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Within-group inequality in inter-group competition

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Abstract

In experiments, contributions to a team public good increase when the team is placed in a competition with another team for prize. This paper is concerned with whether this insight generalises to teams that are internally unequal. In the experiment we report, it does. Indeed, the boost to public goods contributions is bigger with unequal teams than equal ones. We also find that the boost to contributions is most significant among the 'rich' in the team. Hence, since the public good is shared equally, competition not only promotes efficiency, it also reduces inequality in our experiment.

JEL Codes: C72, C91, C92, D31, D63, D72, H41

Keywords: public goods, experiment, team competition, inequality, within group, productivity

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1. Introduction

Contributions to a team public good are boosted in experiments when the team is placed in competition with another for a prize (see Bornstein *et al.*, 1990, Nalbaltian and Schotter, 1997, Bowles and Gintis, 2011, Tan and Bolle, 2007, Ishida, 2006, Guntthorsdottir and Rapoport, 2006, and Marino and Zábojník, 2004). This is a potentially useful insight with respect to how competition might affect economic performance. But, since most experiments have teams where individuals are endowed equally, a question naturally arises: does it also apply when there is inequality within teams? To our knowledge this question has not been considered systematically. We address it with an experiment in this paper.

The question is important for several reasons. First, in practice, teams rarely comprise of equally endowed individuals. So the practical value of the insight regarding the boost to cooperation from competition will depend on whether it generalises to instances of within-team inequality.[1] Second, there are reasons for supposing that it might not, or at least not in the same degree. For instance, suppose that competition has this effect upon individual contributions to a team public good because it primes individual identification with the team in the manner of Social Identity Theory (see Tajfel and Turner, 1979, and Akerlof and Kranton, 2000). We know from experiments on inequality in public goods games that contributions typically fall with inequality (e.g. see Buckley and Croson, 2006, Reuben and Riedl, 2013, and Hargreaves Heap *et al.*, 2016). Thus, team identification in this sense may be plausibly initially weaker under inequality and so, perhaps, less easily primed by competition as compared with when there is equality within a team. An experiment allows a direct test of this empirical question.

Third, there is an important contemporary policy dimension to this question. Policy changes are difficult to enact; so policy makers need to know where best to focus their attention. Should they focus on promoting equality or competition if they want to improve economic performance through higher contributions to team public goods? Against the backdrop of rising inequality and reduced product market competition, there is scope for both. But we cannot answer which will likely be the more effective until we know how competition affects contributions when teams are unequal.

[1] We know mild levels of inequality between competing teams that are internally equal can lead to higher cooperation (Hargreaves Heap et al., 2015).

To examine whether the insight regarding competition generalises to unequal teams, we are able to exploit the results from two earlier linked experiments. Our new experiment links with these by testing how teams that are unequal (in the same way as Hargreaves Heap *et al,* 2016) respond to the injection of the same competition as has been studied in equal teams (in Hargreaves Heap *et al*, 2015). Figure 1 sets this out. From Hargreaves Heap *et al* (2015), we know the public goods contribution by equal teams under competition = X and it is Y when there is no competition; and X > Y (that is, there is a boost from competition). From Hargreaves Heap *et al* (2016), we know the public goods contributions in an unequal team = Z and Z < Y. Our new experiment addresses the magnitude of W: the public goods contribution when there is a competition between unequal teams.

Figure 1. Variation of Public goods contributions (X, Y, Z and W) with competition and inequality

	Within Team Equality	**Within Team Inequality**
Between team competition	**X**	**W?**
No between team competition	**Y**	**Z**

In our experiment, we examine three treatments with inter-group competition between two teams. Within each team, groups play a linear VCM public goods game. A team's aggregate contribution to the public good is also its bid in a Tullock contest for prize. The prize is split evenly between all members of the winning group. We compare competitions where competing teams are each equally endowed, where competing teams are each unequally endowed, and where one team is equally endowed and the other team is unequally endowed. As controls, we also examine two linear VCM treatments, one in which team members are equally endowed and one in which team members are unequally endowed. In all treatments, a team's aggregate endowment is held constant and this aggregate endowment is the same for both competing teams. The difference between equally and unequally endowed teams is the distribution of the aggregate endowment among group members.

We find, contrary to the doubt that we have just sketched about the efficacy of competition when there is inequality, that the introduction of competition among unequal teams boosts contributions by more than is the case when the same competition occurs between equal teams: (W - Z) > (X - Y). Indeed, there is no difference in the level of contributions to the public good when the teams are internally unequal and when they are equal (W = X). Thus, the introduction of competition eradicates the effect of inequality that has been found when competition is absent.

There is another aspect to our results that concerns the behaviour of the 'rich' and the consequent effect of competition on inequality. The fall in public goods contributions that occurs with inequality, in the absence of competition, as compared with when there is equality of endowments is due to the behaviour of the 'rich' under inequality (see Hargreaves Heap *et al*, 2016). The 'poor' and 'middle' income individuals contribute as much in % terms as do individuals with the same endowments in equal groups. It is the 'rich' who lower their % contribution when there is inequality and this accounts for why inequality lowers contributions in the aggregate. There is some other evidence that the 'rich' in unequal societies become less connected to others or less pro-social in other contexts (e.g., see Piff *et al.*, 2012, Dietze and Knowles, 2016 and Rapoport *et al*., 1989). Indeed, the Economist (2018) recently began jts manifesto for liberalism by noting that 'Europe and America are in throes of a popular rebellion against liberal elites, who are seen as self-serving and unable, or unwilling, to solve the problems of ordinary people'. What is interesting in this context is that the improvement in contributions with the introduction of competition when there is inequality occurs largely because the 'rich' raise their % contribution back to the same level as the others. Thus, they appear to reconnect with others in society with the competition. Of course, since all share equally in the public good, when the 'rich' increase their contribution, this action promotes greater equality. Thus, we find that the injection of competition when there is inequality not only raises efficiency, it also reduces inequality.

Another finding is that equal teams increase cooperation by a significantly greater amount when competing with an unequal team than when competing with another equal team. This suggests that competition between equal and unequal teams leads to the greatest efficiency levels, greater efficiency than competition between ex-ante identical teams.

In the next section, we present a model of team production among selfish individuals that takes the form of a public goods problem. We use this model to examine how team production is affected by equality/inequality within the team and by the presence/absence of competition between teams. This provides the baseline predictions regarding contributions to the public good. Section 3 explains the design of the experiment in detail and we develop behavioural conjectures regarding the possible influence of equality/inequality and the presence/absence of competition on cooperation. Section 4 gives the results. We discuss them and conclude the paper in Section 5. The online Electronic Supplementary Material contains additional analysis (Appendix A) and the experimental instructions for the competition treatment with inequality within one group and for the VCM-Inequality treatment (Appendix B).

2. A model of team production

Following Hargreaves Heap et al.'s (2015) adaptation of the setup in Guntthorsdottir and Rapoport (2006), we model team production as a public goods game where individuals have a choice between keeping their endowment (their labour, which may embody more or less human capital) in a private account (where it is experienced as a form of leisure) or make a contribution to a public good (that is, work to produce a good that all members of the team benefit from equally). In this way the average productivity of individuals in a team is given by the average contribution to the public good. We model equality/inequality through the individual endowments of team members (e.g. through the presence of more or less human capital which is productive both in leisure activities and in team production). We introduce competition between the teams by placing two teams into a Tullock contest for an additional prize, where the probability of winning the prize depends upon the relative sizes of their public goods contributions. The contest prize might be thought of either as a managerial device when the two teams belong to the same organisation or as some new third market that the two teams/organisations either do or do not compete for, and where the chances of success when there is competition depends on their relative labour productivities (because this produces price or quality attributes).

