The productivity puzzle: inequality, competition and 'team spirit'

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Abstract

This paper examines with an experiment a new way that inequality and competition may interact to affect productivity: through team public goods contributions. While inequality within a team diminishes team cooperation in the absence of competition, we find there is no effect of inequality when teams compete. Competition boosts cooperation and more so in unequal teams. Thus, an increase in competition overcomes the adverse effect of inequality on productivity. The difference in the effect of inequality is driven by the behaviour of the 'rich'. While they disengage from their teams without competition, the rich recover their 'team spirit' under competition.

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This paper focuses on one hitherto unexamined possible cause of the puzzling productivity slowdown in many OECD countries over the last 10-20 years: a decline in 'team spirit'. By 'team spirit' we mean the inclination of members of a team or organization to do things for the team that go beyond what individual selfishness dictates. The performance of any team will depend on the combined efforts of its members and, given the difficulty in monitoring individual efforts, team performance will always depend to some degree on 'team spirit' in this sense. Given the large share of production that is undertaken by organisations/teams, 'team spirit' could thus be a factor influencing productivity in an economy.

We consider two possible determinants of 'team spirit'. One is the degree of inequality within the team and the other is the extent of competition between teams. There are reasons for believing that each might have contributed to a fall in 'team spirit'. First there is evidence that each, in isolation, is linked to 'team spirit'. Inequality within a group, for example, tends to lower contributions to their public goods [AR1]in experiments (see Buckley and Croson, 2006, Reuben and Riedl, 2013, and Hargreaves Heap *et al*., 2016); and there is cross country survey evidence connecting an increase in inequality with a decline in 'civic virtue' (see Knack and Kneefer, 1997). Likewise, teams[AR2] tend to overcome the free rider problem in a public goods game experiments when they are put in competition with each other (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); and this may be due to the phenomenon of 'parochial altruism' (see Choi and Bowles, 2007). Second, each has moved in the direction, given these links, to produce adverse changes in productivity. That is, inequality has typically increased and competition has decreased in many OECD countries over the same period that productivity has been lagging (see OECD, 2015, on inequality trends and Council of Economic Advisers, 2016, and Barkai, 2016, for competition trends in the US).

What is not known, however, is how inequality and competition interact. This is important because policy changes are difficult to enact and so policy makers need to know where best to focus their attentions. Can they sensibly target reversing one of these changes or must they address both the increase in inequality and the fall in competition? This is the question we address.

The practical difficulty in answering this question is how to distinguish the influence of one from the other when both are changing in ways that seem likely to produce the same adverse effect on productivity. For this reason we adopt an experimental approach. It allows us to control for the distinct influence of inequality and competition on 'team spirit' and to plot their interaction. Towards this end, we use a public goods game[AR3]. It captures well the scope for free riding that can arise in any team and which might be overcome by team spirit to the benefit of efficiency. Two teams in the experiment make contributions to their respective public goods and we examine the effect of competition and inequality in a 2 × 2 design, as set out in Figure 1.

In effect, the literature cited above suggests that, starting in the top left quadrant where there is equality and competition, a movement vertically downward (to less competition) will lower contributions to team public goods; and from here a movement horizontally to the right (towards more inequality) will also lower public goods contributions. What is not known is whether, starting from the bottom right quadrant, the restoration of pubic goods contributions requires both vertical movement (towards more competition) and/or horizontal movement (towards more equality). This is crucial for policy. To answer this question, we need to know

what happens in the quadrant with the ? in comparison with the other quadrants. This is what we do for the first time with our 2x2 design.

	Within Team Equality	Within Team Inequality
Between team competition		?
No between team competition		

Figure 1

We find that policy can restore public goods contributions by targeting an increase in competition alone. Starting in the bottom right quadrant, a movement vertically upwards (towards more competition) restores public goods contributions to the level initially found when there is both competition between teams and equality within teams (i.e. in top left quadrant). This is because, once competition has been restored, there is no adverse effect from inequality on public contributions and so there is no further gain from moving towards equality.

To put this result slightly differently and more generally. We have tested with a laboratory experiment the generality of the current insights regarding the effect of competition and inequality on public goods contributions. The insight that competition boosts public goods contributions survives the new test because it holds when there is within team inequality. In contrast, the insight that more equality boosts public goods contributions does not survive the new test because it does not hold when there is competition between teams. That the competition insight generalises over this restricted domain when the equality insight does not should predispose policy makers to focus attention on boosting competition if they wish to boost 'team spirit'.

