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Non-Rival Intergroup Competition

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EVERYONE IS A WINNER: PROMOTING COOPERATION THROUGH NON-RIVAL INTERGROUP COMPETITION*

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ABSTRACT

In this paper, we study the effectiveness of intergroup competition in promoting cooperative behavior. We focus on intergroup competition that is non-rival in the sense that everyone can be a winner. This type of competition does not give groups an incentive to outcompete others. However, in spite of this fact, we find that intergroup competition produces a universal increase in cooperation. Furthermore, in settings where there are strong incentives to compete, intergroup competition benefits a majority of individuals.

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1. Introduction

Teamwork is often beset with the notorious free-rider problem, and promoting cooperation within teams is therefore a key governance issue in a broad range of organizations. Because of its importance, a considerable literature in experimental economics has investigated the effectiveness of alternative institutions in promoting cooperation within one team.¹

This paper is concerned with promoting cooperation within teams by introducing competition between a set of intrinsically independent teams. A well-known example is the use, by J. Robert Oppenheimer, of competing teams to motivate scientists in Los Alamos during the Manhattan Project (Gosling, 1999). Large automobile companies sometimes let several teams compete when developing the design of a new car. Our mechanism is based on penalizing underperforming teams rather than rewarding the best-performing team. While the incentive mechanism we propose is rather unpleasant for team members as only negative incentives (punishments) are used, it is more pleasant than other competition schemes in other respects. In particular, our mechanism reduces the potentially demoralizing effect of competition because teams can avoid sanctions altogether by exerting high effort and allows for avoiding the negative externality a winning team exerts on other teams.

Given that the high degree of control of laboratory experiments makes them an excellent tool for the study of intergroup competition,² various researchers have used them to demonstrate, for example, that intergroup competition can promote cooperation in social dilemmas (Bornstein et al., 1990; Bornstein and Erev, 1994; Nalbantian and Schotter, 1997; van Dijk et al. 2001), and can facilitate coordination on Pareto-dominant equilibria in coordination games (Bornstein et al., 2002;

¹ Examples include communication (e.g. Isaac et al. 1984), peer pressure (e.g. Fehr and Gächter 2000), tax and subsidy mechanisms (Falkinger et al. 2000), and leadership (Levati et al. 2007).

² For instance, experiments allow us to isolate the various channels through which group competition affects cooperative behavior. A good example is Tan and Bolle (2007) who disentangle the effect of monetary incentives versus the effect of simply observing the performance of another group.

Riechmann and Weimann, 2008). However, to the best of our knowledge, experimental work on intergroup competition has focused on competition schemes in which the winning prize is rival. In other words, there can be only one winning group, which implies that contributing towards your group necessarily harms the groups you are competing with.

Although a large number of situations are well-described by rival intergroup competition (e.g., firms fighting for market share), there are many cases in which groups compete that do not possess an “I win, you lose” characteristic. For example, teams within a firm might be penalized if they fall behind the performance of others, but if all teams perform equally well no punishment is meted out—that is, everyone wins. In this paper, we study the effectiveness of this type of non-rival intergroup competition for promoting cooperation in social dilemmas.

We run a laboratory experiment in which five groups compete with each other. Groups with the highest group output win the contest and those with lower output are penalized. In particular, groups are ranked according to their output and groups who are not ranked 1st have their earnings reduced—with the reduction (weakly) increasing with their distance to 1st place. A group’s ranking is given by: 1 + number of groups with *strictly* better performance.³ Hence, we allow more than one winner. In the case in which all groups produce the same amount, everyone wins and no group is punished. As is typical for group production, our experiment is characterized by having a social dilemma structure (we use a linear public good game, see Isaac et al., 1984), which gives individuals an incentive to free-ride on the effort of other group members.⁴ We think this design captures, in a simple manner, the main characteristics of non-rival intergroup competition.

Non-rival intergroup competition has an important disadvantage as a mechanism for the promotion of within-group cooperation. Namely, groups do not have an incentive to outperform others (although they do have an incentive to avoid falling behind). In other words, it does not eliminate equilibria with low levels of

³ This type of ranking is used in, for example, in Olympic sports in which ties are not broken.

⁴ In the absence of competition, the dominant strategy is to not contribute to group output.

cooperation, which makes it theoretically unclear whether it can reduce free riding. It is therefore interesting to observe under what conditions competing groups can coordinate on high-output equilibria. To explore this question, we run three treatments with different penalty schemes.

Non-rival intergroup competition does have the advantage that it reduces the negative externality of own-group production on the earnings of other groups. This can be important as the possibility of hurting others and have others hurt you can crowd out motivations such as positive reciprocity and altruism (Gächter and Fehr, 2002; Fehr and Rockenbach, 2003).⁵ As shown by Großer and Sausgruber (2005), this crowding out is present in rival intergroup competition. In their paper, they show that competition discourages pro-social individuals from cooperating. With non-rival competition, if groups are in a situation in which nobody is losing, prosocial individuals have no reason to stop cooperating. Our mechanism relies on penalizing under-performing groups, but sanctions can be avoided altogether by providing high performance. Loss-averse team members may therefore be particularly motivated to cooperate in our mechanism.