In particular, in the absence of competition, player *i* in each group *k* composed of *m* players is endowed with $e_{ik} > 0$ tokens, and decides how much of it, $0 \leq x_{ik} \leq e_{ik}$, to contribute to team production (the public good). The retained endoment, (e_{ik} - x_{ik}), is invested in a private good. Each player's return from the private good is 1 and each player's return from the public good is equal to a fraction g ($0 < g < 1 < mg$) of the total contribution to the public good in group

k, denoted by $X_k = \sum_i x_{ik}$. Thus, g is the marginal per-capita return (MPCR) from the public good. The payoff to player i in group k is

$$V_{ik} = (e_{ik} - x_{ik}) + g X_k \tag{1}$$

In the Nash equilibrium, each player contributes nothing to the public good while all players contribute their entire endowments in the social optimum. Both the equilibrium and optimum are the same under finite repetitions of the stage game. These predictions are not affected by whether initial endowments are equal or unequal.

When there is competition between teams, the public goods decision just described is, in addition, linked to a team competition between two groups. Groups k and l ($k \neq l$) compete for a prize S. The total allocations to the public good in the two groups, X_k and X_l, determine the probability with which each group wins the prize according to the Tullock contest success function (Tullock, 1980) given by

$$Prob\ (Group\ k\ wins) = \begin{cases} X_k / (X_k + X_l) & \text{if } (X_k + X_l) \neq 0 \\ 1/2 & \text{otherwise} \end{cases}. \tag{2}$$

The prize S is split equally amongst the m members of the winning group. Individual payoffs are given by

$$V_{ik} = (e_{ik} - x_{ik}) + g X_k + [X_k/(X_k + X_l)].(S/m). \tag{3}$$

In an interior equilibrium, we now have (see Appendix A for a derivation)

$$X_k^* = X_l^* = \frac{S}{[4m\,(1-g)]} > 0. \tag{4}$$

That is, there are positive contributions to the public good. The only requirement is that both groups have sufficient funds. Further, there are multiple equilibria – any combination of contribution decisions that sum to X_k^* in each group constitutes an equilibrium. Since the public goods element of the game still remains, the social optimum remains unchanged, i.e., full contribution by all individuals (and so the predicted cooperation here is still sub-optimal). Once again, both the equilibrium and optimum remain the same under finite repetition.

The key equilibrium predictions of the model are: [2]

1. The competition for the prize raises contributions to the public good above the zero value when there is no competition.

2. As long as both groups have sufficient funds, inequality in endowments among members of one's own group has no effect on contributions.

3. As long as both groups have sufficient funds, inequality in endowments among members of the competing group has no effect on contributions.

3. Experimental design, behavioural conjectures and procedures

Our baseline is a linear VCM without competition. This has two variants: (i) equality of individual endowments (VCM-E) and (ii) inequality of individual endowments (VCM-I). The total value of the endowments is the same in both cases.

Our competition treatments append the Tullock contest and we consider three possible two-team competitions: (i) between teams with equal endowments (COMP-EE); (ii) between teams where both have inequality in their individual endowments (COMP-II) and (iii) between a team with equal endowments and one with unequal endowments (COMP-EI). The first two competition treatments are crucial for the question that primarily concerns us. This is because the comparison of VCM-E with COMP-EE involves a single change: the injection of competition. Likewise, the comparison of VCM-I with COMP-II has one change: the injection of competition. The possible difference in this effect of competition in equal and unequal teams is what interests us. The third competition treatment (COMP-EI) is logically possible, but when compared with either VCM-E or VCM-I, it involves two changes: an injection of competition and a contrast between the groups that are competing (one is equal and the other unequal). For reasons we discuss later such a group contrast may matter for cooperation and so this treatment cannot be used to assess the pure effects of competition. However, when compared with either

[2] Cf. Bhattacharya (2016) who studies between-team inequalities in abilities and effort costs in pure inter-team Tullock contests, i.e., without the public good provision stage. In this paper, we are more interested in the effect of competition on cooperative effort than on competitive effort (as in Bhattacharya, 2016). In our model, greater effort is efficiency enhancing while this is not always the case in pure inter-team contests. In addition to examining a different source of inequality (in endowments) than in Bhattacharya (2016), we are also interested in within-team inequality and not between-team inequality. Finally, in our model, the Nash equilibrium is unaffected by the presence of inequality in endowments.

COMP-EE and/or COMP-II it will provide a test of whether there are such group contrast effects on cooperation.

The precise details of the decisions and pay-offs in each part are as follows.

3.1 Linear VCM treatments

The baselines are linear public goods games that use the Voluntary Contributions Mechanism (VCM). Each subject in a three-person group (m = 3) received an endowment of tokens that he/she could allocate to a private account or contribute to a group account. Returns from the private account were one. Earnings from the group account were the same for each member of the group and were equal to half the total allocations to the group account by all members of the group, i.e., MPCR = g = 0.5.

In VCM-E, each member of the group received an endowment of 50 tokens. In VCM-I, one member of the group received an endowment of 20 tokens, one an endowment of 50 tokens, and the third an endowment of 80 tokens each period. Importantly, the total per-period endowment in a group was the same, 150 tokens, in both treatments.

At the end of a period, subjects were informed of the total contribution to the public good in their group in that period, and their individual earning from the private account and group accounts in that period. Subjects did not receive any information about the individual decisions of the others in their groups, or about decisions and outcomes in other groups, at any time.

3.2 Competition treatments

In treatments with competition, subjects were once again assigned to groups of three members but now participated in two stages in each period. In the first stage in every period, subjects made the above public good provision decision, i.e., how much of their endowment to allocate between their private accounts and the group account. Returns from both accounts were generated in the same way as in the VCM treatments. Each subject received the same information after the first stage as in the VCM treatments.

In an automatic second stage, each group was paired with another group of three members. The two groups were automatically entered into a competition for a prize that was worth $S = 120$ tokens for the group. Total group allocations by both groups influenced the probability with which each group wins the prize using a Tullock contest success function (2). Each member of the wining group received an equal share of the prize, i.e., 40 tokens. Given our parameters, group contribution to the public good in equilibrium is 20 tokens.

In the second stage, subjects were additionally informed of the total allocation to the group account in the competing group, the winning probabilities for each group and which group won the prize in the period.

We used the same endowment configurations as in the VCM treatments. Each member of an equal group received a per-period endowment of 50 tokens. In unequal groups, one member received an endowment of 20 tokens, another an endowment of 50 tokens and the third, an endowment of 80 tokens.

In the first competition treatment (Comp-EE), both competing groups were equal. In the second (Comp-II), both groups had the unequal distribution of endowments. In the third treatment (Comp-EI), the resource distribution was equal (E) in one group and unequal (I) in the other group. In all treatments, subjects knew the distribution of endowments in their own group and in the competing group. However, they were never informed who received each endowment.

Our chosen endowment levels guaranteed that each group could contribute at least the equilibrium prediction of 20 tokens to the public good. Moreover, each individual in each group could single-handedly contribute the equilibrium amount. Thus, we preserved the equilibrium prediction in all competition treatments. Finally, the total amount of resources in each group was kept the same in all groups, regardless of the internal distribution of endowments.

Table 1 summarises our treatments and lists the number of observations in each treatment.

Table 1. Summary of treatments and PG predictions

Treatment	Competition?	Endowments within group: Group 1	Group 2	# groups	# pairs	PG prediction
VCM-E	No	50-50-50	-	12	-	0
VCM-I	No	20-50-80	-	13	-	0
Comp-EE	Yes	50-50-50	50-50-50	22	11	20
Comp-EI	Yes	50-50-50	20-50-80	28	14	20
Comp-II	Yes	20-50-80	20-50-80	24	12	20
Total		**-**		**99**	**37**	

Note: Data from treatments VCM-E and Comp-EE were used in Hargreaves Heap *et al*. (2015) – respectively, VCM50 and Comp50-50. Also, data from treatments VCM-E and VCM-I were used in Hargreaves Heap *et al*. (2016) – respectively, VCM50 and VCM20-50-80. In the latter, we examine the influence of inequality on public good contributions and in the former we consider how inequality between teams affects contributions.

