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Does reducing inequality increase cooperation?

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Abstract

Inequality reduces the ability of communities to work together. The theory of reciprocity suggests reducing inequality allows groups to increase cooperation. We experimentally test if, after experiencing inequality, unconditional income transfers to the poor increase contributions to public goods. Both pure redistribution to eliminate inequality and additional resources directed to the poor without reducing resources of the rich fail to raise cooperation beyond levels observed in groups that were always equal. The rich do not respond to additional resources available to the group, and continue keeping most of their resources for private consumption. After receiving additional resources, the poor mimic the contribution behaviour of the rich. This shift of the majority of additional resources towards private consumption renders transfers ineffective in raising cooperation.

JEL classifications: C91; C92; D31; D63; H41

Keywords: reciprocity; inequality reduction; income transfers; cooperation; public goods; experiment

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1. Introduction

Income inequality is growing around the developed world, and is at its highest since records began (OECD, 2015; Piketty, 2014; Stiglitz, 2012). The ratio of income and wealth shares of the richest to the poorest 10% stands at 10:1 in OECD countries (OECD, 2015, Chapter 1), and the income share of the top 10% in the United States is 50.6% (Saez, 2019). Research in political science and economics shows that inequality leads, causally, to lower levels of social trust and social capital (Putnam, 2000; Barone and Mocetti, 2016; Gould and Hijzen, 2016), which lowers "the sum total of people's involvement in community life" (Wilkinson and Pickett, 2011, p. 54). Importantly, these effects are felt even in 'rich' countries, i.e., the cause is inequality, and not (absolute) poverty (Wilkinson and Pickett, 2011). The evidence linking inequality and poor social and economic outcomes suggests that reducing inequality would improve outcomes for individuals and for society. In this paper, we examine this intuition.

We examine the effects of redistribution in initially unequal groups on a fundamental interaction among individuals, in particular on their ability to voluntarily and cooperatively generate better outcomes for themselves and their fellow group members. To our knowledge, there is little work testing how individuals and groups react to *changes* in inequality, when income is transferred from the rich to the poor. A reason is that widely observable and measurable data on individuals' cooperative behaviour and, perhaps more importantly, this matched with accurate and publicly available measures of individual income are not easily available. In their absence, experiments allow us to cleanly test individuals' and groups' reactions to inequality and changes in inequality.[1]

We study cooperation in an experimental setting that has been widely studied, where behaviour is relatively well understood, and which lends itself to easy and clean manipulations – the linear public goods game (see, for instance, Chaudhuri, 2011). We implement inequality by varying participants' initial endowments of resources that can be contributed to the public good – unequal groups have two poor and two rich members.[2] Groups first interact in a setting with inequality.

[1] Our experimental environment with students is necessarily less complex than the real-world scenarios motivating the research. However, controlled laboratory experiments allow us to test different policy options at a much lower cost than an actual intervention in the field, while also identifying potential reasons for success/failure of each option (Smith, 1994; Binmore, 1999; Falk and Heckman, 2009; Croson and Gächter, 2010).

[2] Other sources of inequality have been studied in this setting: (a) returns from the public good (Fisher et al., 1995; Reuben and Riedl, 2009, 2013; Kölle, 2015; Dekel et al., 2017; Gangadharan et al., 2017), (b) productivity of contributions (Tan, 2008; Kölle, 2015; Ramalingam et al., 2021). Given our focus on income transfers, we focus on inequality in resource endowments.

We then examine two means of reducing inequality in groups in the second part of the experiment.

Motivated by redistributive policies implemented by many governments, the first set of treatments use redistribution as an obvious means to reduce inequality. Motivated by recent policy experiments related to means-tested Universal Basic Income (UBI), our second set of treatments consider different levels of injections of additional resources directed towards the poor.

We formulate a theoretical basis for the desirability of inequality reduction. The theory of reciprocity (Sugden, 1984) successfully explains patterns of observed behaviour in public goods games where group members are homogeneous in all respects (Croson, 2007). We extend the principle of reciprocity to groups with inequality in resource endowments. Reciprocity predicts lower cooperation in unequal than in equal groups. Several studies found evidence of this – e.g., Cherry et al. (2005) and Buckley and Croson (2007). This is the case even after controlling for total resources available to groups and to individuals (Hargreaves Heap et al., 2016), i.e., lower cooperation is a result of inequality per se and not simply low endowment levels.[3] Further, as predicted by reciprocity, Hargreaves Heap et al. (2016) show that lower cooperation is primarily driven by the 'rich' members. These members disengage from the group, further depressing group production (similar to findings in Piff et al., 2012).

Consistent with the findings of Wilkinson and Pickett (2011), reciprocity predicts reductions in inequality can increase engagement of the poor and the rich with the group, thus increasing efficiency. We test this prediction that justifies policies of redistribution. This change or reduction in inequality that permits increased cooperation after first experiencing inequality is novel to our study.

As far as we are aware, ours is the first study to examine redistribution in a linear public goods environment. Further, little work evaluates the effects of *changes* in resource endowments on cooperation levels in groups that are initially unequal. We are aware of only two works that address this question directly. Both study pure redistribution of endowments in a *non-linear* public goods game to test the prediction that redistribution has no effect on aggregate contribution to the non-linear public good – the Neutrality Theorem due to Warr (1983), and its extension by Bergstrom

[3] Inequality that is also associated with greater resources available to the group as a whole, compared to total group resources in equal groups, is not necessarily detrimental to cooperation (Reuben and Riedl, 2013). Further, inequality in endowments is not harmful in certain non-linear environments (Chan et al., 1996, 1999).

et al. (1996). Maurice et al. (2013) find support for neutrality when initial inequality between poor and rich members is small; redistribution does not affect contribution levels at the group level. Rouaix et al. (2015) find that when the inequality is large, an equalising redistribution actually leads to lower cooperation in the non-linear game.

In contrast, we examine a setting where inequality has been shown to have a negative impact on cooperation. Our theoretical and experimental environments better capture common intuition and current policy debates aimed at tackling the ill-effects of inequality. In addition, our experiment provides a simpler and more intuitive decision setting that allows participants to focus on the effects of inequality. Finally, we study a variety of schemes that reduce inequality (in addition to pure redistribution), and offer a broader picture of the effects of transfers on cooperation.

Our study contributes to the literature by examining a linear public goods game that redistributes income within groups after they first make decisions in the presence of inequality. Other studies compare voluntary contributions of always-unequal groups to those of always-equal groups (e.g., Hargreaves Heap et al., 2016). Further, our treatments that examine injections of resources towards the poor who first make decisions in unequal groups, is novel to our design. By making these interventions in groups with experience with inequality, our study more closely mirrors current economic conditions and provides insights on the impact of inequality-reducing policies on voluntary contributions.

Consistent with previous findings, inequality leads to lower cooperation than in equal groups. This is due to lower relative cooperation by the rich than the poor. Contrary to predictions, we find pure redistribution to full equality of resources *completely* fails to raise cooperation in groups that experienced inequality. Post-redistribution, neither the former poor nor the former rich adapt their contributions to levels observed in initially equal groups that never experienced inequality. Further, injections of resources do not greatly help cooperation in previously unequal groups either.

As with redistribution, the rich do not change their previously uncooperative behaviour, even after a change in the group's circumstances. The previously poor simply mimic the behaviour of the 'old' rich upon experiencing a favourable change in their own individual circumstances. 'Old money' is always mostly spent on private consumption and the 'nouveau riche' follow suit when given additional resources.

Individuals' voluntary contributions to public goods in our experiment can be thought of as efforts to develop social capital.[4] A critical component of social capital is participation in or contribution to cultural groups, political groups, youth groups, sports groups, churches, neighbourhood watch schemes, schools, and libraries (Alesina and La Ferrara, 2000). In all these examples, individual actions importantly have positive externalities that benefit all members of the community (Coleman, 1988; Serageldin and Grootaert, 1999). Alesina and La Ferrara (2000) study "a public good (social capital) not generated by policies but by the interaction of private individuals in private groups" (p. 851, footnote 9).[5]

Our results suggest that simply transferring income to reduce inequality may be relatively ineffective in promoting cooperation among individuals and, thus, in increasing the amount of social capital in groups. This is not because equality is not conducive to cooperation. Rather, the additional resources that become available are diverted towards private capital, at least in the short run. Our results suggest that, at the very least, additional research is needed to examine additional settings where redistributive, and transfer policies in general, may be effective at increasing cooperation.

The rest of the paper is organised as follows. Section 2 describes our first set of experiments exploring redistribution. Section 3 describes our second set of experiments that provide additional resources to the poor. Section 4 discusses our findings and concludes.

2. Redistribution and cooperation

2.1 The decision setting: The Voluntary Contributions Mechanism

We employ the Voluntary Contributions Mechanism (VCM) (Isaac and Walker, 1988). In our public goods game, each individual i in a group of n members receives a resource endowment (income) of $e_i > 0$ tokens which he/she can allocate between a private account and a group account

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[4] Social capital is most often measured as trust in others in society (e.g., Knack, 2002). For instance, the trust question on the World Values Survey or behaviour in experimental trust games are used as a measure of social capital (e.g., Johnson and Mislin, 2012; Banerjee, 2018; Fehr et al., 2020). However, a crucial value of social capital is enhancing efficiency by facilitating cooperation (Knack and Keefer, 1997; La Porta et al., 1997). Others have argued that the provision of social capital is a result of cooperation and is better reflected as a multilateral public goods game (Coleman, 1988; Dasgupta and Serageldin, 1999; Thöni et al., 2012). Further, Fukuyama (2001) identifies reciprocity as a norm that forms social capital and promotes cooperation (p. 7).

[5] Donations to charity, while related to social capital and voluntary contributions, generally benefit the donor indirectly by an intangible warm glow. For examples of experiments examining charitable donations, see Fong and Luttmer (2011) and Luccasen et al. (2017).

(the public good). Each token allocated to the private account generates a return of one to the individual alone. Each individual earns a fraction, $0 < m < 1 < mn$, of the total allocation to the group account by all group members. Group member i's payoff is given by

$$\pi_i = (e_i - g_i) + m \sum_{j=1}^{n} g_j,$$

where $g_i \in [0, e_i]$ is i's allocation to the public good and m is the marginal per capita return (MPCR) from the public good.