The literature on intergroup competition has mainly found that rival competition promotes cooperation (for an excellent summary see Bornstein, 2003). However, recent studies have also found that with repetition the gains from competition can be small (Tan and Bolle, 2007) or non-existent (Großer and Sausgruber, 2005). From these studies one can see that, by and large, competition is beneficial when it supports full cooperation as a Nash equilibrium (as was the case in the first papers). To explore the effect of a full-cooperation equilibrium in the case of non-rival competition, we run two treatments in which full cooperation is supported in equilibrium and a treatment where it is not.

The paper is organized as follows. In section 2 we describe the experimental design. In section 3 we present the results and in section 4 we conclude.

⁵ For an extensive review of monetary incentives and the crowding out of pro-social behavior see Frey and Jegen (2001).

2. The experiment

The experiment consists of two parts, each lasting 10 periods. In part 1, participants play a standard linear public goods game in groups of n subjects (Isaac et al., 1984). In each period, subjects receive an endowment $y = 20$ and decide how much of it they want to keep and how much they want to contribute to their group's output. Period earnings are determined by $\pi_i = y - c_i + \alpha \sum_j c_j$, where c_i is subject i 's contribution to group output and α is the marginal per-capita return of group production. In all treatments, $\alpha < 1$ and $n\alpha > 1$, ensuring both an individual incentive to free ride and an efficiency gain from cooperation. In part 1, under the assumption that all players are own-payoff maximizers, the unique subgame-perfect Nash equilibrium is for all subjects to keep all their endowment.

In part 2, competition between K groups is introduced. In each period, groups are ranked according to total contributions. A group k 's rank r_k is given by one plus the number of groups that have contributions that are *strictly* higher than k 's. In other words, groups that contribute the same amount share the same rank. In part 2, a subject's earnings also depend on their group's rank. In particular, members of groups that are not ranked 1st have their earnings reduced. Specifically, the earnings of subject i who is member of group k equal $\pi_{ik} = \pi_i \times f(r_k)$, where π_i is the same as in part 1 and $f(r_k)$ is a function that transforms group k 's rank into a number less than or equal to one.⁶ In the experiment, we set $f(r_k) = 1$ if $r_k = 1$, $f(r_k) < 1$ if $r_k > 1$, and $f(r_k) \leq f(r_m)$ if $r_k > r_m$.

With intergroup competition, although full defection is still an equilibrium, there are many equilibria at positive contribution levels. We concentrate on the Pareto-dominant equilibrium—that is, the equilibrium with the highest average payoff (Harsanyi and Selten, 1988). In this equilibrium, all competing groups exhibit the same total contributions. However, in some cases, individuals within groups can

⁶ This kind of intergroup competition scheme is used in the production of broiler chicken (Knoeber and Thurman 1994). The principal (a large firm called integrator) subcontracts with smaller firms ("growers") to raise the chicks. The growers are provided with baby chicks and feed by the integrator. The growers deliver the mature chicken to the integrator and are paid according to their relative productivity. That is, growers who used less feed per pound of chicken get a higher price per pound.

TABLE 1 – TREATMENT PARAMETERS

Treatment	MPCR α	Group Size n	Number of groups K	$f(r_k)$ for different values of r_k				
				1	2	3	4	5
T1	0.40	4	5	1.00	0.80	0.60	0.40	0.20
T2	0.50	3	5	1.00	0.50	0.50	0.50	0.50
T3	0.50	3	5	1.00	0.95	0.90	0.85	0.80

be contributing different amounts. In other words, to attain this equilibrium, individuals must overcome two coordination problems: one between groups and the other within groups. *A priori*, it is unclear whether subjects will successfully resolve these coordination problems. However, if this is sometimes the case, it is interesting to know under which conditions they manage to do so and whether their success varies with differences in the incentives to compete.

We ran three treatments, each using a different $f(r_k)$. The specific parameters used in each treatment are shown in Table 1. Treatment 1 (T1) implements a strong competition scheme where groups have an incentive to outperform each other if doing so improves their current rank. T1's competition scheme has the desirable property that there is only one Pareto-dominant equilibrium, which consists of full cooperation by all subjects in all groups. To see why, suppose all individuals fully contribute to the public good in T1. The sum of contributions is then 4×20 , and each individual earns 32 (i.e., $(20 - 20 + 0.4 \times (4 \times 20)) \times 1$). Suppose individual i considers unilaterally switching from full to zero contributions. The earnings of individual i fall from 32 to 8.8 (i.e. $(20 + 0.4 \times (3 \times 20 + 0)) \times 0.2$). The drastic reduction in i 's earnings is the result of a drop, from first to last, in the rank of i 's group. Thus, no player has an incentive to unilaterally deviate from full contribution given that everyone else also fully contributes. Unilateral deviation also imposes a large externality on other group members (their earnings fall from 32 each to 4.8). This equilibrium ought to be attractive to all subjects as it maximizes efficiency and produces no within-group inequality. The downside of T1 is the harsh punishment a group suffers if it does not achieve a high rank. In other words, in T1, miscoordination is very costly and might cause an overall reduction in earnings.