3.3 Behavioural conjectures

Despite the classical model being silent on differences we might expect across our treatments varying endowment inequality, we make behavioural conjectures by exploring empirical evidence from previous papers. There is considerable evidence that subjects make non-zero contributions in ordinary public goods games played by subjects with equal endowments; and hence evidence of cooperation that is not predicted in the baseline model. More generally, contributions to public goods are typically higher when individuals identify more strongly with the fellow members of their group (e.g., see Chen and Li, 2009, Corr *et al.*, 2015, on the in-group bias in contributions). One might suspect that inequality between members of a team weakens this identification and so will tend to lower contributions to the public good; and this is what has been found when there is inequality (see Reuben and Riedl, 2013, Hargreaves Heap *et al.*, 2016).

There is also evidence that the injection of competition between teams raises their public goods contributions (see Bornstein *et al.*, 1990, Guntthorsdottir and Rapoport, 2006). It is possible that competition works in this way because it primes or makes more salient team identity. This would be expected, for example, from Social Identity Theory (see Tajfel and Turner, 1979, and Akerlof and Kranton, 2000). Accordingly, if cooperation is initially weaker in unequal teams one might expect the boost from priming team identity through a competition will also be weaker in unequal teams. This is the basis of C1.

C1: Unequal teams respond less strongly to competition through the increase in their aggregate contribution to the public good than do equal teams.

Against C1, a boost to contributions from competition is expected for reasons unrelated to identification, on selfish grounds, in the baseline model above; and this is the same whether the team is equal or unequal. If for this reason there is little difference between the effect of competition in equal and unequal teams (or if C1 cannot be rejected for other reasons), we still expect equal teams in competition to exhibit more cooperation than unequal ones because of their differences when there is no competition (i.e., they start from a higher level of contributions).

C2 Equal teams in competition contribute more to the public good than do unequal teams in competition.

C3 focuses on the behaviour of the ‘rich’ as the specific underpinning for C1. Evidence from public goods games with equality/inequality in the absence of competition suggests contributions to the public good fall with inequality because the % contribution of the rich fall under inequality. Their cooperation diminished and thus we expect competition to have a weaker effect on priming cooperation among the rich.

C3: The rich respond to competition by increasing their % contribution to the public good by less than the poor in their team.

These are the key new conjectures we wish to test regarding the effect of inequality within a team on cooperation under competition. Inequality within a team may, however, have a further effect from the possible contrast with the other team. Social Identity Theory, for example, predicts that a team member’s sense of identity from belonging to that team depends on the contrast with other groups (see Tajfel and Turner, 1979; Akerlof and Kranton, 2000). As a result, we might expect the greatest boost from competition when equal teams compete with unequal ones because this creates a sharp contrast between groups. C4 tests for this effect.[3]

[3] Against these group-identification lines of argument (and C1, C4), it is possible that individuals simply value winning intrinsically (that is, independently of whatever the monetary value is of the prize) and this explains why they contribute more to the public good when there is a competition. Indeed, there is evidence of this effect from experiments on individual contests (see Sheremeta, 2010). If this is also the motive that is triggered in a group competition, then it is not obvious that inequality within the team will affect the level of individual contribution when there is competition. Indeed, in the model we set out in section 2, inequality does not affect contributions to the public good under competition so long as endowments are sufficient to cover an individual’s willingness to pay for this extra non-pecuniary buzz from winning.

C4: The boost in contributions to the public good from competition is greatest for each type of team when an equal team competes with an unequal one.

3.4 Procedures

All experimental sessions were conducted using student subjects at the University of East Anglia (UEA). The 12 or 18 subjects in a session were anonymously and randomly assigned to three-person groups that remained fixed during the session (partner matching). Additionally, in the competition treatments, each group was randomly matched with another group and this matching also remained fixed throughout the session.

Once instructions were read aloud by an experimenter, each subject had to answer correctly a quiz before the experiment began. The experiment was computerised using z-Tree (Fischbacher 2007). A total of 297 subjects participated and no subject participated in more than one session (between-subject design).

In all treatments, the stage game was repeated for 20 periods. Earnings from a period could not be carried forward to future periods. In each period, each subject received a fresh endowment. Further, each subject received the same endowment each period. Subjects were paid their earnings from all 20 periods of the game. In the VCM treatments, accumulated token earnings were converted to cash at the rate of 150 tokens to £1. In the competition treatments, final token earnings were converted to cash at the rate of 200 tokens to £1. As in Hargreaves Heap *et al.* (2015), different exchange rates were used to keep earnings comparable between treatments with and without competition. A session lasted 45 minutes on average and each subject earned between £10 and £11 on average including a £2 show-up fee.

4. Results

Unless otherwise mentioned, we use nonparametric Wilcoxon rank sum tests to make pairwise comparisons of the team contributions across treatments. The p-values reported are for two-sided tests.

4.1 The effects of competition on cooperation in equal and in unequal teams

We begin by identifying whether competition in our experiment produces an increase in contributions to the public good. Figure 2 presents the data on this for each period for equal teams in panel a) and unequal teams in panel b). Table 2 presents summary statistics of per-period (averaged over all 20 periods) group account contributions in equal and unequal groups. An observation is a group of three members, except in Comp-EE and in Comp-II, where an observation is the average group contribution in a competing *pair* of groups.

Figure 2. Average group contributions over time in equal and unequal groups

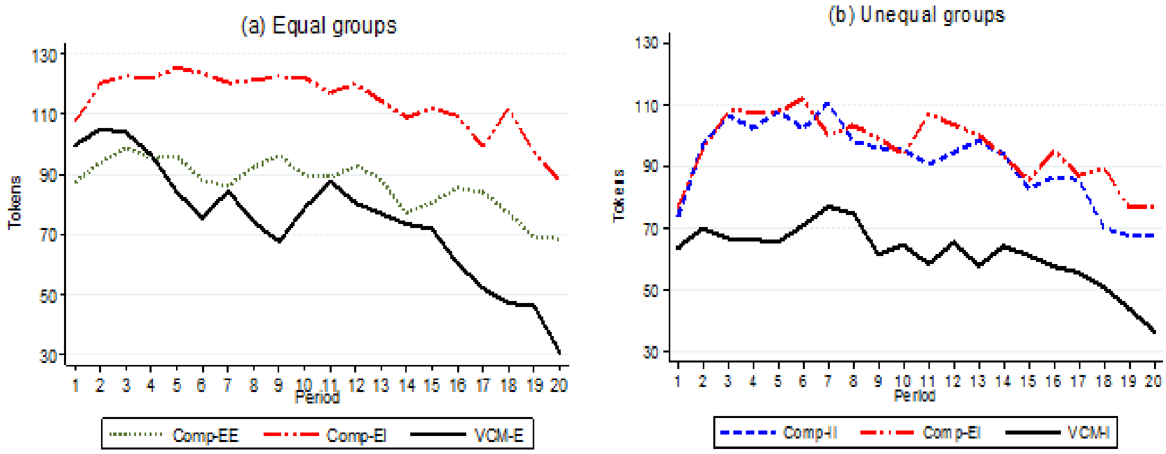


Table 2. Average group contributions

	Obs	Equal groups	Unequal groups
VCM-E	12	74.78 (45.99)	-
VCM-I	13	-	61.49 (45.07)
Comp-EE	11	86.78 (17.72)	-
Comp-EI	14	114.20 (30.24)	95.89 (28.50)
Comp-II	12	-	91.32 (17.69)

Figures in parentheses are standard deviations. In Comp-EE and Comp-II, an observation is a competing pair.