The condition $mn > 1$ implies that it is socially optimal for each individual to contribute his/her entire endowment to the public good in every repetition. However, since $m < 1$, cooperation is fraught with the free-rider problem. Experimental research on public goods games consistently shows that sustained cooperation, as measured by contributions, is hard to achieve, even in groups where all members are symmetric in all respects (Ledyard, 1995; Isaac and Walker, 1988; Fehr and Gächter, 2000). However, aggregate cooperation is rarely zero as in the unique Nash equilibrium prediction for own-payoff maximizing agents or the entire group endowment as in the social optimum (see Chaudhuri, 2011).

The model of inequity aversion due to Fehr and Schmidt (1999) has been used to explain observed patterns of contributions in groups with equally-endowed members. Extending the model to unequal groups does not explain contribution behaviour in unequal groups. Hence, we employ another model that does explain behaviour from previous studies to unequal groups – reciprocity, due to Sugden (1984). We present both models in Appendix B.

We summarise here the implications of redistribution on contributions through reciprocity. Controlling for total resources available to a group with reciprocal members, the set of equilibria is strictly smaller in unequal groups than in equal groups. In particular, equal groups permit more efficient equilibria that are not achievable in unequal groups. Further, holding total group resources constant, any reduction in inequality in groups with reciprocal agents permits more efficient equilibria.

For instance, a guaranteed minimum income may free up time and resources to contribute to community welfare and health programmes, and/or allow poorer families to send children to cultural and sports activities in school. Such increased investments of time and resources confer positive externalities on communities at large. Further, these investments increase the value of public programmes to the rich as well, who then reciprocate with increased investments on their part. Reciprocity thus predicts that income transfer schemes potentially raise investment in the public good by *both* poor and rich individuals, and thus efficiency. We experimentally test this prediction.

In our first set of experiments, we investigate the effect of a fully equalising redistribution of resources on the level of cooperation within an initially unequal group.

2.2 Experimental design and procedures

We are interested in observing the effects of a *reduction* in inequality, i.e., a *change* in resource endowments within the group. We thus use a within-subject design to observe behaviour before and after the change. In all treatments, there are two Parts to the experiment. In each Part, groups of four members ($n = 4$) play a repeated VCM game with an MPCR of 0.4 ($m = 0.4$) for 20 rounds. Individual per-period endowments are either 20, 50 or 80 tokens ($e_i \in \{20, 50, 80\}$). We refer to subjects with an endowment of 20 as 'poor', those with an endowment of 50 as 'middle', and those with an endowment of 80 as 'rich'. Individuals' endowments remain the same for all 20 rounds in each Part.[6]

Endowments are assigned randomly. An alternative to random assignment of endowments is subjects earning their endowments by completing another task prior to the public goods game. While this is interesting, we are initially interested in exogenous inequality, such as the family into which an individual is born. Previous experimental and field work shows support for redistributive policies is stronger when inequality is believed to be determined by luck (Alesina and Angelotos, 2005; Almås et. al., 2010; Lefgren et al., 2016; Gee et al., 2017; Almås et. al., 2020).[7] We explicitly tie inequality to luck, giving redistribution the best chance to increase cooperation in initially unequal groups. Further, the source of endowments has little effect on contribution behaviour when all group members had earned/experimenter-determined endowments (Cherry et al., 2005;

[6] In a group of four members with $m = 0.4$, the *minimal effective subgroup* (MES, see Appendix B1) consists of three members; a unit contribution to the public good generates a return of 1.2 for the members of the subgroup. Further, the MES must contain at least one poor member.

[7] The empirical literature presents several results that point in different directions, and a consensus on the relationship between redistribution and inequality remains elusive (Acemoglu et al., 2015).

Spraggon and Oxoby, 2009; Cox et al., 2018).[8]

In our baseline treatment (*Equality*), each group member receives an endowment of 50 tokens in each round in Part 1 and Part 2. In *Inequality*, two randomly chosen group members receive a per-period endowment of 20 tokens each and the other two receive 80 tokens each in both Parts 1 and 2. Importantly, in these two treatments, individual endowments do not change from Part 1 to Part 2. The third treatment, *Redistribution*, explores the effect of an equalising redistribution of endowments. While groups begin with two poor and two rich members in Part 1, all members receive a per-period endowment of 50 tokens in Part 2.[9]

In all three treatments, the total resources available to groups is fixed at 200 tokens (= [2×20 + 2×80] = 4×50) per round in Part 1 and in Part 2.[10] Thus, we explore the pure effects of redistribution alone on cooperation. Table 1 summarises the treatments in our first set of experiments.

Table 1. Summary of treatments with constant group resources

	Endowments within group				
Treatment	**Part 1**	**Change?**	**Part 2**	**# groups**	**# subjects**
Equality	50, 50, 50, 50	No	50, 50, 50, 50	10	40
Inequality	20, 20, 80, 80	No	20, 20, 80, 80	12	48
Redistribution	20, 20, 80, 80	Yes	50, 50, 50, 50	12	48
			Total	34	136

We also conducted another treatment – *Reverse Redistribution* – to check if behaviour persists from Part 1 to Part 2 in general, and/or if such persistence is dependent on the initial condition being equality or inequality. In this treatment, groups start out equal with all group members receiving an endowment of 50 tokens each in Part 1. In Part 2, groups undergo a redistribution of

[8] The source of endowments does appear to affect contributions when a clear minority of group members receive endowments from a different source than the rest of the group (Oxoby and Spraggon, 2013). We do not consider this additional source of heterogeneity in our study.

[9] We focus on exogenous redistribution. Experimental studies examining endogenous redistribution in real-effort tasks found that when a redistributive tax is imposed exogenously, there exists a disincentive to work. However, the disincentive to work is substantially lower when the redistributive tax is endogenously imposed (Sausgruber et al., 2019). In addition, as inequality in wages increases, subjects are more willing to vote for higher redistributive tax rates, but efficiency in terms of total income decreases due to lower labour supply (Agranov and Palfrey, 2015).

[10] In unequal groups, the bottom 50% of group members receive 20% of the group's resource endowment. In 2014, the income share of the bottom 50% of the population in the United States was 12% (Piketty et al. 2016) and 22% in France (Garbinti et al., 2018). If the poor in our experiment received a lower share than 20%, even full cooperation by all group members would lead to lower earnings for the rich relative to when they contribute nothing.

resources to make them unequal, with two poor (20 tokens) and two rich (80 tokens) members. Since our main focus is on the effects of reduction in inequality, we report contribution behaviour in this treatment in Appendix C.

In each round in each Part, subjects were informed of the distribution of endowments in their group, but not of which member had which endowment. At the end of each round, subjects were informed of the total allocation to the group account in the round, and of their earnings from the private and group accounts in the round. Subjects were not informed of the individual allocations of the other group members. The chosen information structure is common in the literature (see Chaudhuri, 2011) and corresponds to real-life examples where there is always a degree of uncertainty about individuals' abilities to contribute to a common project, as well as their actual contributions.

All sessions were conducted at the Appalachian Experimental Economics Laboratory (AppEEL) at Appalachian State University using z-Tree (Fischbacher, 2007). Subjects were randomly assigned groups and endowments at the beginning of a session and stayed in the same groups through Parts 1 and 2 (partners matching). In *Inequality* and *Equality*, individual endowments stayed fixed through both Parts. In *Redistribution*, the above changes in endowments were made at the beginning of Part 2 and endowments then remained fixed for the following 20 rounds.

Subjects were told that there would be two Parts to the experiment, but received instructions for Part 2 only at the end of Part 1. They read printed instructions (available in Appendix D) at their own pace. To ensure common information, an experimenter then publicly summarised the main features of the game, including the repeated nature of interactions, partner matching, and the inequality. To keep the instructions neutral, we do not use the term redistribution to avoid politically charged emotions related to the term. We simply say that in Part 2, all group members have a per-period endowment of 50 tokens.

Subjects answered control questions before Part 1 of the experiment could begin. Earnings from a round could not be used in future rounds. Subjects were paid the sum of their earnings from all 40 rounds of the experiment. Token earnings were converted to cash at the rate of 150 tokens to US$1. A session lasted approximately 60 minutes on average and a subject earned an average of US$ 17.02.

An important predictor of behaviour in public goods games is a player's beliefs about the behaviour of others in the group. Hence, several studies elicited incentivised beliefs during the game. In Part 2 after redistribution, it would be interesting to elicit beliefs of group members as to how the formerly rich and poor will change their contributions. However, the process of belief elicitation itself has been shown to affect behaviour (Croson, 2000; Gächter and Renner, 2010). Moreover, "it is *only* the players who have strongly asymmetric payoff opportunities who show all these strong belief elicitation effects" (Ruström and Wilcox, 2009, p. 617; italics in original). Since our experiment is designed to study the effects of asymmetry, we chose not to elicit beliefs in this first study so as to cleanly isolate the effects of the asymmetry on behaviour.[11]

Finally, as mentioned earlier and similar to Maurice et al. (2013), we consider a treatment where groups that start out equal undergo a redistribution of resources that makes them unequal. Findings from this treatment, *Reverse Redistribution*, are reported in Appendix C. Given previous evidence that inequality harms cooperation, our primary focus is on changes with the potential to raise cooperation. In groups that become more unequal over time, there are two possible outcomes: (i) the efficiency enhancing effects of initial equality persist with later inequality, or (ii) the later inequality reduces cooperation. Neither outcome is directly informative of policies designed to tackle *existing* inequality. However, we find evidence of the latter possible outcome, implying persistence in behaviour is observed only after subjects first experience inequality.

2.3 Hypotheses

We use the theory of reciprocity (see Appendix B) to generate testable hypotheses. As more efficient equilibria are possible with equal groups, reciprocity suggests that contributions will be lower in unequal than in equal groups. In conjunction with existing evidence, we make the following hypothesis.

Hypothesis 1: *(a) Group contributions are lower in Inequality than in Equality in Parts 1 and 2.*

[11] Further, Martinangeli (2021) notes that the elicitation of beliefs in unequal groups presents an "information hurdle" (p. 5) due to the prevalence of both absolute and relative contribution norms, as documented in Reuben and Riedl (2013). This may be especially so when beliefs can be updated based on observed behaviour. He elicits beliefs *before* group members interact in a public goods game. Nevertheless, we do analyse a version of naïve beliefs on the part of group members where their (future) contributions match the past contributions of other group members. We find that such an approximation captures observed behaviour rather accurately. This analysis is presented in Appendix A5.