Treatment 2 (T2) somewhat weakens the competition scheme by eliminating a group's incentive to improve if this only leads to a change within ranks 2 to 5. This could lead to lower cooperation levels if, for example, a group is clearly outcompeting the rest. In T2, full cooperation is also the only Pareto-dominant equilibrium. Moreover, failing to achieve a high rank is again quite costly.

Treatment 3 (T3) keeps the motivation to improve at all ranks as in T1, but lowers considerably the size of the incentive. This treatment is interesting because full cooperation is no longer an equilibrium. In effect, the highest contribution level supported in equilibrium occurs when contributions in all groups equal 40 out of 60 (67% of their resources). This fact makes coordination between and within groups harder to achieve. In particular, there are now numerous Pareto-dominant equilibria, and the majority of them imply within-group differences in cooperation. For example, a group can attain contributions of 40 by having either all its group members contribute 13.3 (which produces no in-group inequality) or by having two group members contribute 20 and one member contribute 0 (which gives the non-contributing member a much higher payoff). Hence, unlike in T1 and T2, the multiplicity of Pareto-dominant equilibria might hinder a group's ability to coordinate on the desired contribution level as each individual might vie for the equilibrium that favors them. The upside of T3 is that the payoff loss of failing to get a high rank is smaller and hence miscoordination is less costly.

We conducted three sessions per treatment. Each session consisted of five groups that played individually in part 1 and then competed with each other in part 2. Treatment 1 was conducted in the University of St. Gallen with MBA students as subjects. Treatments 2 and 3 were conducted in the University of Copenhagen with undergraduate students of various fields. The experiment was programmed and run with z-Tree (Fischbacher, 2007), and we used the usual experimental procedures of anonymity, incentivized payments, and neutrally worded instructions. Overall, 150 subjects participated in our experiment, and they earned US\$23.75 on average. An example of the instructions is available in the appendix.

3. Results

We present the experimental results in the following order. First, we analyze the effect of intergroup competition on mean contributions in all treatments. Second, we focus on the behavior of individual groups. Third, we report how the different competition schemes affect overall earnings.

3.1 Overall cooperation

Figure 1 shows the mean contributions to the public good in the three treatments. In periods 1 to 10 subjects play without intergroup competition whereas groups compete in periods 11 to 20. As is common in public goods games without competition (Ledyard, 1995), we observe a significant decline in contributions over time (Spearman's $\rho < -0.39$ $p < 0.001$). We also see in part 1 that mean contributions in T1 at 6.3 are somewhat lower than those in T2 and T3, which are 8.8 and 10.0 respectively. However, if we do pair-wise comparisons with Wilcoxon-Mann-Whitney tests (WMW), we cannot reject the hypotheses that contributions in all treatments come from the same distribution ($p > 0.100$).⁷

As soon as competition is introduced, we see a sharp increase in contributions. Averaging over all ten periods of part 2, contributions increase to 18.4 in T1, 17.4 in T2, and 13.7 in T3, which corresponds to a striking increase of 191% in T1, 97% in T2, and 37% in T3. Wilcoxon signed-rank tests (WSR) confirm that the change in contributions is statistically significant in all treatments ($p < 0.003$). In addition, in T1 and T2, contributions no longer display a significantly decreasing trend.⁸

⁷ Throughout this section, we apply two-sided test statistics and use group averages across all periods of a part as independent observations. Moreover, when we test the same hypothesis in multiple treatments or when we do pair-wise comparisons, we adjust p -values with the method of Benjamini and Hochberg (1995) to minimize the chance of false positives due to multiple testing.

⁸ Spearman's $\rho = 0.39$ ($p < 0.001$) in T1, $\rho = 0.07$ ($p = 0.385$) in T2, and $\rho = -0.30$ ($p < 0.001$) in T3.

