses. Random Effect Panel Linear Model. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$