(b) Group contributions are lower in Redistribution than in Equality in Part 1.

Redistribution of endowments from the rich to the poor implies that all group members have 50 tokens to contribute to the public good. Thus, the constraint faced in unequal groups (the endowment of the poor – see Appendix B1) is relaxed for both poor and rich group members. Groups with reciprocal members that transitioned from inequality to equality can sustain higher contributions than previously possible. Hence, redistribution is expected to raise group contributions relative to a situation of inequality.

Hypothesis 2: *(a) Group contributions are higher in Part 2 than in Part 1 in Redistribution.*

(b) Group contributions are higher in Redistribution than in Inequality in Part 2.

Post-redistribution, groups are in the same situation as those in Equality in Part 2. The feasible contributions that can be attained by both sets of groups are now the same. Thus, contributions are expected to be similar in equal groups, regardless of initial circumstances.

Hypothesis 3: *Group contributions are not different in Equality and Redistribution in Part 2.*

2.4 Results

We use regression analysis to make comparisons between pairs of treatments and Wilcoxon signed rank (SR) tests to make comparisons within individuals in a treatment.[12] We present p-values from two-sided tests. The number of observations is the entire panel in regression analysis and the number of groups in the treatment being considered in the SR test. Panel regressions provide more power than tests of means between pairs of treatments (Cox and Stoddard, 2018). Implied power of SR tests with p-values relatively close to standard significance levels ($0.05 \leq p \leq 0.30$) are also reported.[13]

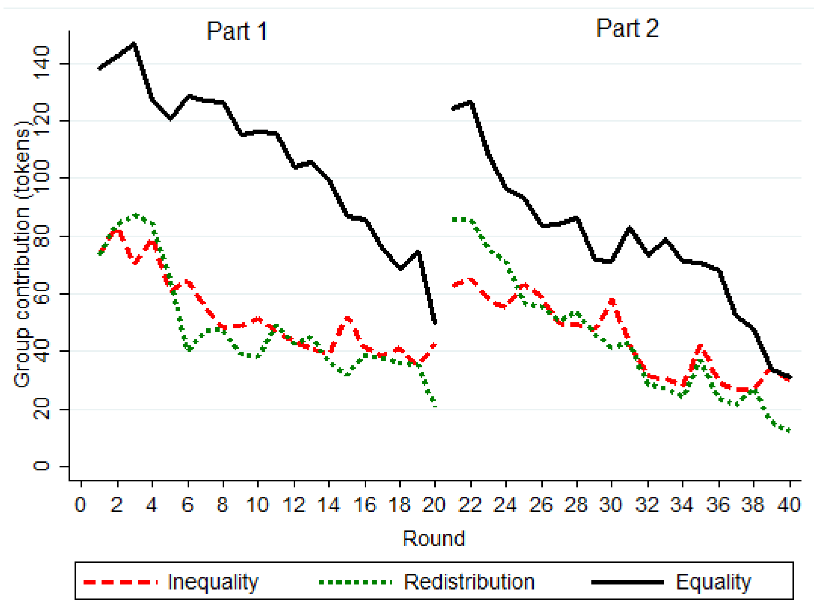
2.4.1 Group contributions

Figure 1 presents average group contributions to the public good over time in the three treatments, and Table 2 presents summary statistics on group contributions averaged across all 20 rounds in

[12] In Appendix A1, we supplement regression analysis with t-tests (t) and Wilcoxon ranksum (RS) tests to make comparisons between pairs of treatments. Power calculations for these tests are also reported. These test results are consistent with the regression results we present here.
[13] The implied power of a test is the probability of detecting a Type II error given an effect size and the variability in our sample data.

each Part, along with signrank tests for differences between Parts in each treatment.[14] Figure 1 shows the usual downward trend in contributions over time along with a noticeable end-game effect in both Parts and in all three treatments (Sefton et al., 2007).[15] Between Parts, we also observe the restart effect (Andreoni, 1988; Croson, 1996); group contributions are higher in the first round of Part 2 than in the last round of Part 1 in all treatments. The declining contributions under equality may indicate that, in the long run, equal and unequal groups may end at the same level of contributions. Politicians and policy advisors are likely to care more about the short-term effects because re-election and funding typically depends on immediate outcomes. Further, and more importantly, significant events in the real world – shocks to the economy, election cycles, natural disasters, and new policies – may act like restart effects where cooperative behaviour adjusts upward.

Figure 1. Average group contributions with constant group resources: Pure redistribution



[14] The implied power of the test to find a difference of 20 tokens (average of 5 tokens per group member) to be significant is approximately 0.64 in *Inequality*.
[15] The sample size and average group-level contribution in Part 1 of *Equality* are within the range of those in similar equal public goods studies with multiple parts, albeit the contribution in round 1 is on the high end (e.g., Sefton et al., 2007, Stoddard et al., 2014 & 2021).

Table 2. Mean group contributions with constant group resources

	Obs.	Part 1	Part 2	Signrank test
Equality	10	107.74	77.77	-2.803
		(32.55)	(33.71)	[0.0051]
Inequality	12	52.84	44.51	-1.412
		(32.45)	(28.12)	[0.1579]
Redistribution	12	49.02	44.11	-0.628
		(28.33)	(28.81)	[0.5303]

Total group endowment = 200 tokens in both Parts in all three treatments. Figures in parentheses are standard deviations. Figures in brackets are two-sided p-values corresponding to each Signrank test statistic.

Table 3 presents group-level panel random effects regressions. The dependent variable is a group's total contribution in a round, while the independent variables are treatment dummies (*Equality* excluded) and a time trend. We report standard errors clustered on independent groups. Our results confirm previous results that inequality is detrimental to voluntary contributions to public goods, and provide support for Hypothesis 1 (both treatment dummies in the Part 1 regression and the *Inequality* dummy in the Part 2 regression are negative and significant).

Table 3. Group-level regressions: treatments with constant group resources

	Part 1	Part 2
Inequality	-54.89^{***}	-33.26^{**}
	(13.49)	(12.98)
Redistribution	-58.71^{***}	-33.66^{**}
	(12.73)	(13.10)
Round	-3.000^{***}	-3.204^{***}
	(0.332)	(0.343)
Constant	139.2^{***}	175.5^{***}
	(10.28)	(16.41)
Observations	680	680
Wald test p-value	0.7524	0.9721

Panel RE regressions. Std. errors clustered on group in parentheses. Excluded category: *Equality*. The Wald test is a post-regression test for *Inequality* = *Redistribution*. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 1: *(a) Group contributions are lower in Inequality than in Equality in both Parts 1 and 2.*

(b) Group contributions are lower in Redistribution than in Equality in Part 1.

Focusing on the effects of redistribution, average group contributions in *Redistribution* are not significantly different between Part 1 and Part 2 (49.02 vs. 44.11; SR p = 0.5303). Further, even after redistribution to full equality, group contributions are no different than in groups that remain unequal; there is no significant difference in group contributions between *Inequality* and *Redistribution* in Part 2 (Part 2 Wald test, p = 0.9721). We do not find support for Hypothesis 2.

Result 2: *(a) Redistribution does not raise contributions in groups that experienced inequality.*

(b) Group contributions in Inequality and Redistribution are not different in Part 2.

Finally, we do not find support for Hypothesis 3 - the *Redistribution* dummy is negative and significant (p = 0.01) in the Part 2 regression.

Result 3: *Contributions of groups that experienced inequality remain lower in Part 2 than those of groups that have not, even after a fully equalising redistribution of resources.*

2.4.2 Individual contributions

In order to explore why redistribution is ineffective, we examine individual contributions of the rich and the poor.[16] Figure 2 shows average individual contributions over time of the poor and rich in Part 1 in *Redistribution* and in both Parts in *Inequality*. Though everyone receives equal endowments in Part 2 in *Redistribution*, Figure 2 separates average contributions of the former poor and the former rich. For purposes of comparison, Figure 2 also shows average individual contributions in *Equality* in both Parts. Table 4 shows summary statistics of average (across all groups and all rounds) individual contributions in both Parts in the three treatments.

[16] Results reported in this section are based on absolute contributions. Appendix A2 reports similar tables and figure based on % contributions.

Figure 2. Average individual contributions with constant group resources: Pure redistribution

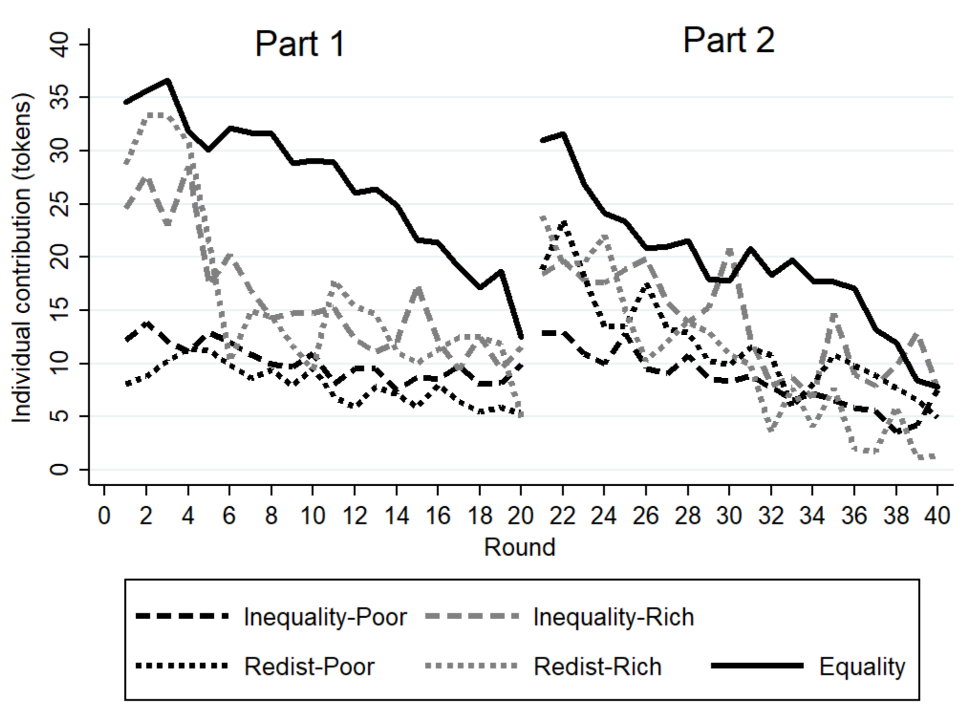


Table 4. Average individual contributions with constant group resources

		Part 1		Part 2	
	Obs.	Poor	Rich	Poor	Rich
Equality	10	26.93		19.44	
		(8.14)		(8.43)	
Inequality	12	10.16	16.26	8.47	13.78
		(4.09)	(13.44)	(4.17)	(11.35)
Redistribution	12	7.99	16.53	11.81	10.24
		(5.12)	(11.52)	(9.42)	(6.91)

Figures in parentheses are standard deviations. Poor and rich are defined based on endowments in Part 1.