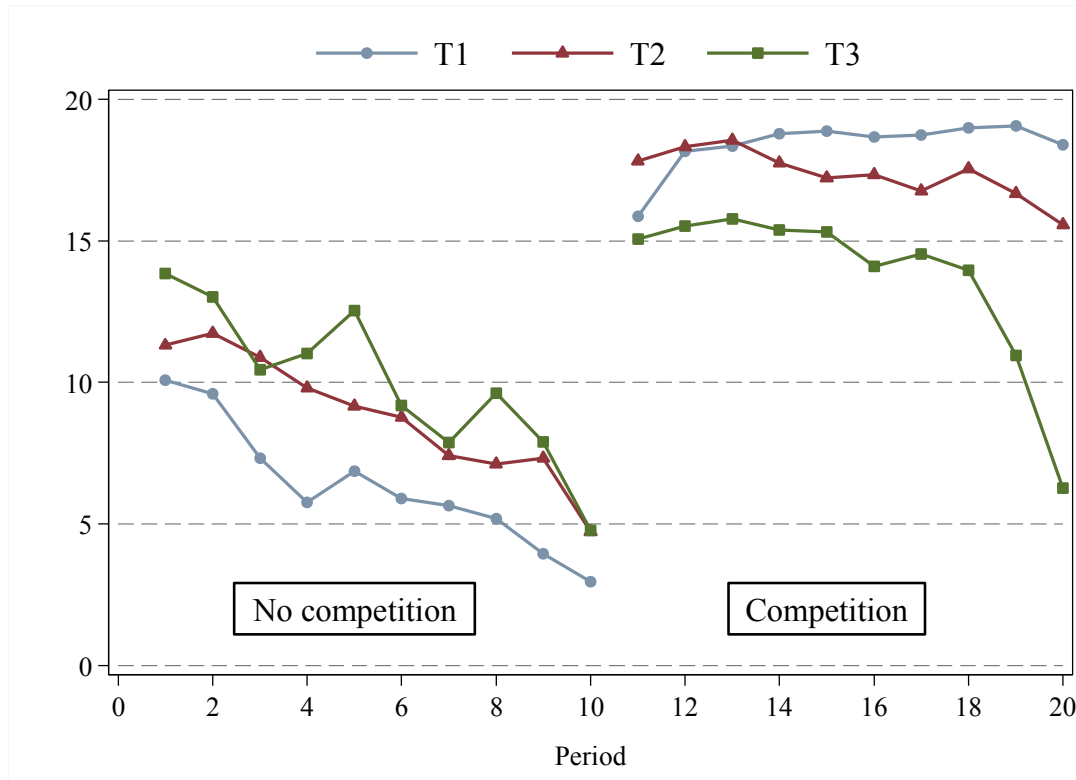


FIGURE 1 – MEAN CONTRIBUTIONS

If we compare contributions across treatments in part 2, we find them to be significantly lower in T3 relative to T1 and T2 (WMW tests, $p < 0.030$). This difference is consistent with the theoretical predictions in the sense that in T3, full contribution by all subjects in all groups is not supported in equilibrium. In fact, it is interesting to see that, on average, contributions in all treatments are fairly close to the Pareto-dominant equilibrium (20.0 in T1 and T2, and 13.3 in T3).

Next, we look at whether intergroup competition increases the contributions of all groups or just of some. We find that, in T1 and T2, competition produces an increase in average contributions in all 15 groups. In T3, average contributions increase in 12 out of 15 groups, they remain constant in 1 group, and decrease in 2 groups.

In summary, in spite of the fact that groups do not have an incentive to outperform others, intergroup competition results in a large increase in cooperation.

3.2. Relative performance and cooperation

The increase in cooperation can also be seen if we look at groups by rank. That is, we look at the average difference in contributions between groups that are ranked k^{th} when there is competition and when there is no competition. This difference can be seen in Figure 2, which shows average contributions by rank for each treatment (see red lines). Periods with no competition are displayed in the top part of the figure and periods with competition are displayed in the bottom part.

Without competition, average contributions in T1, T2, and T3 range from 2.0, 2.8, and 3.7 for groups ranked 5th to 12.6, 15.0, and 17.0 for groups ranked 1st (see right scale in Figure 2). Once competition is introduced, we see an increase in contributions at all ranks: average contributions now range from 13.3, 9.3, and 7.3 for groups ranked 5th to 20.0, 20.0, and 19.8 for groups ranked 1st.⁹ Hence, we can conclude that non-rival intergroup competition produces a universal improvement in cooperation.

Nevertheless, since an increase in contributions does not necessarily translate into higher earnings, it is yet unclear whether most groups would find it desirable to compete. In order to guarantee themselves a higher payoff, groups also have to be ranked 1st. Ideally, all groups are ranked 1st and nobody suffers a payoff loss. In other words, we must also take a look at the distribution of rankings.

Figure 2 also contains bar diagrams. The height of the bar shows the average number of groups (across periods) that attained a given rank. For example, the rightmost bar in the bottom left diagram shows that about 3 (out of 5) groups were ranked first in a typical period of treatment T1 with competition. We can see that, without intergroup competition, there is usually one group per rank in all treatments. In other words, cooperation levels are dispersed such that, in an average period, one group has the highest cooperation level, another group the second highest, yet another one the third highest, and so on.

⁹ With one exception, the change in cooperation between no competition and competition is statistically significant for all ranks in all treatments (WMW tests, $p < 0.022$ for all comparisons except for of groups ranked 2nd in T3 where $p = 0.389$).