Our expectation, as set out in the later sections, was the contrary of this result. We thought that the lack of 'team spirit' in unequal teams would mean that they responded less (rather than more) vigorously to the injection of team competition than do equal teams where 'team' membership seems to be more salient. Our opposite result is, interestingly, almost entirely driven by the behavior of the 'rich'. The difference between an equal and unequal team when there is no competition turns exclusively on the behavior of the 'rich'. The 'poor' and 'middle' income individuals contribute as much in % terms as they would if there was equality, it is the 'rich' who lower their % contribution when there is inequality and this accounts for why inequality lowers contributions in the aggregate. What is interesting about the injection of competition into unequal teams is that the 'rich' % contribution jumps back up to that of the other income groups[AR4][SBV5].

This is an important insight in itself about the 'rich', but for a different reason. There is some evidence that the 'rich' in unequal societies become less connected to others in society or less pro-social (e.g., see Piff *et al*, 2012, Dietze and Knowles, 2016 and Rapoport *et al*., 1989). The issue raised by these findings is whether it is inequality *per se* or something else about being 'rich' that explains why the 'rich' appear to stop 'caring'. Our experiment is important in this regard. We find that inequality does seem to make the 'rich care less' when there is no competition but <u>not</u> when there is competition. So it is not a general insight about the effect of inequality. Or to put this round the other way, if you really want to jolt the 'rich' back into 'caring' about others, then a boost to competition is likely to be more reliable.

In the next section, we present a model of team production that takes the form of a public goods problem in the absence of 'team spirit'. 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 that enable us to determine whether subjects actually display some 'team spirit' in the form of greater contributions to the public good. Section 2 explains the design of the experiment in detail and we develop some hypotheses regarding the possible influence of equality/inequality and the presence/absence of competition on 'team spirit'. Section 3 gives the results. We discuss them and conclude the paper in Section 4. 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).

1. A model of team production

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 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 Tullock prize might be thought of either as a managerial device when the two teams belong to 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, each player i in group k composed of m players receives an endowment of $e_{ik} > 0$ and must decide how much to invest $0 \leq x_{ik} \leq e_{ik}$ in a public good. The remainder, $(e_{ik} - x_{ik})$, 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 ($0 < g < 1$ and $mg > 1$) 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 given by

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

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 a competition between teams, the public goods decision just described is, in addition, connected 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

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

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

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

In an interior equilibrium, we now have (see Hargreaves Heap *et al.*, 2015)

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

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. Once again, both the equilibrium and optimum remain the same under finite repetition.

The key equilibrium predictions of the model are:

1. The competition for the prize raises contributions to the public good above levels observed in the absence of 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.

2. Experimental Design, Hypotheses and Procedures

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

Our competition treatments append the Tullock contest and we consider 3 possible two-team competitions: (i) between teams with equal endowments (EE); (ii) between a team with equal endowments and one with unequal endowments (EI); and (iii) between teams where both have inequality in their individual endowments (II).

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

2.1 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.

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

Our chosen endowment levels guaranteed that each group could contribute at least the equilibrium amount 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 in absence of 'team spirit'

Treatment	Competition ?	Endowments within group		# groups	# pairs	PG prediction
		Group 1	Group 2			
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.

2.3 Hypotheses regarding 'team spirit'

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 'team spirit' in our sense in this setting. 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 HH et al, 2016….).

There is also evidence that the injection of competition between teams raises their public goods contributions (see). 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). Accordingly, if 'team spirit' is initially weaker in unequal teams one might expect the boost from priming team identity will also weaker in unequal teams. This is the basis of H1.

> **H1:** Unequal teams respond less strongly to competition through the increase in their aggregate contribution to the public good than do equal teams.

Against this, the boost to contributions that comes from competition between equal teams is not obviously different from what might be expected through the boost to the selfish motive for making contributions (see above). Thus the boost from competition may have nothing to do with priming 'team spirit' and may affect equal and unequal teams in the same way. If this was the case (or if H1 cannot be rejected), we still expect equal teams in competition to exhibit more 'team spirit' than unequal ones because of their differences when there is no competition. This H2.

> **H2** Equal teams in competition contribute more to the public good than do unequal teams in competition.

H3 focuses on the behaviour of the 'rich' as specific underpinning for H1.

> **H3:** 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 hypotheses we wish to test regarding the effect of inequality within a team on the 'team spirit' 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). 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. H4 tests for this effect.

> **H4:** 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.

H1 and H4 are based on the idea that group identification affects 'team spirit' and that such identification may depend respectively on the way groups are constituted through their internal relations of equality/inequality (H1) and external relations of contrast/similarity (H4). Another line of thinking on the relation between a sense of group identity and action focuses on the way that cognitive dissonance between identity and actions can produce a change in either or both (see Festinger, 1957). 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). This is the same prediction as H4 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, H4 will not hold for unequal teams. Thus depending on whether H4 holds only for equal or both types team, we will favour either the cognitive dissonance account or the Social Identity one of how the contrast between teams affects team spirit.