Figure 2 shows that average individual contributions are highest in *Equality*. Importantly, contributions in equal groups are higher than those by rich individuals in unequal groups who have higher token endowments. In unequal groups, in Part 1, the rich members contribute higher amounts than do the poor in the initial rounds. By about round 5, average contributions of the rich drop to levels closer to the absolute contributions of the poor.[17] The means in Table 4 confirm these aggregate patterns.

Individual panel regressions of contributions with controls for past outcomes and behaviour (one-period lagged average contribution of the other group members) are presented in Table 5. These show that the rich contribute (at least weakly) more than do the poor in both Parts of *Inequality* (negative Poor dummy, p = 0.07 in Part 1 and 0.061 in Part 2) and Part 1 of *Redistribution* (Poor dummy; p = 0.009).

The last column of Table 5 presents individual regressions that compare contributions of the former rich and poor in Part 2 of *Redistribution* with those of group members in *Equality*. Post-redistribution, average contributions of the former poor and the former rich are similar in Part 2 in *Redistribution* (post-regression Wald p = 0.39). The former rich and former poor in *Redistribution* contribute lower amounts than do group members in *Equality* in Part 2 (negative former poor dummy p = 0.074 and negative former rich dummy p = 0.002). Thus, despite the fact that group members have the same abilities to contribute, those who experienced inequality in Part 1 contribute less to the public good than those who did not. Both the (former) rich and poor drive the ineffectiveness of redistribution.

Table 5. Individual panel regressions comparing contributions of rich and poor members

	Inequality		*Redist.*	
	Part 1	Part 2	Part 1	Part 2
Lagged average cont. of others	0.267^{***}	0.248^{***}	0.051	0.325^{***}
	(0.057)	(0.033)	(0.061)	(0.056)
Poor dummy	-6.331^{*}	-5.760^{*}	-8.054^{***}	-
	(3.498)	(3.071)	(3.095)	
Former poor dummy	-	-	-	-4.508^{*}
				(2.526)
Former rich dummy	-	-	-	-6.591^{***}
				(2.160)
Round	-0.380^{***}	-0.399^{***}	-0.658^{***}	-0.612^{***}
	(0.105)	(0.081)	(0.138)	(0.101)

[17] This finding provides support for our (sup)position that reciprocity more closely applies to absolute rather than percentage contributions – see Appendix B1.

Constant	16.73***	23.33***	22.54***	31.28***
	(4.264)	(4.863)	(4.764)	(4.376)
Observations	912	912	912	1672
Wald test: Former poor vs. Former rich, p-value =				0.3990

Panel RE regressions. Std. errors clustered on group in parentheses. Excluded category: rich group members in the first three regressions, and *Equality* in the fourth regression. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 4: *In Part 2, contributions of the former rich and the former poor in Redistribution are similar to each other, and are lower than the contributions of individuals in Equality.*

Result 3 shows that the net effect from redistribution is that group contributions do not increase. However, is this because neither type reacts to the change in their circumstances, i.e., endowments? Figure 2 and Table 4 show a change in contribution levels of the poor and the rich once redistribution has taken effect. Relative to contributions in Part 1, the increase in Part 2 is weakly significant for the poor (7.99 vs. 11.81; SR, p = 0.0712) and the decrease in Part 2 is weakly significant for the rich (16.53 vs. 10.24; SR, p = 0.0597).[18]

A look at percentage of endowment contributed is insightful here. The poor significantly reduce percentage contributions in Part 2 (39.93% vs. 23.63%; SR, p = 0.0047) while the rich do not alter their contribution behaviour much at all (20.66% vs. 20.48%; SR, p = 0.8139).

Result 5: *After redistribution, relative to Part 1:*

(a) The former poor (rich) weakly increase (decrease) their absolute contributions to the public good.

(b) The former poor reduce their percentage contributions to the public good while the former rich contribute the same percentage of their (reduced) endowment.

Combined with Result 4, this implies that the rich do not alter their (percentage) behaviour, and that the poor simply match them when their endowment increases. Naïve beliefs on the part of the poor, i.e., the belief that the relative contributions of the rich in Part 2 will remain unchanged from Part 1, captures observed behaviour accurately – see Appendix A5. As a result, redistribution does not even improve over previously low outcomes achieved in unequal groups (Result 2).

[18] The implied power of the tests to find a difference of 5 tokens (25% of poor endowment) to be significant is approximately 0.63 for the poor and 0.67 for the rich in *Redistribution*.

3. Injection of additional resources

A reason for the ineffectiveness of redistribution may be the loss of endowment by the rich individuals in a group. An adverse reaction to a reduction in endowment may be greater than a favourable response to an increase in endowment. This might therefore be a reason that the former rich lower contributions after redistribution.

To account for this possibility, we next consider the effects of reductions in inequality when the rich never face decreases in their endowments. Previous evidence suggests that an injection of resources that creates pure equality may increase group contributions to the public good. Hargreaves Heap et al. (2016) found that contributions were higher in groups where all three members were equally endowed with 80 tokens relative to contributions in groups where the distribution of endowments was (20, 50, 80). However, they do not examine behaviour in groups that undergo a change in the distribution of endowments within the group. Here, we consider injections of resources directed to the poor in groups that are initially unequal, and have experienced the (negative) effects of inequality.

A practical application of such injections is to Universal Basic Income (UBI) policies where some or all sections of the population receive unconditional income transfers from the state. Because a primary focus of many proponents of UBI is on labour market outcomes, previous programmes did not track recipients' investments in education, training, health, and their community participation, all of which have positive externalities for society. As a main channel through which inequality is linked to negative outcomes is through reduced social capital, we focus on the effects of transfers on individuals' involvement in groups, as measured by contributions to local public goods. We examine inequality reduction through a system akin to means-tested basic income transfers, where only the poorer individuals in a group receive supplementary income (as in the Finnish experiment), and there is no corresponding reduction in the incomes of the rich.[19]

[19] Experiments with UBI from the 1970s were evaluated only for their effects on labour market participation of the recipients of transfers. In this sense, the earlier experiments were not very successful (Hum and Simpson, 1993). The recent Finnish experiment showed that, while individuals who received a guaranteed income reported higher happiness levels, they were no more likely to find work than a control group who received no state support (Kela, 2019; BBC News, 2019). Nevertheless, similar trials are planned or are underway in one US city (Stockton, CA) and India, Kenya, the Netherlands, Scotland and Spain.

3.1 Experimental design and procedures

We focus on groups that experienced inequality, i.e., Part 1 is identical to Part 1 in *Inequality* and *Redistribution*. The resource endowments within groups are then made less unequal in Part 2 through the injection of additional resources. Treatments differ in the total amount of additional resources injected, and how they are distributed in Part 2.

In *One Poor*, an additional 60 tokens are added to the group's total available endowment in each round in Part 2. The entire additional 60 tokens are given to *one* of the players who was poor in Part 1 (randomly chosen), and the other poor player receives no additional endowment relative to his/her endowment in Part 1. In *Two Medium*, an additional 60 tokens are also added to the group's total available endowment in each round in Part 2. However, this addition is split equally between the poor; each of the two poor individuals (in Part 1) receives an additional endowment of 30 tokens in each round in Part 2. In both treatments, group members who were rich in Part 1 continue to be rich in Part 2. Thus, in Part 2, there are three rich members and one poor member in a group in *One Poor*, and two middle and two rich members in a group in *Two Medium*.

Our final treatment adds 120 tokens to the group endowment in each round in Part 2. In *All Rich*, each of the group members who was poor in Part 1 receives an additional 60 tokens in each round in Part 2. Thus, a group is composed entirely of rich individuals in Part 2. The above two treatments implement partial reduction of inequality within groups while *All Rich* eliminates inequality in Part 2. Additionally, the treatments also differ in the total resources available to the group as a whole in Part 2. Groups have a total of 260 tokens per round in *One Poor* and *Two Middle,* while groups have a total of 320 tokens per round in *All Rich*. Table 6 summarises our additional treatments.

Table 6. Summary of additional treatments with increasing group resources

	Endowments within group				
Treatment	**Part 1**	**Change?**	**Part 2**	**# groups**	**# subjects**
Equality	50, 50, 50, 50	No	50, 50, 50, 50	10	40
OnePoor	20, 20, 80, 80	Yes	20, 80, 80, 80	16	64
TwoMedium	20, 20, 80, 80	Yes	50, 50, 80, 80	16	64
AllRich	20, 20, 80, 80	Yes	80, 80, 80, 80	12	48
	Total for additional treatments			44	176

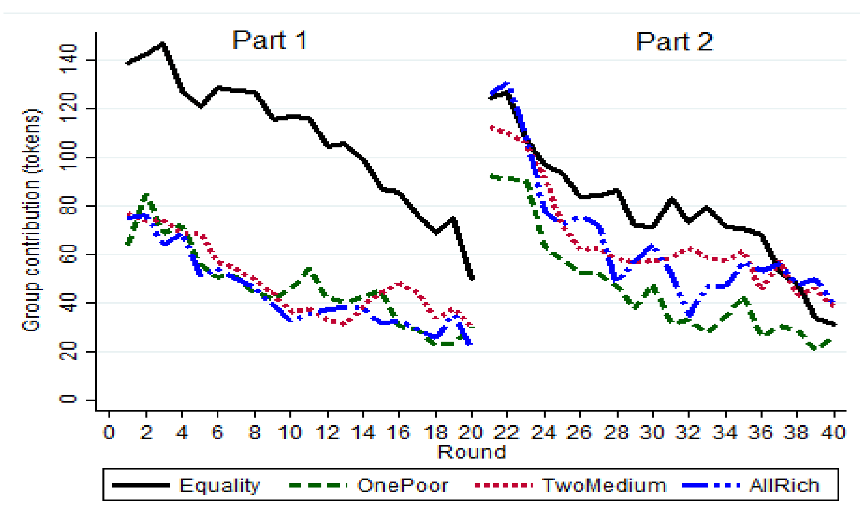
Following the reasoning used to generate Hypotheses 1 – 3, reciprocity predicts that group contributions are higher in Part 2 than in Part 1 in all treatments. This is due to an increase in contributions of all group members except those who do not receive additional resources. This is because the additional resources relax the obligation constraint beyond 20 tokens for all individuals in one *minimal effective subgroup* (MES, see Appendix B1) (with the three rich members in Part 2) in *OnePoor*, and in all subgroups in the other two treatments. We test the prediction that *any* inequality-reducing injection of resources increases contributions to the public good.