Figure 2 (a) shows the usual pattern of declining contributions in VCM-E (for instance, see Fehr and Gächter, 2000) and it suggests that while equal groups contribute more throughout in COMP-EI, it is only towards the end that equal groups contribute more in COMP-EE. Table 2 reinforces this impression. The contributions are only statistically significantly higher in Comp-EE than in VCM-E in the last 5 periods (p = 0.0423; Result 1 in Hargreaves Heap et al., 2015). However, the increase in the equal group in Comp-EI over VCM-E is significant when averaged over all rounds (p = 0.0221).

Figure 2 (b) shows a similar decline over time in the contributions in unequal groups and a much clearer difference when there is competition. Averaged over all 20 rounds, mean group contributions are significantly higher for the unequal group in Comp-EI (p = 0.0153) and in Comp-II (p = 0.0339) than in VCM-I.

The positive effects of competition on equal and unequal groups are robust to group-level panel random effects regressions (separate for equal and unequal groups). The dependent variable is group account contribution in a round. Independent variables are one-period lagged group contribution, treatment dummies and period dummies. The regressions are presented in columns 2 and 4 in Table A1 in Appendix A in the Electronic Supplementary Material.

We turn now to our Conjectures relating to the effects of competition. For C1-C3, we consider only competitions between equal teams and competitions between unequal teams. This avoids any confounding effect from an external contrast in the equal/unequal contests. Measured by the difference between a competing group's average aggregate contribution across all rounds and a VCM group's mean aggregate contribution, the boost in equal teams when they compete with other equal teams is significantly lower than the boost that comes for unequal teams when they compete with other unequal teams (11.99 vs. 29.83; p = 0.0423).[4]

Result 1 (against C1): *Competition between unequal teams increases their contributions to their team public goods by more than does competition between equal teams.*

Note that average contributions are lower in unequal teams than in equal teams in the absence of competition (Table 2 and Hargreaves Heap *et al*., 2016). However, the greater boost in unequal teams due to competition leads to higher average group contributions in Comp-II than

[4] This result is supported in group-level regressions reported in columns 1 and 3 of Table A1 in Appendix A in the Electronic Supplementary Material – the boost from competition (over all 20 rounds) is statistically significant only for unequal groups.

in Comp-EE (see Table 2). While a test shows that this difference in average group contributions is not statistically significant at the 10% level, the group-level regression reported in column 5 of Table A1 in Appendix A shows the difference is significant at the 10% level (p = 0.075).

Result 2 (against C2): *Unequal teams contribute (weakly) more to the public good in competitions between themselves than do equal teams in competitions with other equal teams.*

We gain some insight into why unequal teams gain more from competition by examining the behaviour of the rich. Table 3 presents average (over all 20 rounds) individual percentage (of endowment) contribution for unequal teams by endowment level (20, 50 and 80) with and without competition with other unequal teams.

Table 3. Mean percentage contribution in unequal groups

	Obs	End 20	End 50	End 80
VCM-I	13	49.00	50.49	33.05
		(33.48)	(35.44)	(29.46)
Comp-II	12	67.44	66.72	55.59
		(18.37)	(10.60)	(17.45)

Figures in parentheses are standard deviations.

The disengagement of the rich is apparent in the VCM when there is no competition: the contribution of the rich is significantly smaller than those with the poor and middle endowment levels ($p = 0.0131$ and 0.0159, respectively). The boost from competition is apparent for each endowment level, but it is greatest for the rich (endowment 80). Further, comparing the contribution with and without competition by each endowment level, the only boost that is statistically significant is that for the rich ($p = 0.0123$; $p > 0.10$ for the other endowment levels).

Result 3 (against C3): *The rich respond to competition by increasing their % contribution to the public good by more than others in their team.*

4.2 The effect of contrast in competition on cooperation when equal and unequal teams compete

We turn now to C4 and the effect on cooperation of contrast between teams in competition.

Figure 2a suggests that equal teams contribute more when they compete with unequal ones than equal ones and the difference in Table 2 averaged over all rounds is significant (114.20

vs. 86.78; p = 0.0285). A post-regression Wald test on regression (2) reported in Table A1 confirms that group contributions in equal groups are higher in Comp-EI than in Comp-EE (p = 0.0297).

Result 4a (consistent with C4 for equal groups): *In the presence of competition, equal groups contribute more on average to the public good when they face an unequal group than when they face another equal group.*

There is no such apparent difference for unequal teams in Figure 2 (b). Table 2 shows that average per-round contributions by Unequal groups are higher in Comp-EI than in Comp-II (95.89 vs. 91.32), but this is not statistically significant (even at the 10% level). A Wald test after regression (4) reported in Table A1 confirms that group contributions in unequal groups in Comp-EI and Comp-II are not significantly different (p > 0.10).

Result 4b (against C4 for unequal groups): *In the presence of competition, average contributions to the public good in unequal groups are not significantly affected by whether the competing group is equal or unequal.*

In other words, combining Results 4a and 4b, it seems that equal groups do not simply recover their competitive instinct when competing with unequal teams, they actually compete more vigorously than do the unequal ones. We interpret this as equal teams becoming, as it were, 'evangelical'.[5] To explore this 'evangelical' behaviour in equal teams, we extend what is known from individual contest and public goods experiments when there is no competition: that individual contributions in contests depend on the lagged contribution of their opponent (for instance, see Dechenaux *et al.*, 2015) and that individual contributions to public goods depend on the lagged contributions of other group members (for instance, see Sefton *et al.*, 2007).

We estimate two individual panel random-effect regressions of public good contributions by those in equal groups in Comp-EE and in Comp-EI. In the first regression, the independent variables are the individual's one-period lagged contribution, the lagged deviation of his/her contribution from the average of others in the group, an indicator for whether his/her group won the prize in the previous period, the competing group's total contribution in the previous

[5] Figure A2 and Table A2 in Appendix A compare contributions in the equal and unequal groups when facing one another, i.e., in Comp-EI. In a competition between an equal group and an unequal group, controlling for past behaviour, average contributions to the public good are (weakly) higher in equal groups than in unequal groups.

period, a dummy for the Comp-EI treatment (excluded category = Comp-EE), and period dummies. In the second regression, we additionally include interactions between the treatment dummy and the lagged win dummy and the lagged opponent's contribution. In both regressions, we estimate robust standard errors clustered on competing pairs of groups. The regression estimates are presented in Table 4.[6]

Table 4. Determinants of individual contributions in equal competing groups

Lagged own contribution	0.662***	0.651***
	(0.043)	(0.046)
Lagged deviation from contribution of others in own group	-0.128***	-0.123***
	(0.025)	(0.025)
Lagged indicator for win	-0.605	-0.590
	(0.941)	(1.425)
Lagged group contribution in competing group	-0.006	-0.024
	(0.012)	(0.015)
Comp-EI	2.030**	-2.063
	(0.917)	(2.344)
Lagged win × Comp-EI	-	-0.119
		(1.802)
Lagged competitor's group contribution × Comp-EI	-	0.046**
		(0.022)
Constant	9.319***	11.57***
	(2.341)	(3.042)
Observations	2034	2034

Dependent variable = individual contribution in a period. Only includes data for individuals in equal groups that face competition. Standard errors clustered on pairs in parentheses. Includes period dummies (not reported). In both regressions, the excluded category is Comp-EE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The first regression confirms at the individual level the earlier finding that contributions are higher in equal groups when they compete against unequal ones. The second regression shows that this increase is driven by a difference in the reaction to the contribution by the competing group. While the lagged contribution of the competitor is not significant in both regressions, the interaction of this variable with the Comp-EI dummy is positive and significant in the