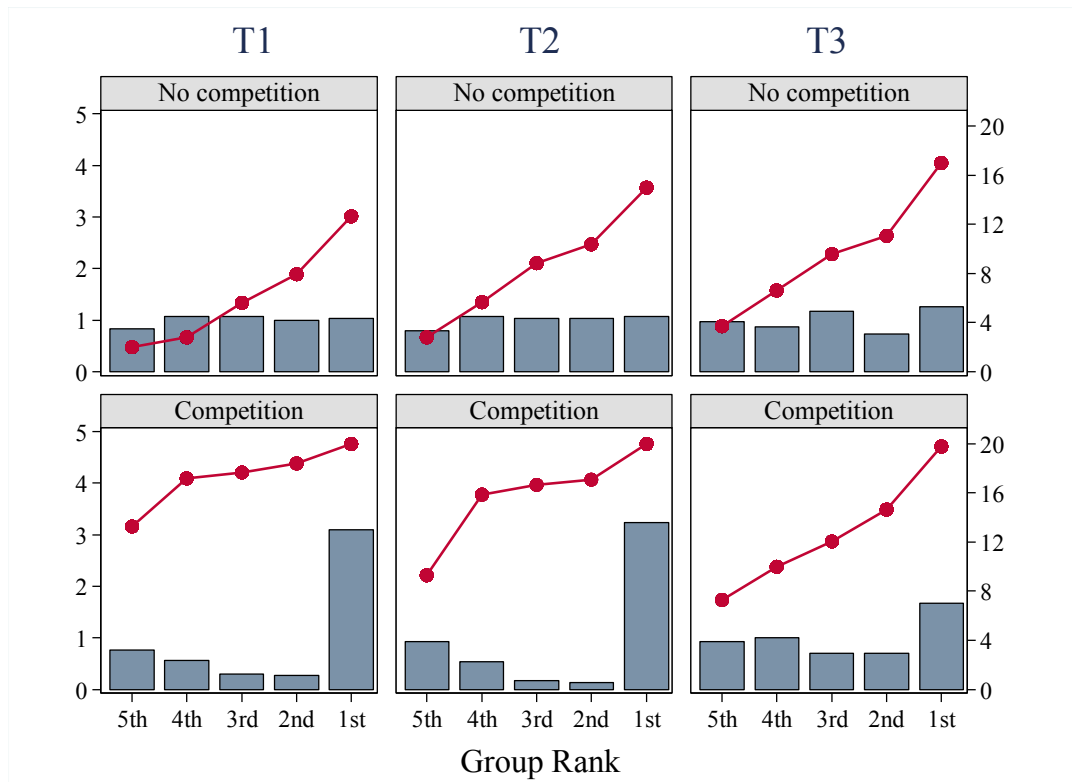


FIGURE 2 – GROUP RANKINGS

With intergroup competition, the distribution of rankings changes considerably. In particular, there is an increase in the number of groups that are ranked 1st. In an average period with competition, 3.1 groups are ranked 1st in T1, 3.2 in T2, and 1.7 in T3 (up from 1.0, 1.1, and 1.3 respectively). The change in the number of groups that are ranked 1st is statistically significant in T1 and T2 but not in T3 (WSR tests, $p < 0.007$ in T1 and T2, and $p = 0.288$ in T3). The number of groups ranked 1st is even bigger and the differences between T3 and the other treatments are more pronounced if we consider only periods close to the end. For example, if we look at the last five periods with competition, the number of groups ranked 1st is 3.9 in T1, 3.5 in T2, and 1.5 in T3.

This is a remarkable result for T1 and T2 as not only are a substantial number of groups attaining the top rank, they attain it at the maximum cooperation level (i.e., at 20.0). This virtually perfect cooperation is consistent with groups trying to coordinate on the Pareto-dominant equilibrium. In T3, competition stimulates contributions to group production but groups fail to coordinate on the same

cooperation level. In fact, given that the highest level of contributions supported in equilibrium is 13.3 and that groups ranked 1st are clearly contributing more than this amount, it appears that (some) groups are not even attempting to coordinate on one of the Nash equilibria.

3.3 Group and individual cooperation

Next, we check whether cooperation in periods without competition predicts cooperation in periods with competition. This is important as it allows us to observe whether intergroup competition is robust to preferences for cooperation. In other words, we check whether the increase in contributions is due to groups or individuals who are intrinsically motivated to cooperate or whether those with more selfish preferences also react with higher cooperation. We start the analysis at the group level.

A simple way of observing whether relatively cooperative groups remain cooperative once intergroup competition is introduced is to look at the correlation between the groups' average ranking with and without competition. In T1, Spearman's correlation coefficient between these two variables is $\rho = 0.25$ ($p = 0.547$). In T2 it is $\rho = 0.15$ ($p = 0.595$), and in T3 it is $\rho = 0.74$ ($p = 0.005$). Hence, in both T1 and T2, cooperativeness without competition is not a good predictor of cooperativeness with competition, unsurprisingly perhaps, as competition increases contributions in all groups to very high levels. The opposite is true for T3. In this treatment, a group's ranking with no competition is an excellent predictor of the group's ranking once competition is introduced. In other words, competition increases contributions in all groups but does not alter the groups' relative position.