3.2 Results

3.2.1 Group contributions

Figure 3 presents average group contributions over time in the three new treatments. Table 7 presents summary statistics of average group contributions (averaged over all 20 rounds in each Part) in each treatment, along with SR tests for differences between Parts in each treatment.[20] For purposes of comparison, the Figure and Table also present average contributions in *Equality*. Note that in Part 1, groups in all treatments have the same total endowment of 200 tokens. Group endowments only differ in Part 2. Relative to Part 1, average absolute group contributions in Part 2 are no higher in *OnePoor* but are higher in *TwoMedium* and in *AllRich* (signrank tests confirm these observations).

Figure 3. Average absolute group contributions over time: Injection of resources



[20] We present complementary analysis related to percentage contributions in Appendix A3.

Table 7. Mean absolute group contributions: injection of resources

	Obs.	Part 1	Part 2	Signrank test
Equality	10	107.74	77.77	-2.803
		(32.55)	(33.71)	[0.0051]
OnePoor	16	46.84	46.64	< 0.0001
		(31.87)	(25.61)	[> 0.999]
TwoMedium	16	49.01	65.84	2.172
		(28.29)	(47.84)	[0.0299]
AllRich	12	44.09	65.76	2.589
		(20.35)	(33.71)	[0.0096]

Total group endowment = 200 in Part 1 in all treatments. In part 2, total group endowment = 200 in *Equality*, = 260 in *OnePoor* and in *TwoMedium*, and = 320 in *AllRich*. Figures in parentheses are standard deviations. Figures in brackets are two-sided p-values corresponding to each Signrank test statistic.

Result 6: *(a) Average absolute group contributions are similar in Part 1 and Part 2 in OnePoor. (b) Average absolute group contributions are higher in Part 2 than in Part 1 in TwoMedium and AllRich.*

Table 8 presents group-level regressions for Part 2 analogous to those in Table 3. Despite more resources being available in Part 2, group contributions are noticeably lower in *OnePoor* than in *Equality* (negative dummy, p = 0.009). Group contributions in Part 2 are lower in *TwoMedium* and in *AllRich* relative to *Equality*, but not significantly (treatment dummies p = 0.44 and 0.33 respectively). Finally, there is no significant difference in group contributions in Part 2 between *TwoMedium* and *AllRich* (Wald Test p = 0.9953).

Table 8. Group level regressions for Part 2: injection of resources

Part 2	Absolute cont.
One Poor	-31.13***
	(12.00)
Two Medium	-11.93
	(15.55)
All Rich	-12.01
	(12.25)
Round	-3.492***
	(0.364)
Constant	184.3***
	(16.17)
Observations	1080

Panel RE regressions. Std. errors clustered on group in parentheses. Excluded category: *Equality*.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 7: *(a) In Part 2, group contributions are lower in OnePoor than in Equality.*

(b) Group contributions are not different in Equality, TwoMedium and All Rich in Part 2.

It seems clear that additional resources directed at just one of the poor group members does not change cooperation levels at all. Directing additional resources to both poor members, on the other hand, does help groups increase cooperation levels. However, additional resources do not allow initially unequal groups to achieve higher cooperation than in groups that were always equal, *but also have a lower resource endowment*. Most striking is the finding that *All Rich* does not improve over *Equality* in Part 2, in spite of the group now: (i) having access to an additional 120 tokens to invest in the public good, and (ii) having moved to a state of complete equality.[21]

3.2.2 Individual contributions

Table 9 presents summary statistics of average (over 20 rounds) individual contributions by endowment level in Part 1 and in Part 2. Average contributions of the rich remain similar from Part 1 to Part 2, even after groups receive additional resources. In particular, they do not increase

[21] Looking at percent of group endowment contributed to the public goods presents a much starker contrast. In particular, percent group contributions are significantly lower in all treatments than in *Equality*.

contributions in Part 2. Those who remain poor in *OnePoor* also do not increase their contributions from Part 1 to Part 2.[22] Thus, those whose endowments do not change from Part 1 to Part 2, also do not change their contributions.

Table 9. Mean individual absolute contributions: injection of resources

		Part 1		Part 2			
	Obs.	Poor	Rich	Always Poor	New Medium (Poor→50)	New Rich (Poor→80)	Always Rich
Equality	10	26.93 (8.14)		19.44 (8.43)			
OnePoor	16	7.96 (4.27)	15.46 (12.78)	7.18 (5.09)	-	12.84 (8.99)	13.31 (10.35)
TwoMedium	16	8.91 (4.60)	15.59 (12.34)	-	16.80 (11.57)	-	16.12 (14.26)
AllRich	12	7.62 (2.75)	14.43 (9.06)	-	-	19.07 (10.46)	13.81 (5.49)

Figures in parentheses are standard deviations. The Poor (Rich) endowment is 20 (80) tokens.

Those who receive additional resources in Part 2 significantly increase their contributions when moving from Part 1 to Part 2 in *OnePoor* (7.96 vs. 12.84; SR, p = 0.0066), in *TwoMedium* (SR, 8.91 vs. 16.80; SR, p = 0.0013) and in *AllRich* (7.62 vs. 19.07; SR, p = 0.0022).

Result 8: *Individuals' contributions increase from Part 1 to Part 2 <u>only</u> when their endowments increase between the two Parts.*

Table 10 presents individual regressions of contributions in Part 2 for each treatment. In all regressions, contributions of the different types of group members (those who are always rich, those who become rich in Part 2, etc.) are compared to the contributions of those in *Equality* (excluded category). The contributions of those who receive additional resources in Part 2 are not significantly different from the contributions of the 'old rich' in Part 2 in *OnePoor* and *TwoMedium* (Wald p > 0.73 in both cases), and are very weakly significantly higher in *AllRich*

[22] There are no significant differences in individual behaviour across the inequality treatments in Part 1. Appendix A4 presents this analysis.

(Wald p = 0.09).[23] However, contributions of the 'new rich' in *AllRich* are still not higher than contributions in *Equality*, despite having an additional 30 tokens (New rich dummy, p = 0.748).

Table 10. Individual regressions: comparing player Types in Part 2 to *Equality*

Part 2	*One Poor*	*Two Medium*	*All Rich*
Lagged average cont. of others	0.354***	0.439***	0.377***
	(0.037)	(0.060)	(0.043)
Always poor	-9.512***	-	-
	(2.200)		
New rich	-3.963	-	0.978
	(2.606)		(3.044)
New medium	-	-1.094	-
		(2.336)	
Always rich	-3.070	-2.039	-4.897**
	(2.706)	(2.916)	(2.083)
Period	-0.529***	-0.433***	-0.515***
	(0.103)	(0.0814)	(0.103)
Constant	28.13***	23.44***	27.23***
	(4.091)	(3.924)	(4.278)
Observations	1976	1976	1672
Wald test p-values	0.7809	0.7340	0.0924

Panel RE regressions. Std. errors clustered on group in parentheses. Excluded category: *Equality*. The Wald tests are post-regression tests for equality of the Always rich dummy and the dummy for the player type that gained additional resources in Part 2. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Result 9: *Those who receive additional resources in Part 2 match the contributions of those who were always rich in their groups.*

In Part 2, contributions by the 'old rich' are lower than in *Equality*. There is evidence that this difference is significant in *All Rich* (Always rich dummy p = 0.019). However, the difference is not statistically significant in *TwoMedium* (p = 0.485) or in *OnePoor* (p = 0.256).

Result 10: *Average contributions of the 'old rich' in Part 2 are no higher than average individual*

[23] Naïve beliefs based on aggregate contribution information in *AllRich* are examined in Appendix A5. Average behavior based on such beliefs are in line with what is reported here.

contributions in Equality.

These findings imply that the ineffectiveness of redistribution in raising contributions is *not* due to potential adverse reactions of the rich to reductions in their endowments. To the contrary, the above results suggest that the rich do not respond to changes, particularly increases, in others' abilities to contribute to the public good. Note that their own abilities to contribute remains unchanged, as do their contributions. While the former poor do increase their contributions, it is to a much lower extent than needed to match contributions in equal groups; they only match the unchanged behaviour of the old rich. Both the former poor and the rich thus allocate the majority of resources to private consumption. Therefore, injections of resources do not lead to increases in cooperation above levels observed in groups that were always equal.

4. Discussion and conclusion

Inequality in individuals' resource endowments has been linked to low cooperation in groups, as measured by contributions to group public goods. The principle of reciprocity identifies the lower resource endowments of a subset of the group as the constraint to groups achieving higher cooperation levels. In doing so, the principle also presents a potential policy solution – redistribution of resource endowments among group members to reduce inequality. We report the results from an experiment that tests the viability of such a policy.

In a finitely repeated linear public good game, we implement endowment inequality by including randomly determined 'poor' and 'rich' group members. After unequal groups play the game for 20 rounds, we redistribute endowments to ensure full equality among members before they play the game for another 20 rounds.

We find, contrary to the prediction of reciprocity, that redistribution fails to raise cooperation in previously unequal groups. To explore reasons for this result, we run additional treatments exploring the potential effects of injections of additional resources to groups targeted to the poor, in particular avoiding the reduction of endowments of the rich. Such injections mirror means-tested Universal Basic Income schemes across the world. Our results support our finding related to the ineffectiveness of redistribution. Even the injection of additional resources in initially unequal groups fails to raise cooperation to levels observed in equal groups that have lower resource endowments.