[6] They generate the usual significant effect of own lagged contribution and deviation from contribution of others as has been found in the public goods literature.

second regression. This suggests that individuals in equal groups react more strongly, in the sense of increasing their own contributions, to an increase in contributions by an *unequal* competing group than by an equal competing group.[7]

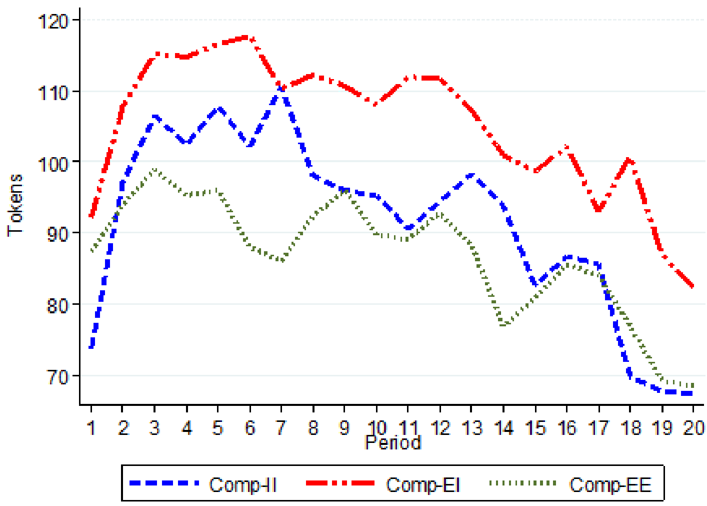
Result 5: *Individuals in equal groups raise contributions by a greater amount in response to an increase in contributions by unequal competing groups than by equal competing groups.*

Since this responsiveness to the contribution of the other team can be taken as another indicator of a team's competitiveness, this reinforces the conclusion from the evidence on aggregate contributions that equal teams are less inclined to compete with each other.

4.3 The welfare effects of inequality under competition

To complete the analysis of the effects of inequality when there is competition, we consider whether the combined average contributions of both teams in the competition depends on level of inequality. For this purpose, we measure inequality by the number of teams with unequal internal distributions. So, we compare equality (where both teams are equal), with part inequality (where one team is equal and the other is unequal) and finally with full inequality (where both teams are unequal). Figure 3 presents average group contributions in a pair over time.

Figure 3. Average group contributions over time in competing pairs of groups



[7] We have conducted similar analysis for unequal groups, using % contributions to adjust for the differences in endowment and we find that there is not a similar difference in how unequal group members respond to the contribution of their opponent between different types (see Table A3 in Appendix A in the Electronic Supplementary Material).

Comp-EI stands out as one might expect, given Results 2, 4a, and 4b. The average group contribution is marginally significantly higher in Comp-EI than Comp-EE (p = 0.0798), and the other differences are not significant.

As above, we estimate a group-level panel random effects regression of group account contributions in the competition treatments on lagged group contributions, treatment dummies (the excluded treatment is Comp-EE), and period dummies. In addition, since we only include data from the competition treatments, we also include controls for past competitive outcomes – an indicator for winning the prize in the previous period, and the competing group's lagged group account contribution. The second regression also includes a dummy for unequal groups in Comp-EI. The regression estimates are presented in Table 5. We report robust standard errors clustered on independent competing pairs of groups.

Table 5. Comparing competition treatments – group level regressions

Lagged group account contribution	0.731***	0.725***
	(0.000)	(0.038)
Lagged indicator for win	-1.959	-1.934
	(1.706)	(1.716)
Lagged group account contribution in competing group	-0.002	0.003
	(0.034)	(0.034)
Comp-EI	5.417**	7.678**
	(2.45)	(3.092)
Comp-II	1.766	1.757
	(2.176)	(2.176)
Unequal group in Comp-EI	----	-4.548
		(3.125)
Constant	36.62***	36.62***
	(4.574)	(4.580)
Observations		1398

Standard errors clustered on pairs in parentheses. Includes period dummies (not reported). The excluded treatment is Comp-EE. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The first regression confirms the finding from the aggregate tests that group contributions in Comp-EI are significantly higher than in Comp-EE (p = 0.027) and that contributions in Comp-II are not significantly different from those in Comp-EE (p > 0.10). The second regression highlights that equal groups in Comp-EI have higher contributions than equal groups in Comp-EE, as the Comp-EI dummy is significant (p = 0.013).[8]

Result 6: *In the presence of competition, total contributions are highest when there is one unequal group in a competing pair. Thus, it appears the effect of unequal groups on total contributions in group competitions is non-monotonic.*

As reported above, the ‘rich’ increase their % contribution in competition treatments to levels similar those of the ‘middle’ and ‘poor’ subjects. Theoretically, this decreases inequality in COMP-II and within the unequal groups in COMP-EI relative to VCM-I because earnings from the group account are divided evenly. Empirically, Table 6 reports Gini coefficients based on final accumulated group member earnings at the group level (or competing pair level in COMP-II) for each treatment.

Table 6. Gini coefficients based on group members’ final earnings

	Obs	**Gini coeff.**
Starting Endowments (20, 50, 80)	---	0.27 (---)
VCM-I	13	0.17 (0.08)
Comp-II	12	0.10 (0.03)
Comp-EI	14	0.08 (0.05)

Figures in parentheses are standard deviations.

The possible range for the Gini coefficient is between 0 and 1. If group members’ earnings were perfectly equal, the Gini coefficient would be 0. As the Gini coefficient approaches 1, group members’ earnings become more unequal. Based on the initial endowments of (20, 50, 80), the Gini coefficient is 0.27. Compared to the initial endowments, inequality of final earnings is lower in all inequality treatments. However, inequality is significantly greater in

[8] A post-regression Wald test after the second regression rejects the conjecture that Comp-EI = Comp-II (p = 0.0520). This suggests that equal groups in Comp-EI contribute more than groups in Comp-II.

groups in VCM-I compared to COMP-II (p = 0.012) and unequal groups in COMP-EI (p = 0.005).

Result 7: *Compared to unequal groups in VCM-I, competition lowers inequality within groups that are initially unequally endowed.*

5. Discussion and Conclusion

Competition in markets has, of course, been well known, at least since Adam Smith, to promote efficiency through the allocation of resources. The possible beneficial influence of competition on efficiency through its generation of increased cooperation is, in comparison, relatively new. It is nonetheless important because, like the earlier insight, it has policy implications. For example, policy makers have an additional reason to care about the effective absence of competition in markets and managers may want to create competitions between different work groups. However, members of teams in markets or within firms are rarely equally endowed. Indeed, this may itself be a policy choice. What is not known is whether the boost to cooperation from introducing a team competition is robust to the existence of inequality within a team. There are reasons for doubting that it is because the experimental evidence suggests that inequality erodes cooperation when there is no competition. If cooperation is low to begin with, why should it be primed much by the introduction of competition?

We find, however, that the boost to cooperation from competition is actually bigger in unequal teams than equal ones. The extra boost is largely explained by the rich under inequality increasing cooperation when there is competition, which they otherwise lose when there is inequality. In this sense, the new insight regarding team competition and the promotion of efficiency is robust to the existence of within team inequality.

In contrast, the negative influence of equality/inequality on cooperation is not robust in our experiment. It is there when there is no competition but it disappears in the comparison between COMP-EE and COMP-II in our experiment. This does not mean, however, that inequality has no effect on efficiency when there is competition because we find a non-monotonic relation between efficiency and inequality when there is competition. The highest contributions to the public good are in COMP-EI where inequality comes from a mix of E and I endowments rather than the two extremes of COMP-EE and COMP-II.