If we look at contributions by individuals, we find a similar result. We calculate for each individual in each treatment, group, and period their ranking within the group. Rankings are calculated using the same procedure as for groups. At this point we can look at the correlation between the individuals' average ranking with and without competition. In T1 and T2, Spearman's correlation coefficients are low and are not significantly different from zero (for T1 $\rho = -0.09$, $p =$

0.509, and for T2 $\rho = 0.15$, $p = 0.477$). In other words, both cooperative and uncooperative individuals start cooperating substantially with competition in T1 and T2. This finding is exciting because it shows that the success of intergroup competition does not rely on the presence of highly motivated cooperators that reliably generate high levels of cooperation. However, the results from T3 remind us that this desirable robustness depends on the proper implementation of incentives for competition (in T3 high levels of cooperation are not sustained by an equilibrium). In T3, in spite of the increase in contributions, relatively cooperative individuals (within their group) keep on being the most cooperative during periods with intergroup competition ($\rho = 0.53$, $p = 0.001$).¹⁰

3.4. Competition and welfare

The previous discussion has shown that intergroup competition increases overall contributions, in all treatments, and the effect is particularly strong in T1 and T2. Contributions to the public good are directly proportional to a measure of efficiency, namely, the output produced by all groups. This measure is relevant if we consider how competition improves overall output in a firm, say. However, a more conservative measure of efficiency is to consider the sum effective earnings of participants and treating the sanctions as “waste”. This measure is relevant if we ask how much popular support the introduction of competition may enjoy.

We find that intergroup competition has an ambiguous effect on earnings. Averaging over all periods, earnings per subject in periods without competition are 23.8 in T1, 24.4 in T2, and 25.0 in T3, and in periods with competition, they are 24.5 in T1, 24.0 in T2, and 24.7 in T3. Hence, we see a slight increase in earnings in T1 and a slight decrease in T2 and T3. However, these differences are not statistically significant in any of the treatments (WSR tests, $p > 0.100$). We do see some differences when we look at how earnings change with repetition. Without competition, earnings display a significantly decreasing trend (Spearman’s

¹⁰ Note that we do not find that competition crowds out contributions by ‘pro-social’ individuals—that is, individuals who are high contributors in the absence of competition.

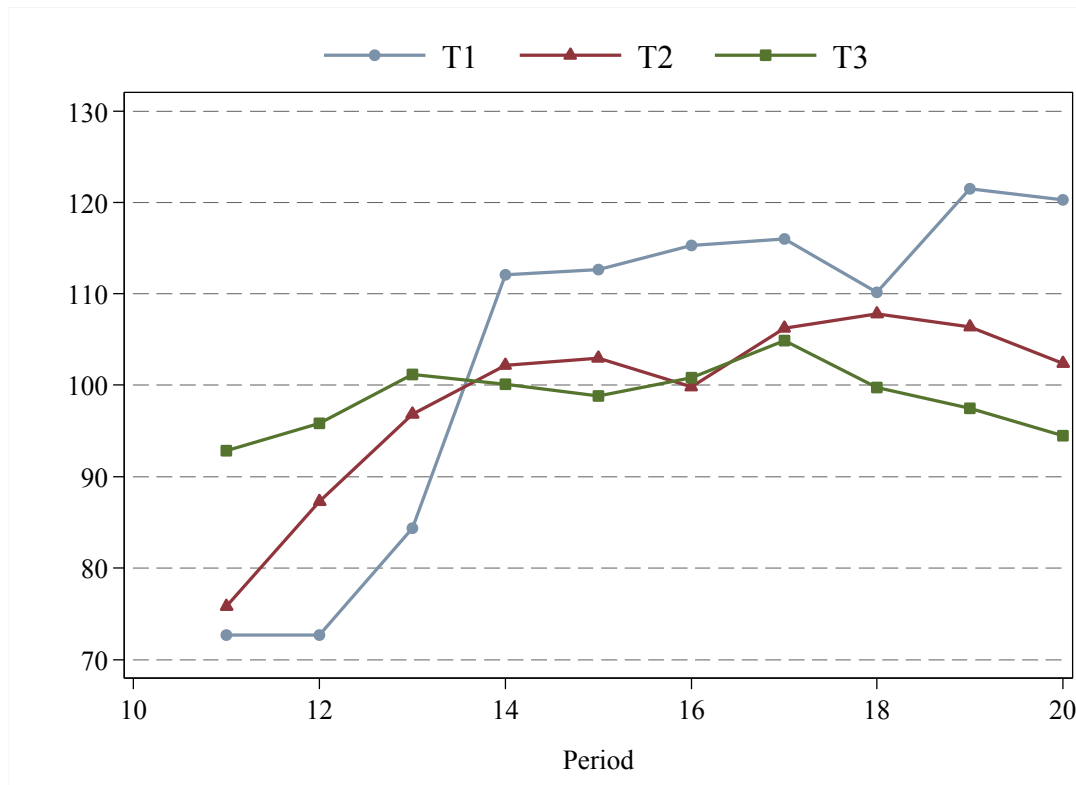


FIGURE 3 – RELATIVE EARNINGS

correlation coefficients are the same as for contributions). In contrast, in T1 we find that earnings significantly increase with time (Spearman's $\rho = 0.34$, $p = 0.001$) and in T2 they do not show a significant decrease (Spearman's $\rho = 0.07$, $p = 0.385$). In T3, it is still the case that earnings exhibit a significantly decreasing trend (Spearman's $\rho = -0.21$, $p = 0.017$).