Contribution behaviour in the additional treatment – *Reverse Redistribution* – suggests that groups that start out equal but then transition to inequality experience a drop in contributions. Post-redistribution, their contributions are similar to levels observed in unequal groups, despite having started out at higher levels consistent with equality (see Appendix C). Thus, the benefits of initial equality do *not* survive the introduction of inequality. However, the mere experience of inequality appears to lock groups into low cooperation for a long time; i.e., a pattern of low contributions established under inequality in Part 1 persists even after changes in income that would be compatible with higher cooperation, thus leading to persistent inefficiency. This initial negative experience limits a group's ability to benefit from inequality-reducing income transfers.

While pure redistribution may not benefit groups, there are important implications for the allocation of spending at the individual level. The (initially) rich spend nearly 80% of their endowment on private consumption before and after redistribution. Despite a change in their endowment, their (relative) spending behaviour does not change – old habits die hard. The (initially) poor, on the other hand, spend a significantly higher (increase from 60 to 76%) share of their (higher) endowment on private goods after redistribution.

This shift towards greater private consumption is starker in groups that receive additional resources in Part 2, all of which are directed to the poor. In unequal groups in Part 1, the (old) rich already allocated most of their resources to private consumption. Their private consumption does not change in Part 2. The private spending of the poor increases in Part 2, and ranges from 66.4% in *Two Medium* to 83.95% in *One Poor*. This shift towards private consumption of the majority of additional resources given to the (old) poor and the unaltered private consumption of the old rich renders both redistribution and the injection of resources ineffective at raising cooperation.[24]

Our results suggest unconditional income transfers may create a 'nouveau riche' class that almost immediately mimics the behaviour of those with 'old money', and spends most of their resources on private consumption. Thus, our results do <u>*not*</u> imply that transfers make the poor more selfish than the rich, just equally so. The net effect is that, in groups that experienced inequality, transfers

[24] Such behaviour is akin to the finding of Martinangeli (2021) where group members' contributions are correlated with their *ex-ante* beliefs about contributions of only the rich members and not the poor. This matching behaviour is also borne out by our analysis of naïve beliefs based on past behaviour, a sort of *ex-post* beliefs.

are not effective in increasing contributions to the public good in the short run. However, note that individual welfare is undoubtedly increased – incomes of the poor are directly increased as a result of transfers. It is only that the group does not benefit from the transfers.

Our findings suggest a need to investigate factors that can enhance the effectiveness of transfers, and/or to explore alternative policy instruments to combat the negative effects of inequality. For instance, is redistribution more or less effective with increased contribution transparency? If each group member knows others can observe his/her type (rich/poor) and contributions, does it make them more likely to cooperate with others when they are provided additional resources? Finally, now that we have a clearer picture of baseline behaviour before and after redistribution, we could elicit beliefs to learn what might be driving observed behaviour while controlling for the effects of beliefs themselves.

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The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

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for

Does reducing inequality increase cooperation?

Abhijit Ramalingam Brock V Stoddard

A. Additional Analyses

A1. Ranksum and t-tests to make comparisons between pairs of treatment supplement regression analysis

The unit of observation is the relevant contribution at the group level averaged across all rounds in a Part and across all groups in a treatment. The number of observations is the total number of groups in the pair of treatments for t- and RS tests. Implied power of tests with p-values relatively close to standard significance levels ($0.05 \leq p \leq 0.30$) are also reported. Mean contributions are reported in Tables 2, 4, 7, & 9 in the main body of the paper.

Related to Result 1:

Figure 1 and Table 2 show that average group contributions are lower in *Inequality* than in *Equality* in both Part 1 and in Part 2. The difference is significant in Part 1 (52.84 vs. 107.74; t, p = 0.0009; RS, p = 0.0012) and in Part 2 (44.51 vs. 77.77; t, p = 0.0234; RS, p = 0.0101). Contributions are lower in Part 1 in *Redistribution* than in *Equality*, and this difference is statistically significant (49.02 vs. 107.74; t, p = 0.0003; RS, p = 0.0008). Average contributions in Part 1 are not significantly different from each other in *Inequality* and *Redistribution* (52.84 vs. 49.02; t & RS, p > 0.7616).

Related to Result 2:

Even after redistribution to restore full equality, group contributions are no different than in groups that remain unequal; there is no significant difference in group contributions between *Inequality* and *Redistribution* in Part 2 (44.51 vs. 44.11; t & RS, p > 0.6861).

Related to Result 3:

Average group contributions are significantly higher in *Equality* than in *Redistribution* in Part 2 as well (77.77 vs. 44.11; t, p = 0.0229; RS, p = 0.0750)

Related to Result 4:

Post-redistribution, average contributions of the former poor and the former rich are similar in Part 2. Tests confirm that there is no significant difference between the absolute (11.81 vs. 10.24; SR p = 0.7537) contributions of the former poor and rich in Part 2 in *Redistribution*.

Related to Result 7:

Despite more resources available in Part 2, group contributions are noticeably lower in *OnePoor* than in *Equality* (46.64 vs. 77.77; RS, p = 0.0061; t, p = 0.0240). Group contributions in Part 2 are somewhat lower in *TwoMedium* and in *AllRich* relative to *Equality*. However, the difference is not statistically significant for *TwoMedium* (65.84 vs. 77.77; RS, p = 0.2684; t, p = 0.4638) or for *AllRich* (65.76 vs. 77.77; RS, p = 0.3913; t, p = 0.3597).[1] Finally, there is no significant difference in group contributions in Part 2 between *TwoMedium* and *AllRich* (65.84 vs. 65.76; RS, p = 0.3532; t, p = 0.9955).

Related to Result 10:

In Part 2, the contributions by the 'old rich' are lower than in *Equality*. There is weak evidence that this difference is marginally significant in *OnePoor* (RS, p = 0.0820; t, p = 0.1129). However, the difference is not statistically significant in *TwoMedium* (RS p = 0.3102) or in *AllRich* (RS p = 0.1593),[2] despite those who stay rich having an additional 30 tokens.

[1] The implied power of the tests compared to Part 2 of *Equality* to find a difference of 20 tokens (average of 5 tokens per group member) to be significant is approximately 0.73 for *TwoMedium* and 0.75 for *AllRich*.
[2] The implied power of the test comparing contributions of the old rich to *Equality* in Part 2 to find a difference of 5 tokens (25% of poor endowment) to be significant is approximately for 0.60 for *OnePoor* and 0.65 for *AllRich*.

A2. Individual percentage contributions related to Figure 2 & Tables 4 & 5

Figure A1 shows average individual percentage contributions over time of the poor and rich in Part 1 in *Redistribution* and in both Parts in *Inequality*. Though everyone receives equal endowments in Part 2 in *Redistribution*, Figure A1 separates average contributions of the former poor and the former rich. For purposes of comparison, Figure A1 also shows average individual contributions in *Equality* in both Parts.

Figure A1. Average individual % contributions with constant group resources: Pure redistribution

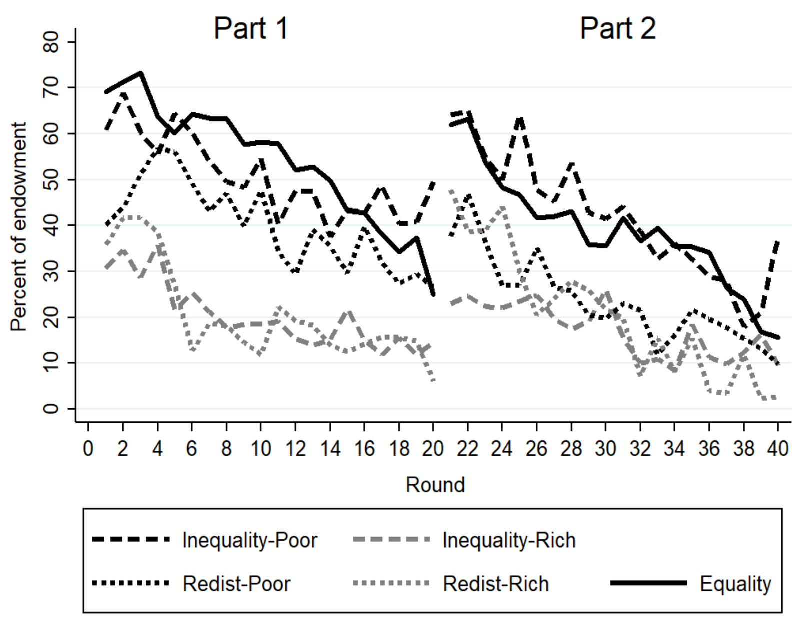


Table A1 shows summary statistics of average (across all groups and all rounds) individual percentage contributions in both Parts in the three treatments.

Table A1. Average individual % contributions with constant group resources

	Obs.	Part 1 Poor	Part 1 Rich	Part 2 Poor	Part 2 Rich
Equality	10	53.87		38.89	
		(16.27)		(16.86)	
Inequality	12	50.80	20.32	42.35	17.23
		(20.48)	(16.80)	(20.86)	(14.18)
Redistribution	12	39.93	20.66	23.63	20.48
		(25.58)	(14.40)	(18.83)	(13.82)

Figures in parentheses are standard deviations. Poor and rich are defined based on endowments in Part 1.

Individual panel regressions of percentage contributions with controls for past outcomes and behaviour (one-period lagged average contribution of the other group members) are presented in Table A2.

Table A2. Individual panel regressions comparing % contributions of rich and poor members

	Inequality		*Redist.*	
	Part 1	Part 2	Part 1	Part 2
Lagged average cont. of others	0.347***	0.244***	0.076	0.325***
	(0.073)	(0.043)	(0.054)	(0.056)
Poor dummy	32.83***	25.63***	20.38***	-
	(5.042)	(5.350)	(7.121)	
Former poor dummy	-	-	-	-9.016*
				(5.053)
Former rich dummy	-	-	-	-13.18***
				(4.320)
Round	-0.728***	-1.167***	-1.314***	-1.224***
	(0.258)	(0.193)	(0.221)	(0.202)
Constant	17.13***	46.78***	32.20***	62.57***
	(5.831)	(7.813)	(5.806)	(8.752)
Observations	912	912	912	1672
Wald test: Former poor vs. Former rich, p-value =				0.3990

Panel RE regressions. Std. errors clustered on group in parentheses. Excluded category: rich group members in the first three regressions, and *Equality* in the fourth regression. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A3. Percentage contributions: injection of resources

A3.1 Percentage group contributions

Figure A2 presents average percentage of group endowment contributed to the public good over time. Table A3 presents summary statistics of average percentage group contributions (averaged over all 20 rounds in each Part) in each treatment, along with signrank tests for differences between Parts in each treatment. For purposes of comparison, the Figure and Table also present average contributions in *Equality*. Note that in Part 1, groups in all treatments have the same total endowment of 200 tokens. Group endowments only differ in Part 2.