C1 (unequal teams respond less strongly to competition than equal teams) and C4 (boost to contributions from competition is greatest for each type of team in COMP-EI) are based on the idea that group identification affects cooperation and that such identification may depend respectively on the way groups are constituted through their internal relations of equality/inequality (C1) and external relations of contrast/similarity (C4). Another line of thinking that may offer a better explanation for our results focuses on the way that cognitive dissonance between identity and actions can produce a change in either or both (see Festinger, 1957; Akerlof and Dickens, 1982; Konow, 2000). Thus, an equal team that competes with another equal team may experience some cognitive dissonance because the competition will create inequality (between the teams) where previously there was none. To avoid such dissonance, team members may adjust downwards their identification with equality and hence their team, with the result that they compete less vigorously than when there was no such (or less) dissonance associated with competing.

In comparison, when an equal team competes with an unequal one, the dissonance for members of the equal team is likely to be milder because inequality already exists prior to the competition (and so we expect a stronger boost from competition in these circumstances for the equal team cf. the competition between equal teams). This is the same prediction as C4 for equal teams. Following the same dissonance line of argument, unequal teams will not experience dissonance when they compete with either unequal ones or equal ones and so there will be no difference in team identification: that is, C4 will not hold for unequal teams. Thus, because C4 holds only for equal teams, this speculation favours the cognitive dissonance account over the Social Identity one of how the contrast between teams affects cooperation.

The importance of this result is perhaps best appreciated by considering what it means for our understanding of the recent productivity puzzle in many OECD countries (and the observation that the rich seem increasingly to be living in a world of their own). There are reasons for supposing that both the increase in inequality and the decrease in competition have contributed to the recent poor productivity performance in many OECD countries. This experiment supplies evidence of a new mechanism through which inequality and the absence of competition could have had this effect: that is, both lead to reduced contributions in interactions that have the character of a public goods game. The experiment is also important because it suggests that a policy of promoting competition will be more robust in reversing this trend than an egalitarian redistribution policy. This is not because inequality has no effect on cooperation.

It does. It is because the relationship is non-monotonic in our experiment when there is competition; and so a movement to equality does not always boost productivity.

If, for this reason of robustness, our results suggest that policy makers should lead with a policy of promoting competition, the experiment also points to a further possible beneficial effect such a policy can have on inequality. This is where the fact that it is the ‘rich’ who are primarily affected by the injection of competition in our experiment is important. An injection of competition encourages the ‘rich’ to re-connect with the other income groups in their teams in our experiment: they increase their contributions to a public good. The public good is, of course, equally shared. So by increasing their contribution, the rich are engaging in redistribution.

This is the final contribution of this paper. To return to the Adam Smith insight regarding the beneficial effects of competition in the allocation of resources, it is also well known from the comparison of competition with monopoly in markets that, ceteris paribus, profits are higher under monopoly than competition. Thus, in so far as the entitlement/ownership of profit streams is more unequally distributed than other sources of income (as it is in many OECD countries), an increase in competition will have an equalising effect on incomes (through the reduction in the share of income going to profit). Our experiment not only points to a new mechanism linking competition to productivity via increased team cooperation, the operation of this mechanism reinforces the conclusion that more competition is also likely to promote greater equality. Competition revives what might be called ‘team spirit’ among the ‘rich’ and this is redistributive in its effects.

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ONLINE ONLY

Electronic Supplementary Material for

Within-group inequality in inter-group competition

Shaun P. Hargreaves Heap, Abhijit Ramalingam, Brock V. Stoddard

Appendix A. Supporting Analysis

Derivation of an interior equilibrium (Hargreaves Heap *et al*., 2015)

The first order condition of (3) in the main body of the paper for player *i* in group *k* and player *j* in group *l* are respectively

$-1 + g + (X_l / (X_k + X_l)^2)*(S/m) = 0$ (A3.i)

$-1 + g + (X_k / (X_k + X_l)^2)*(S/m) = 0$ (A3.ii)

The two first-order conditions imply that, in equilibrium the aggregate contribution to the public good must be the same: $X_k* = X_l*$. As long as both groups have sufficient endowments, in an interior equilibrium we have (4) in the main body of the paper. Without further assumptions, such as symmetry, we cannot solve for individual contribution levels. In equilibrium, they should sum to the value given by (4) in the main body of the paper. Since this can be generated by a variety of individual contributions, there are multiple equilibria.

Figure A1 shows the reaction functions of the two groups in the competition treatments, given that $m = 3$, $S = 120$, and $g = 0.5$ in the experiment.

Figure A1. Reaction functions of the two competing groups (Figure 1 in Hargreaves Heap *et al*. 2015)

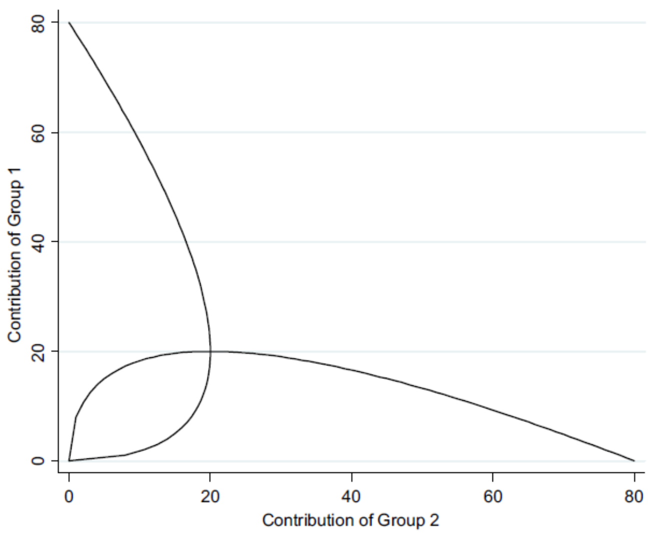

Table A1. The effect of competition - group level regressions

Panel random effect regressions

Unit of analysis = group of three players

Dependent variable = total contribution to the group account in a round

Robust standard errors clustered on independent competing pairs of groups

	(1) Equal: VCM vs. Comp-EE	(2) All Equal groups	(3) Unequal: VCM vs. Comp-II	(4) All Unequal groups	(5) Comp: Equal vs. Unequal
Lagged group account contribution	0.825*** (0.045)	0.826*** (0.037)	0.747*** (0.000)	0.729*** (0.046)	0.761*** (0.000)
Comp-EE	4.485 (2.880)	4.468 (2.791)	-	-	-
Comp-EI	-	9.259*** (3.505)	-	10.651** (4.715)	-
Comp-II	-	-	8.619* (4.681)	9.146** (4.609)	6.980* (3.919)
Constant	19.389*** (6.452)	20.134*** (5.037)	29.644*** (4.561)	29.996*** (4.248)	32.479 (5.841)
Observations	646	912	703	969	684

Standard errors clustered on pairs in parentheses. Includes period dummies (not reported). In regressions (1)-(4), the corresponding VCM treatment is the excluded treatment. In regression (5), Comp-EE is the excluded treatment. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Post regression Wald tests:

Equal groups – regression (2): H_0: Comp-EE = Comp-EI: z = 4.73; p = 0.0297

Unequal groups – regression (4): H_0: Comp-EI = Comp-II: z = 0.31; p = 0.5791

Figure A2. Average group contributions over time in Comp-EI

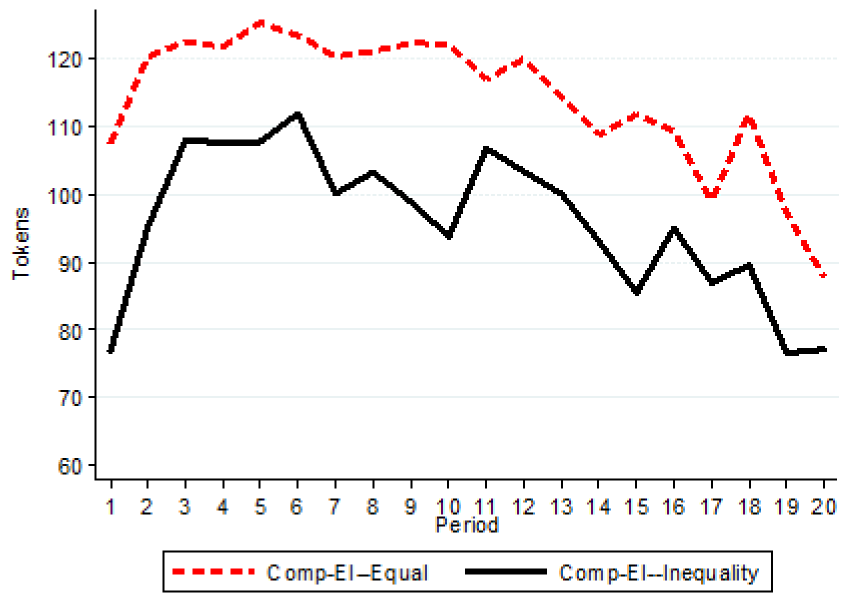

Table A2. Comparing groups in Comp-EI – group level regression

Lagged group account contribution	0.750*** (0.044)
Lagged indicator for win	-2.302 (2.81)
Lagged group account contribution in competing group	0.076 (0.05)
Unequal	-5.30* (3.092)
Constant	36.62*** (4.580)
Observations	1398

Standard errors clustered on pairs in parentheses. Includes period dummies (not reported). The excluded category is the equal group in Comp-EI. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A3. Determinants of individual percent contributions in unequal competing groups

Lagged own percent contribution	0.713***	0.712***
	(0.048)	(0.048)
Lagged deviation from percent contribution of others in own group	-0.171***	-0.170***
	(0.047)	(0.047)
Lagged indicator for win	-1.875	-2.259**
	(0.961)	(1.030)
Lagged percent group contribution in competing group	0.0351	0.025
	(0.032)	(0.039)
Comp-EI	1.263	-1.226
	(1.744)	(4.023)
Lagged win × Comp-EI	-	1.081
		(1.848)
Lagged percent group contribution of competitor × Comp-EI	-	0.028
		(0.061)
Constant	28.68***	29.45***
	(2.904)	(3.346)
Observations	2160	2160

Dependent variable = individual percent contribution in a period. Only includes data for individuals in unequal groups that face competition. Standard errors clustered on pairs in parentheses. Includes period dummies (not reported). In both regressions, the excluded category is Comp-II. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix B. Experimental Instructions

B1. Instructions for Comp-EI

Thank you for coming. This is an experiment about decision-making. You will be paid £2 for your participation PLUS whatever you earn in the experiment.

During the experiment you are not allowed to communicate with any of the other participants or with anyone outside the laboratory. Please switch off your mobile phone now. If you have any questions at any time during the course of this experiment, please raise your hand. An experimenter will assist you privately.

The experiment consists of twenty (20) consecutive decision rounds. Your total earnings will be the sum of your earnings from all these rounds.

At the beginning of the experiment, participants will be randomly divided into groups of three (3) individuals. The composition of the groups will remain the same in each round. This means you will interact with the same people in your group throughout the experiment. However, you will never know the identities of the others in your group.

Your group will also be matched with another group of three people in the lab. In each round, your group will be matched with the same group. You will not know the identities of the members of the other group.

The experiment is structured so that the other participants will never be informed about your personal decisions or earnings from the experiment. You will record your decisions privately at your computer terminal.

During the experiment, all decisions and transfers are made in tokens (more details below). Your total earnings will also be calculated in tokens. At the end of the experiment, your earnings will be converted to Pounds at the following rate:

200 tokens = £1

You will be paid individually and privately in cash at the end of the experiment.

Task

Stage 1

At the beginning of each round, each member of each group receives an endowment of tokens. The endowment can be either 20 tokens, 50 tokens or 80 tokens. There are two possible scenarios for each group.

Endowment Scenario 1: Every member of your group receives an endowment of 50 tokens, i.e., the endowment is the same for each member of your group.

Endowment Scenario 2: One member of your group receives an endowment of 20 tokens, one member receives an endowment of 50 tokens and one member receives an endowment of 80 tokens.

Either Scenario 1 or Scenario 2 will apply to your group. However, the distribution of endowments in your group and the distribution of endowments in the group that your group is matched with WILL be different. If members of your group are endowed with 50 tokens each, then one member of the other group (the one your group is matched with) will be endowed with 20 tokens, another with 50 tokens and the third with 80 tokens. If one member of your group is endowed with 20 tokens, another with 50 tokens and the third with 80 tokens, then the members of the other group (the one your group is matched with) will be endowed with 50 tokens each.

You will be told the Scenario which applies to your group and your endowment within the Scenario at the beginning of the experiment.

The distribution of endowments within your group and your endowment will be the same in each round.

Your task is to allocate your endowment of tokens between your private account and a group account. Each token not allocated to the group account will automatically remain in your private account. Your total earnings include earnings both from your private account and the group account.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account. No one else will earn from your private account.

Earnings from the group account in each round: For each token you allocate to the group account, you will earn 0.5 tokens. Each of the other two members of your group will also earn 0.5 tokens for each token you allocate to the group account. Thus, the allocation of 1 token to the group account yields a total of 1.5 tokens for your group. Your earnings from the group account are based on the total number of tokens allocated to the group account by all members in your group. Each member will profit equally from the tokens allocated to the group account – for each token allocated to the group account, each member of your group will earn 0.5 tokens regardless of who made the allocation. This means you will receive earnings from your own allocation to the group account as well as from the allocations to the group account of your two group members.

<u>Your earnings in Stage 1 in each round</u> =

Earnings from your private account + Earnings from the group account

The following examples are for illustrative purposes only.

Example 1. Suppose Endowment Scenario 2 applies in your group. Assume that your endowment is 20 tokens. The endowments of the other two members of your group are 50 tokens and 80 tokens. Suppose you allocate 0 tokens to the group account. Suppose each of your other group members also allocates 0 tokens to the group account. The total number of tokens in the group account would be 0. Your earnings from Stage 1 in this round would be 20 tokens (= 20 tokens from your private account and 0 tokens from the group account). The earnings of the other members of your group would be 50 tokens for the member with an endowment of 50; and 80 tokens for the member with an endowment of 80.

Example 2. Suppose Endowment Scenario 2 applies in your group. Assume that your endowment is 80 tokens. The endowments of the other two members of your group are 20 tokens and 50 tokens. Suppose you allocate 40 tokens to the group account. Suppose each of your other group members allocates 0 tokens to the group account. The total number of tokens in the group account would be 40. Your earnings from Stage 1 in this round would be 60 tokens (= 40 tokens from your private account + 0.5*40 = 20 tokens from the group account). The earnings of the other members of your group would be 40 tokens for the member with endowment of 20 (= 20 tokens from his/her private account + 0.5*40 = 20 tokens from the group account); and 70 tokens for the member with an endowment of 50 (= 50 tokens from his/her private account + 0.5*40 = 20 tokens from the group account).

Example 3. Suppose Endowment Scenario 1 applies in your group. Your endowment is 50 tokens. It is the same (50 tokens) for each member of your group. Suppose that you allocate 50 tokens to the group account. Suppose that each of the other group members also allocates 50 tokens to the group account. The total number of tokens in the group account would be 150. Your earnings from Stage 1 in this round would be 75 tokens (= 0 tokens from your private account + 0.5*150 = 75 tokens from the group account). The earnings of the other members of your group would also be 75 tokens each.

After all individuals have made their decisions in the first stage you will be informed of the total allocation to the group account by your group and your earnings in tokens from the first stage of the round.