Figure 3 shows average earnings for periods with competition as a percentage of earnings in the equivalent period without competition. As can be seen, in both T1 and T2, earnings with competition are initially well below earnings without competition. However, after three periods, the opposite is true. In T1, the effect is particularly strong. Thus, if the time trends continue, one could argue that, given enough repetition, competition will eventually produce a positive effect on earnings.

Instead of looking at average earnings, another way of evaluating the welfare effect of intergroup competition is to look at the number of individuals who benefit from it. In T1, averaging across all periods, 42 out of 60 subjects (70%) earned more with competition and 18 (30%) earned more without competition. In T2, 25 out of 45

(56%) earned more and 20 (44%) earned less, and in T3, 22 out of 45 (49%) earned more, 22 (49%) earned less, and 1 (2%) earned the same amount. Hence, in T1 and T2, a majority of subjects benefit from competing whereas in T3 this is equally split. If we test whether a significantly more subjects benefit from competition than suffer from it, we find that this is the case in T1 but not in T2 and T3 (Sign tests, $p = 0.008$ for T1, $p = 0.827$ for T2, and $p = 1.000$ for T3).

4. Conclusions

In this paper, we study the effectiveness of intergroup competition in promoting cooperative behavior. In particular, we focus on intergroup competition that is non-rival in the sense that everyone can be a winner. We report the results of a laboratory experiment where we vary the incentives to compete. We find that intergroup competition produces a universal increase in cooperation. Hence, we find it to be an effective way of increasing overall group output. Furthermore, in settings where there are strong incentives to compete, intergroup competition benefits a majority of individuals, albeit, it does not produce an increase in everyone's earnings.

The type of intergroup competition considered in this paper does not give groups a strict incentive to outcompete others. However, in spite of this fact, intergroup competition increased contributions in 93.33% of the groups. This is even the case in the treatment with relatively weak incentives to compete, in which 80% of the groups increased their average contribution. Thus, for the purpose of increasing group output, non-rival intergroup competition works remarkably well.

In treatments with strong incentives to compete, intergroup competition generally produced the desired result, that is, many winners and few (or no) losers. Thus, in spite of the multiplicity of equilibria, subjects seem to focus on the Pareto-dominant equilibrium. With reduced incentives to compete, groups fail to coordinate on the same cooperation level. Interestingly, this miscoordination seems to be due to the fact the highest-paying equilibrium is no longer the Pareto-dominant outcome. This gives 'naturally' cooperative groups an incentive to deviate

from it, as by doing so they can obtain higher earnings. The downside is that groups which are less cooperative are not able to match those contribution levels and thus may be discouraged by constantly losing the competition.

The effect of intergroup competition on the earnings of individuals is less straightforward. In the two treatments with strong incentives to compete a majority of participants receive higher earnings with competition. However, in spite of the fact that most groups manage to be winners, the few losing groups combined with the large penalty for not winning results in comparable average earnings with or without competition. This fact is apparent when comparing the earnings of the best- and worst-performing groups. In the two treatments with strong incentives, the average earnings of the worst-performing group (out of five) decrease from 21.8 without competition to 14.2 with competition. In contrast, the earnings of the best-performing group increase from 27.0 to 30.4. In other words, intergroup competition increases the earnings of a majority but strongly reduces those of a minority. When groups compete in the treatment with weaker incentives, the penalty for losing is smaller but so are the gains from cooperation, which results again in statistically indistinguishable earnings from the case where there is no competition.¹¹

In summary, we find that that strong non-rival intergroup competition produces a robust increase in cooperative behavior and can benefit a majority of individuals. However, it also produces a few individuals that are severely disadvantaged.

¹¹ In this treatment, the difference between worst- and best-performing groups is affected less by competition. With competition, the average earnings of the worst-performing group decrease from 22.5 to 20.3, and those of the best-performing group increase from 27.6 to 28.9.

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Appendix – Instructions

Below we reproduce the instructions used in T3. Instructions for other treatments are available upon request.

General Instructions

You are now taking part in an economic experiment. Depending on your decisions and the decisions of other participants you can earn a considerable amount of money. How you can earn money is described in these instructions. It is therefore important that you read these instructions carefully.

During the experiment you are not allowed to communicate with other participants in whatever way. If you have any questions please raise your hand. One of us will come to your table to answer your question.

During the experiment your earnings will be calculated in points. At the end of the experiment points will be converted to Danish kroner (DKK) at the following rate:

$$25 \text{ points} = 10 \text{ DKK}$$

After the experiment your total earnings from the experiment will be paid out to you anonymously and in cash.

In the experiment, all participants are randomly divided into groups of 3. This means that you are in a group with two other participants. You will be part of the same group throughout the experiment. Nobody knows which other participants are in their group, and nobody will be informed who was in which group after the experiment.

The experiment today consists of two parts. You will receive detailed instructions of each part of the experiment before the start of the respective part. The following pages describe in detail part one of the experiment.

Instructions for part one

Your decision

The first part of the experiment has 10 periods. In each period, everyone will be given an endowment of 20 points. Then, you and the other group members simultaneously decide how to use the endowment of 20 points. You have two possibilities:

1. You can allocate points to a group account.
2. You can allocate points to a private account.

You have to use your entire endowment in each period. That is, the points you put into the group account and the points you put into the private account have to sum up to 20. You will be asked to indicate the number of points you want to put in the group account. The remaining points will be automatically allocated to the private account.