Figure A2. Average percentage group contributions over time: Injection of resources

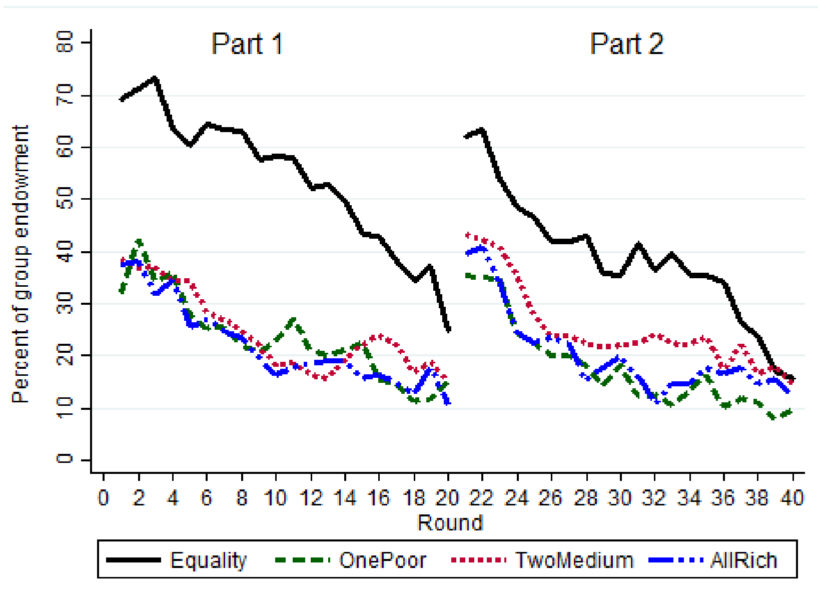


Table A3. Mean percentage group contributions: injection of resources

		Percent		Signrank
	Obs.	Part 1	Part 2	test
Equality	10	53.87	38.89	-2.803
		(16.27)	(16.86)	[0.0051]
OnePoor	16	23.42	17.94	-2.585
		(15.93)	(9.85)	[0.0097]
TwoMedium	16	24.50	25.32	-0.982
		(14.14)	(18.40)	[0.3259]
AllRich	12	22.05	20.55	-0.628
		(10.17)	(7.54)	[0.5303]

Total group endowment = 200 in Part 1 in all treatments. In part 2, total group endowment = 200 in *Equality*, = 260 in *OnePoor* and in *TwoMedium,* and = 320 in *AllRich*. Figures in parentheses are standard deviations. Figures in brackets are two-sided p-values corresponding to each Signrank test statistic.

Average percent contributions in unequal groups are below those in equal groups (RS, $p < 0.01$ for all pairwise comparisons with *Equality*).

Within treatments, relative to Part 1, average percent group contributions are no higher in *TwoMedium* and in *AllRich*, but are significantly lower in *OnePoor*.

Result A1: *(a) Average percentage group contributions are similar in Part 1 and Part 2 in TwoMedium and AllRich.*

(b) Average percentage group contributions are lower in Part 2 than in Part 1 in OnePoor.

In Part 1, contributions in *Equality* are higher than in the other three treatments (RS, $p < 0.001$ for all pairwise comparisons with *Equality*) while there are no significant differences among the three treatments with inequality (RS, $p > 0.70$ for all pairwise comparisons). The sign rank tests in Table 5 show that percentage contributions are lower in Part 2 than in Part 1 in *Equality* ($p = 0.0051$), which is consistent with declining contributions over time in public good games (see Chaudhuri, 2011). That there is no change in absolute contributions between Parts in *OnePoor* implies that percentage contributions are significantly lower in Part 2 than in Part 1 in *OnePoor* ($p = 0.0097$), i.e., groups contribute a lower percentage after an increase in available resources when all the additional resources are given to one of the initially poor members. When additional resources are distributed between both the poor (*TwoMedium* and *AllRich*), there is no change in percentage contributions between Parts.

Result A2: *When additional resources are directed to just one of the poor, percentage group contributions decline. There is no change in percentage group contributions when additional resources are directed to both poor group members.*

Figure A2 and Table A3 both show that percentage group contributions are highest in *Equality* in Part 2. Of the three inequality treatments, percentage contributions are highest in *TwoMedium* followed by *AllRich* and then *OnePoor*, although the differences between the three treatments are barely discernible in Figure 3(b). Tests show that percentage group contributions in Part 2 are significantly higher in *Equality* than in *TwoMedium* (RS, $p = 0.0452$), in *AllRich* (RS, $p = 0.0030$) and in *OnePoor* (RS, $p = 0.0005$). There are no significant differences in Part 2 among the three inequality treatments (RS, $p > 0.10$ in all pairwise comparisons).

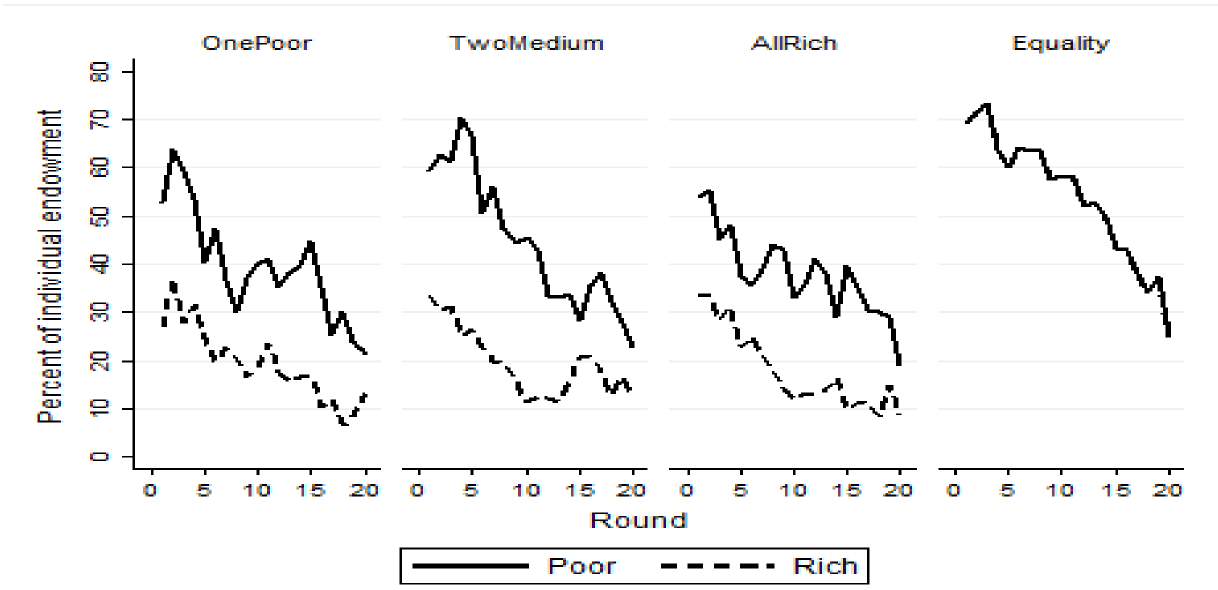
Result A3: *Percentage group contributions in Part 2 are higher in Equality than in the treatments where the resources available to groups are higher, but started out unequal.*

A3.2 Percentage individual contributions: injection of resources

Figure A3 and Table A4 are the counterparts of Figure 4 and Table 6 in the main text. The Figure presents time trends of average individual percent contributions over time by endowment level, and the Table presents summary statistics of the same.

Figure A3. Average individual percent contributions over time: injection of resources

(a) Part 1



(b) Part 2

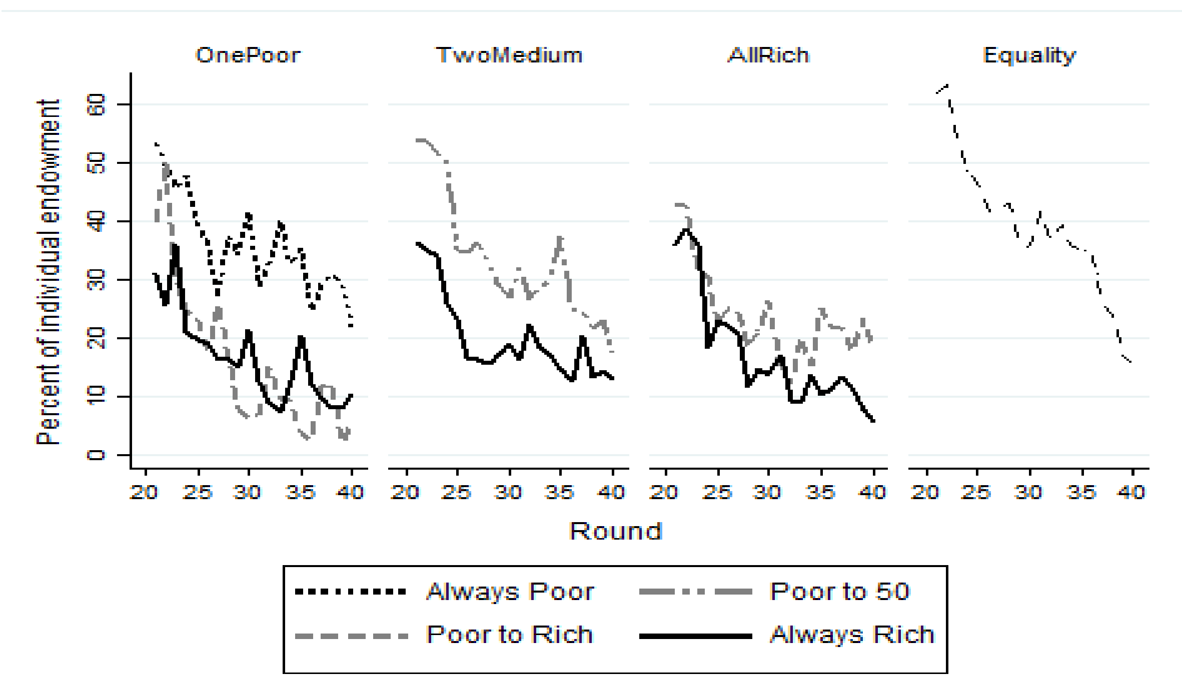


Table A4. Mean individual percent contributions: injection of resources

	Obs.	Part 1		Part 2			
		Poor	Rich	Always Poor	Poor→50	Poor→Rich	Always Rich
Equality	10	53.87 (16.27)		38.89 (16.86)			
OnePoor	16	39.79 (21.37)	19.33 (15.97)	35.89 (25.48)	-	16.05 (11.25)	16.64 (12.94)
TwoMedium	16	44.56 (23.00)	19.49 (15.43)	-	33.60 (23.15)	-	20.15 (17.83)
AllRich	12	38.09 (13.74)	18.03 (11.32)	-	-	23.84 (13.07)	17.26 (6.87)

Figures in parentheses are standard deviations. The Poor (Rich) endowment is 20 (80) tokens.