<u>Stage 2</u>

Your group will be matched with another group. In Stage 2, either your group or the other group will receive a prize of **120** tokens (40 tokens per group member). In each period, only one of the two groups can obtain the prize. By contributing to your group account you increase the **chance** of receiving the prize for your group. If the total number of tokens in your group account exceeds the total number of tokens in the other group's account, your group has a **higher chance** of receiving the prize.

The probability that your group receives the prize is calculated according to the following formula:

$$\frac{\text{Tokens in } \textbf{your group's} \text{ group account}}{\text{Tokens in } \textbf{your group's} \text{ group account } + \text{ Tokens in the } \textbf{other group's} \text{ group account}}$$

The computer will assign the prize either to your group or to the other group, **via a random draw** that depends on the total allocation in the group accounts of the two groups as in the above formula. Below is a hypothetical example used to illustrate how the computer makes a random draw to decide which group wins the prize.

Note: The following example is for illustrative purposes only.

Example 4. Random Draw

Think of the random draw in terms of the computer randomly choosing a ball from a box of different coloured balls. For **each** token in your group's account the computer puts **1 red ball** into a box and for each token in the other group's account the computer puts **1 black ball** into the box. Then the computer randomly draws one ball out of the box. If the ball drawn is red then your group receives the prize, if the ball drawn is black then the other group receives the prize. Suppose **members of your g**roup allocate a total of **65** tokens to your group account while members of the other group allocate **35** tokens to their group account. Thus, the computer will place **65 red balls** and **35 black balls** into the box (**100 balls in total**). Then the computer will randomly draw one ball out of the box. You can see that since your group has contributed more it has a **higher chance** of receiving the reward. Your group will receive the prize - **65 out of 100** times. The other group has a lower chance of receiving the prize - **35 out of 100** times.

A group can never guarantee itself the prize. However, by increasing your contribution to the group account, you can increase your group's chance of receiving the prize. If your group receives the prize, 120 tokens will be divided equally among the members of your group, i.e., you and the other 2 members of your group will receive 40 tokens each.

The other group your group will be matched with will remain the same in all 20 rounds. You will not know the identities of the members of the other group.

You will be informed of the total allocation to the group account in your group and the total allocation to the group account by the other group. You will also be informed of the probability of winning the prize for your group. Finally, you will be informed which group won the prize - your group or the other group.

NOTE: You will **NEVER** be informed of the individual allocations of the other members of your group or the members of the other group.

<u>Your earnings in Stage 2 in each round</u> = 40 tokens if your group wins the prize

<u>OR</u> 0 tokens if the other group wins the prize

<u>Your TOTAL earnings in each round</u> = Earnings from Stage 1 + Earnings from Stage 2

At the end of each round, you will be informed of your earnings from the first stage, whether your group won the prize, your earnings from the second stage and your total earnings from the round.

Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment in each round. The same process will be repeated for a total of 20 rounds.

<u>Questions to help you understand the decision task</u>

When everyone has finished reading the instructions, we will ask you a few questions regarding the decisions you will make in the experiment. These questions will help you understand the calculation of your earnings and ensure that you understand the instructions. Please answer these questions on your computer terminal. Once everyone has answered all questions correctly, we will begin the experiment.

B2. Instructions for VCM-I

Thank you for coming. This is an experiment about decision-making. You will be paid £2 for your participation PLUS whatever you earn in the experiment.

During the experiment you are not allowed to communicate with any of the other participants or with anyone outside the laboratory. Please switch off your mobile phone now. If you have any questions at any time during the course of this experiment, please raise your hand. An experimenter will assist you privately.

The experiment consists of twenty (20) consecutive decision rounds. Your total earnings will be the sum of your earnings from all these rounds.

At the beginning of the experiment, participants will randomly be divided into groups of three (3) individuals. The composition of the groups will remain the same in each round. This means that you will interact with the same people in your group throughout the experiment. However, you will never know the identities of the others in your group.

The experiment is structured so that the other participants will never be informed about your personal decisions or earnings from the experiment. You will record your decisions privately at your computer terminal.

During the experiment, all decisions and transfers are made in tokens (more details below). Your total earnings will also be calculated in tokens. At the end of the experiment, your earnings will be converted to Pounds at the following rate:

150 tokens = £1

You will be paid individually and privately in cash at the end of the experiment.

Task

At the beginning of each round, each member of each group receives an endowment of tokens. The endowment can be either 20 tokens, 50 tokens or 80 tokens. One member of your group receives an endowment of 20 tokens, one member receives an endowment of 50 tokens and one member receives an endowment of 80 tokens.

You will be told your endowment at the beginning of the experiment.

Your endowment will be the same in each round.

Your task is to allocate your endowment of tokens between your private account and the group account. Each token not allocated to the group account will automatically remain in your private account. Your total earnings include earnings both from your private account and the group account.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account. No one else will earn from your private account.

Earnings from the group account in each round: For each token you allocate to the group account, you will earn 0.5 tokens. Each of the other two members of your group will also earn 0.5 tokens for each token you allocate to the group account. Thus the allocation of 1 token to the group account yields a total of 1.5 tokens for your group. Your earnings from the group account are based on the total number of tokens allocated to the group account by all members in your group. Each member will profit equally from the tokens allocated to the group account – for each token allocated to the group account, each member of your group will earn 0.5 tokens regardless of who made the allocation. This means that you will earn from your own allocation to the group account as well as from the allocations to the group account of your two group members.

<u>Your earnings in each round</u> =

Earnings from your private account + Earnings from the group account

The following examples are for illustrative purposes only.

Example 1. Assume that your endowment is 20 tokens. The endowments of the other two members of your group are 50 tokens and 80 tokens. Suppose you allocate 0 tokens to the group account. Suppose each of your other group members also allocates 0 tokens to the group account. The total number of tokens in the group account would be 0. Your earnings from this round would be 20 tokens (= 20 tokens from your private account and 0 tokens from the group account). The earnings of the other members of your group would be 50 tokens for the member with an endowment of 50; and 80 tokens for the member with an endowment of 80.

Example 2. Assume that your endowment is 80 tokens. The endowments of the other two members of your group are 20 tokens and 50 tokens. Suppose you allocate 40 tokens to the group account. Suppose each of your other group members allocates 0 tokens to the group account. The total number of tokens in the group account would be 40. Your earnings from this round would be 60 tokens (= 40 tokens from your private account + 0.5*40 = 20 tokens from the group account). The earnings of the other members of your group would be 40 tokens for the member with endowment of 20 (= 20 tokens from his/her private account + 0.5*40 = 20 tokens from the group account); and 70 tokens for the member with an endowment of 50 (= 50 tokens from his/her private account + 0.5*40 = 20 tokens from the group account).

Example 3. Assume that your endowment is 50 tokens. The endowments of the other two members of your group are 20 tokens and 80 tokens. Suppose that you allocate 50 tokens to the group account. Suppose the group member with the endowment of 20 allocates 20 tokens to the group account and the group member with the endowment of 80 allocates 80 tokens to the group account. The total number of tokens in the group account would be 150. Your earnings from this round would be 75 tokens (= 0 tokens from your private account + 0.5*150

= 75 tokens from the group account). The earnings of the other members of your group would also be 75 tokens each.

After all individuals have made their decisions you will be informed of the total allocation to the group account in your group and your earnings in tokens from the round.

Your earnings from earlier rounds cannot be used in the following rounds. You will receive a new endowment in each round. The same process will be repeated for a total of 20 rounds.

Questions to help you understand the decision task

When everyone has finished reading the instructions, we will ask you a few questions regarding the decisions you will make in the experiment. These questions will help you understand the calculation of your earnings and ensure that you have understood the instructions. Please answer these questions on your computer terminal. Once everyone has answered all questions correctly we will begin the experiment.