How to calculate your income

Your total income depends on the total number of points in the group account, and the number of points in your private account.

Your income from your private account is equal to the number of points you allocated to the private account. For each point you put into the private account you get an income of 1 point. The income of other group members is not affected by the points you allocate to your private account. For example, your income from the private account is 3 points if you put 3 points into it.

Your income from the group account is the sum of points allocated to the group account by all 3 members multiplied by 0.5. For each point you put into the group account you and all other group members get an income of 0.5 points. For example, if the sum of points in the group account is 24, then your income from the group account and the income of each other group member from the group account is 12.

Your income in points

$20 - (\text{points you allocate to the group account}) + 0.5 \times (\text{the sum of points allocated by all 3 group members to the account})$

You get an income of 1 point for each point you allocate to your private account. If you instead allocate 1 extra point to the group account, your income from the group account increases by $1 \times 0.5 = 0.5$ points and your income from your private account decreases by 1 point. Note that by doing this the income of other group members increases by 0.5 points. Therefore, the total group income increases by $3 \times 0.5 = 1.5$ points. Other group members therefore also obtain income if you allocate points to the group account. Note that, you also obtain income from points allocated to the group account by other members. You obtain $1 \times 0.5 = 0.5$ points for each point allocated to the group account by another group member.

Examples

Suppose you allocate 10 points to the group account, the second member of your group allocates 20 points and the third group member allocates 0 points. In this case, the sum of points on the group account will be 30 points, and all group members get an income of $30 \times 0.5 = 15$ points from the group account.

Your income in that period is: $(20 - 10) + 15 = 25$ points.

The second group member's income is: $(20 - 20) + 15 = 15$ points.

The third group member's income is: $(20 - 0) + 15 = 35$ points.

Instructions for part two

In this part of the experiment, everything is the same as in part one, except that your income will be influenced by the "rank" that your group has relative to the other groups.

The ranking is based on the number of points on the group account of your group compared to the other groups. This will be explained in more detail later.

In the experiment there are 5 groups in total. Group composition will be the same as in part one. That is, the two other members of your group will be the same

as before. Except for the ranking everything is the same. In particular each participant decides how to allocate 20 points in each period as before.

How to calculate your income

Here is an illustration of, how your decision determines your income, note that it is *the points allocated to the group account by all members* that determine the rank of the group.

Your decision → Points in the group account → Rank → Conversion → Income

Your decision, that is, the number of points you allocate to the group account, influences the total number of points on the group account. The total number of points on the group account determines the rank of your group. The rank determines the conversion factor. The conversion factor influences all your period's income.

Your income in points

$$[20 - (\text{points you allocate to the group account}) + 0.5 \times (\text{the sum of points allocated by all 3 group members to the account})] \times \text{conversion factor}$$

The size of the conversion factor, is determined by the points allocated to your group account compared the group account of other groups. *Note that all of your income is multiplied by the conversion factor.*

For a given contribution, the higher the conversion factor of your group, the higher your income. The group with the highest number of points on the group account is assigned rank 1, which means that this group gets the highest conversion factor of 1.0. The group with the second highest number of points on the group account is assigned rank 2, which means that this group gets a conversion factor of 0.95, and so on. The conversion factor for a given rank is given in the following table.

Rank	Conversion factor
1	1.00
2	0.95
3	0.90
4	0.85
5	0.80

If more than one group contributes the same number of points to the group account, then they get the same conversion factor. For example if all groups have the same number of points in the group account, they all have the same rank (that is, rank 1) and the same conversion factor (that is, 1.00).

If two groups are ranked 1, the group with the third highest number of points in the group account will have the rank 3 and a conversion factor of 0.90 (see table below).

Examples

Group number	Number of points in the group account	Rank	Conversion Factor
1	29	3	0.90
2	32	1	1.00
3	32	1	1.00
4	29	3	0.90
5	11	5	0.80

Suppose you are a member of group 1 and suppose you have allocated 10 points to the group account, suppose the other two members allocated 19 points in total. In this case the sum of points on the group account is 29, and the rank of your group is 3. The conversion factor of your group is 0.90. As a consequence your income is: $(20 - 10 + 0.5 \times 29) \times 0.90 = 22.05$ points.

Now, suppose you are a member of group 2 and suppose you have allocated 0 points to the group account, suppose the other two members allocated 32 points in total. In this case the sum of points on the group account is 32, and the rank of your group is 1. The conversion factor of your group is 1.00. As a consequence your income is: $(20 - 0 + 0.5 \times 32) \times 1.00 = 36$ points.

As a further example, suppose you are a member of group 5 and suppose you have allocated 11 points to the group account, suppose the other two members allocated 0 points in total. In this case the sum of points on the group account is 11, and the rank of your group is 5. The conversion factor of your group is 0.80. As a consequence your income is: $(20 - 11 + 0.5 \times 11) \times 0.80 = 11.6$ points.