Against these group-identification lines of argument (and H1, H4), 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 3, inequality will 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.

2.4 Procedures

All experimental sessions were conducted using student subjects at the University of East Anglia (UEA). The 12 to 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 correctly answer a quiz before the experiment began. The experiment was computerised using z-Tree

(Fischbacher 2007). A total of 297 subjects participated in our experiment. 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.

3. 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.

3.1 The effects of competition on team spirit in equal and in unequal teams

We begin by identifying whether competition in our experiment produces a boost to 'team spirit' in the form of increased contributions to the public good. First, for equal groups, we compare the contributions to the group account when there is equality and no competition (VCM-E) with the contributions by equal groups (E) when there is competition (i.e., COMP-EE and E-COMP-EI). This is done in Figure 1a for each period. In Figure 1b we do the same for unequal groups by comparing contributions when there is no competition (VCM-I) with the contributions when there is competition (i.e., I-COMP-EI and COMP-II). 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 1. Average group contributions over time in equal and unequal groups

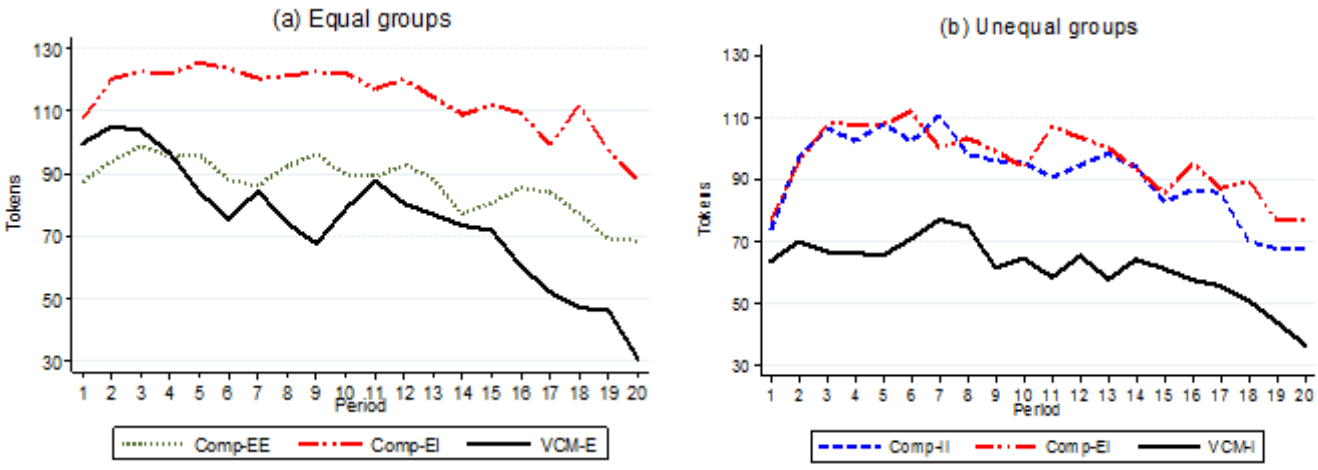


Table 2. Average group contributions

	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 1 (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 ($p = 0.0423$). However, the increase in the equal group in Comp-EI over VCM-E is significant when averaged over all rounds ($p = 0.0221$).

Result 1: *Competition raises average contributions to the public good in equal groups as compared with the contributions by equal groups in the VCM. This is apparent throughout when the equal group competes with an unequal one and, in the later stages, when the equal group competes with another equal group.*

Figure 1 (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.

Result 2: *Competition raises average contributions to the public good in unequal groups throughout as compared with contributions in an unequal VCM.*

Results 1 and 2 are robust to group-level panel random effects regressions (separate for equal and unequal groups) where the dependent variable is group account contribution in a round and 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 Hypotheses. For H1-H3, 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; $p = 0.0423$).[1]

Result 3 (against H1): *Unequal teams gain more from a competition between themselves than do equal teams from a competition with other equal teams, judged by the boost in contributions to the public good.*

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

[1] 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.

unequal teams due to competition leads to higher average group contributions in Comp-II than in Comp-EE (see Table 2). While a test shows that this difference 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 4 (against H2): *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) when there is no competition and when there is competition with other unequal teams.

Table 3. Mean contribution percentage 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 5 (against H3): *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 team spirit when equal and unequal teams compete

We turn now to H4 and the effect on team spirit of contrast between teams in competition.

Figure 1a 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 6 (consistent with H4 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 1 (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 7 (against H4 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 6 and 7, 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'.[2]

To explore the differences in behaviour that those in equal teams display when competing with an equal as compared with an unequal team, we develop what is known from the individual contest and public goods literature 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

[2] Figure A1 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.

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 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.[3]

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 that compete against unequal groups. The second regression shows that this increase is driven by a difference in the reaction to the contribution by the competing

[3] 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.

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 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.[4]

Result 8: *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.*

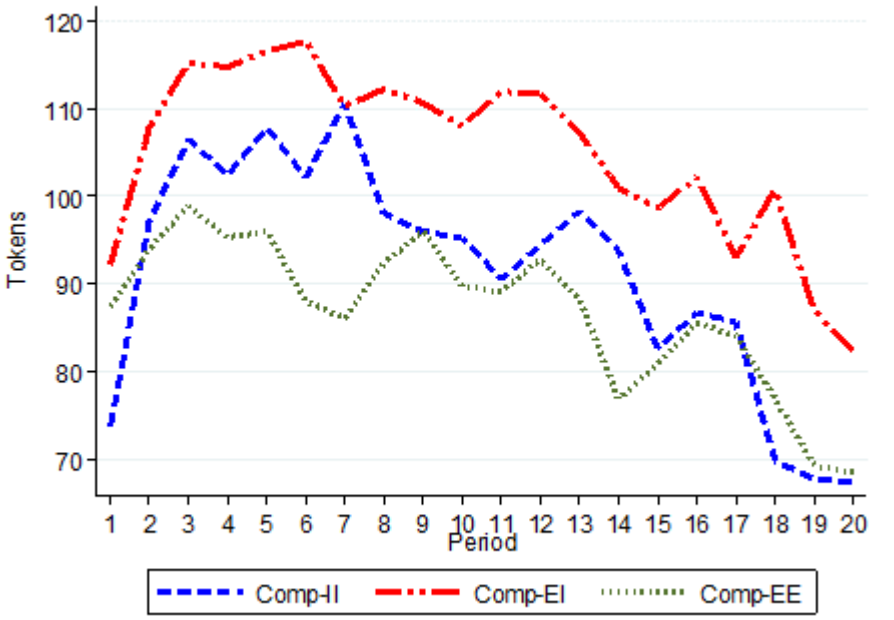
Since this responsiveness to the contribution of the other team can be taken as another indicator of a team's competitiveness, this reinforces the conclusion from the evidence on aggregate contributions that equal teams are less inclined to compete with each other.

4.3 The welfare effects of inequality under competition

To complete the analysis of the effects of inequality, 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 2 presents average group contributions in a pair over time.

[4] 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).

Figure 2. Average group contributions over time in competing pairs of groups



Comp-EI stands out as one might expect, given Results 4, 6, and 7. 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 included 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 ($p = 0.013$).[5]

Result 9: *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.*

5. Discussion and Conclusion

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

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 'team spirit' 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 well known is whether the boost to 'team spirit' 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 'team spirit' when there is no competition.

We find, however, that the boost to 'team spirit' from competition is actually bigger in unequal teams than equal ones. The extra boost is largely explained by the rich under inequality regaining the 'team spirit' 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.

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 has been a growth in inequality and on many accounts a fall in competition. It is this combination that, our results suggest, has particularly adverse effects on productivity through the influence of the behaviour of the rich. The absence of competition diminishes 'team spirit' generally and so undermines productivity, but this is especially so in unequal teams because the rich seem to respond to inequality by becoming notably more selfish than others when there is no competition. Or to put this point in terms of the dis-connect of the rich, our experiment suggests that it is not inequality per se that leads to the rich showing less interest in the public good because this is not apparent when there is competition. Instead, it is the absence of competition when combined with inequality that produces the dis-connect. In short, it is possible to tackle the problem of the rich's disconnect from society without, as it were, abolishing them through a move to equality because policies that promote competition will have the same effect.

It is tempting to draw a similar conclusion in relation to productivity policy. The promotion of competition may again seem the key since the gain to efficiency from greater equality within

a team, that is present when there is no competition, seems to disappear once there is competition. However, this is not quite right. We also find that competition between an unequal team and an equal team notably boosts 'team spirit' in the equal team as compared with the unequal one. This result favours cognitive dissonance theory over social identity theory as an explanation of how such contrasts contribute to 'team spirit'.[6] However, it is perhaps more important because it reinforces the general thought that inequality is only good up to some point and thereafter it has adverse effects on efficiency (see OECD, 2015). This is so in our experiment even when there is competition. In our case, efficiency through competition is served better by having one unequal team rather than two equal ones, but it is also ill-served by having two unequal teams.

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[6] That the size of the boost is affected by inequality in these ways suggests that individuals are not simply responding to competition because they get some extra buzz from competing. Instead it seems that 'team spirit' is in play and is affected by inequality.

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