Tests show that the percent contributions of the rich do not change significantly from Part 1 to Part 2 in all three treatments (SR, $p > 0.10$ in all cases). The percent contributions of those who remain poor in *OnePoor* are also not different between the two Parts (SR, $p = 0.1476$).

Those who receive additional resources in Part 2 significantly reduce their percent contributions when moving from Part 1 to Part 2 in *OnePoor* (SR, $p = 0.0010$), in *TwoMedium* (SR, $p = 0.0045$) and in *AllRich* (SR, $p = 0.0029$).

Result A4: *(a) Individuals' percent contributions remain unchanged across the two Parts when their endowments do not change between the two Parts.*

(b) Individuals' percent contributions decrease from Part 1 to Part 2 when their endowments increase between the two Parts.

In *OnePoor*, the percent contributions of those who remain poor are significantly higher than that of those who become rich (SR, $p = 0.0113$) and those who remain rich (SR, $p = 0.0113$) in Part 2. The percent contributions of those who receive additional resources in Part 2 are not significantly different from the contributions of the 'old rich' in Part 2 in *OnePoor* (SR, $p = 0.7960$) or in *AllRich* SR, $p = 0.1361$), but are significantly higher in *TwoMedium* (SR, $p = 0.0084$).

Result A5: *Those who receive additional resources in Part 2 match the percent contributions of those who were always rich in their groups in OnePoor and in AllRich, but contribute a higher percentage in TwoMedium.*

Result 18 in the main text implies that, in Part 2, percentage contributions of those in *Equality* are higher than that of the old rich in all three inequality treatments. Tests confirm this observation (RS, $p < 0.01$ in all three pairwise comparisons).

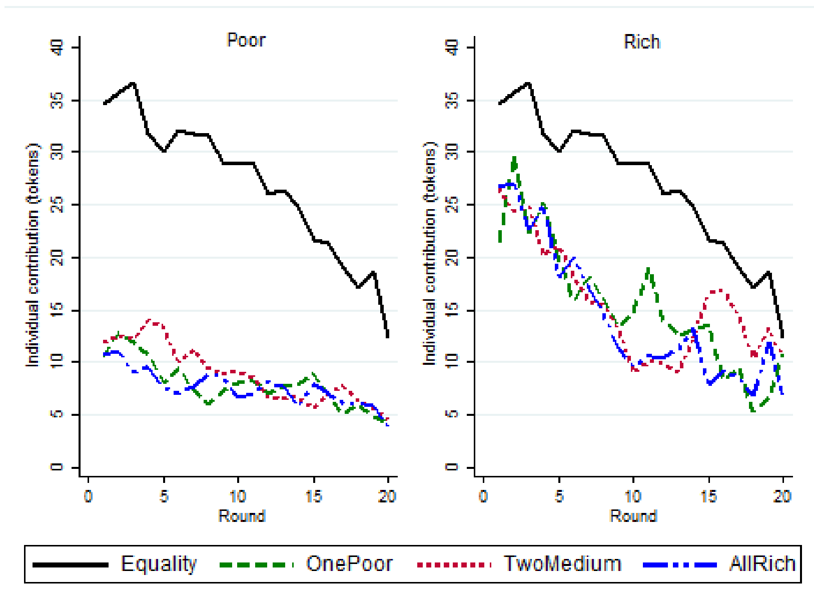
Result A6: *Average percent contributions of the 'old rich' in Part 2 are lower than average percent contributions in Equality.*

A4. Individual contributions in Part 1: injection of resources

Figure A4(a) presents average individual absolute contributions by the poor and the rich over time in Part 1 while Figure A4(b) presents time trends of average percent contributions in Part 1. Average individual contributions in *Equality* are also presented for comparison. Table A5 presents summary statistics of absolute and percentage contributions by the rich and the poor in Part 1.

Fig A4. Average individual contributions by the poor and the rich in Part 1

(a) Absolute contributions



(b) Percent contributions

Table A5. Average individual contributions in Part 1: injection of resources

	Obs.	Absolute contributions Poor	Absolute contributions Rich	Absolute contributions Signrank	Percentage contributions Poor	Percentage contributions Rich	Percentage contributions Signrank
Equality	10	26.93		-	53.87		-
		(8.14)			(16.27)		
OnePoor	16	7.96	15.46	-2.482	39.79	19.33	3.361
		(4.27)	(12.78)	[0.0131]	(21.37)	(15.97)	[0.0008]
TwoMedium	16	8.91	15.59	-2.223	44.56	19.49	2.999
		(4.60)	(12.34)	[0.0262]	(23.00)	(15.43)	[0.0027]
AllRich	12	7.62	14.43	-2.510	38.09	18.03	2.667
		(2.75)	(9.06)	[0.0121]	(13.74)	(11.32)	[0.0076]

Figures in parentheses are standard deviations. Figures in brackets are two-sided p-values corresponding to each Signrank test statistic.

In all treatments, the rich contribute more than do the poor in absolute terms. However, the rich contribute a smaller percentage of their endowment than do the poor. The absolute contributions of the poor and the rich are significantly lower than the contributions of those in *Equality* (RS, $p < 0.01$ in all cases). The percentage contributions of the rich are lower than that of those in *Equality* (RS, $p < 0.001$ in all cases). Relative to *Equality*, the percentage contributions of the poor are weakly significantly lower in *OnePoor* (RS, $p = 0.0867$), not significantly different in *TwoMedium* (RS, $p = 0.1705$) and significantly lower in *AllRich* (RS, $p = 0.0349$). These findings are similar in nature to those reported in Results 4 – 6. Finally, absolute and percentage contributions of the poor and the rich are not significantly different across the three inequality treatments (RS, $p > 0.10$ for all comparisons).

A5. Naïve beliefs and behaviour in Part 2

In our experiment, subjects are not informed about the individual allocations of group members. Hence, they have to form beliefs about behaviour. For simplicity, we assume they have naïve beliefs. In particular:

(i) they believe that the other group member of the same type contributed the same amount as they did, and

(ii) the other two group members contributed the same amount as each other.

We calculate the average contribution of each group member in Part 2. We double that to calculate the (believed) contribution of both players of the same type. The remainder in the group account is then the total contribution to the group account by both group members of the other type. Finally, we halve this remainder to arrive at the beliefs of a player about the contributions of a 'typical' member of the other type.

Figure A5 presents, for each type (poor or rich), the average (over all 20 rounds) differences between the percent contribution of a group member in Part 2 and the average believed contribution of a group member of the same type and of the other type in Part 1. The Figure presents these differences for the two treatments in which all group members are equal in Part 2 – *Redistribution* and *AllRich*.

Figure A5. Difference in average percent contribution in Part 2 (all 20 rounds)

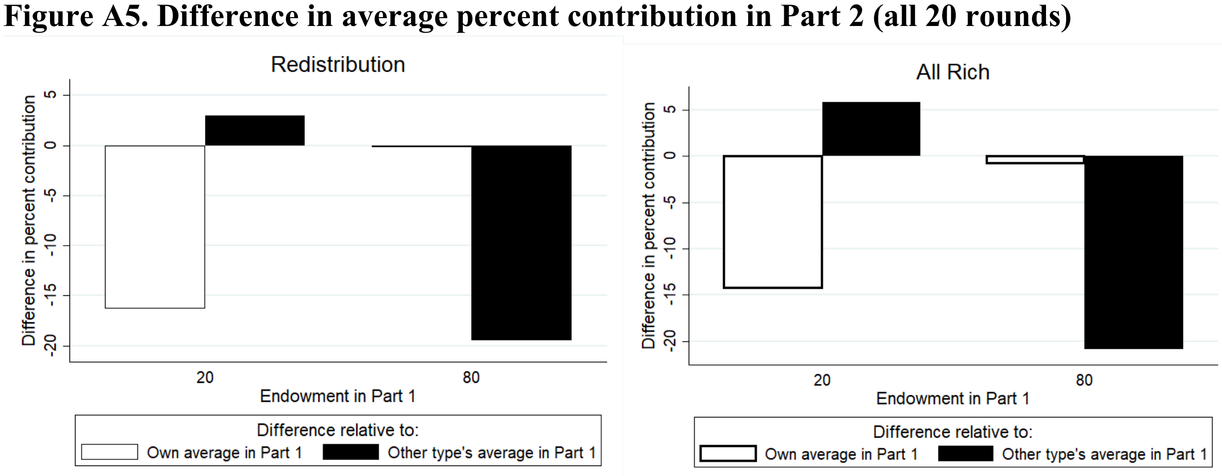


Figure A5 shows that, in both treatments, the former poor reduce their percent contribution in Part 2 relative to their own average contribution in Part 1, while they increase percent contributions relative to those of the rich in Part 1. On the other hand, the (former) rich do not alter their behaviour in Part 2 – the difference between their percent contributions in Part 2 and their own average contributions in Part 1 is nearly zero on average in both treatments. However, their percent contributions in Part 2 are a lot lower than the average contributions of the poor in Part 1.

This finding mirrors those reported in the main text. In the regressions in the main text, we control for lagged *actual* contributions of other group members. As we show there, the contributions of the rich do not change between Parts. Therefore, naïve beliefs on the part of the poor capture actual behaviour accurately.

A6. Ranking contributions within the group

Here, we consider if there is path dependence in the level of contributions at the individual level. In particular, do those who contribute higher amounts in Part 1 also contribute higher amounts in Part 2. Again, we focus on the two treatments in which all group members are equal in Part 2 – *Redistribution* and *AllRich*. Figure A6 presents average percent contributions in Part 1 and Part 2 by the higher and lower contributors within endowment level.

Figure A6. Average percent contribution in Part 1 and Part 2

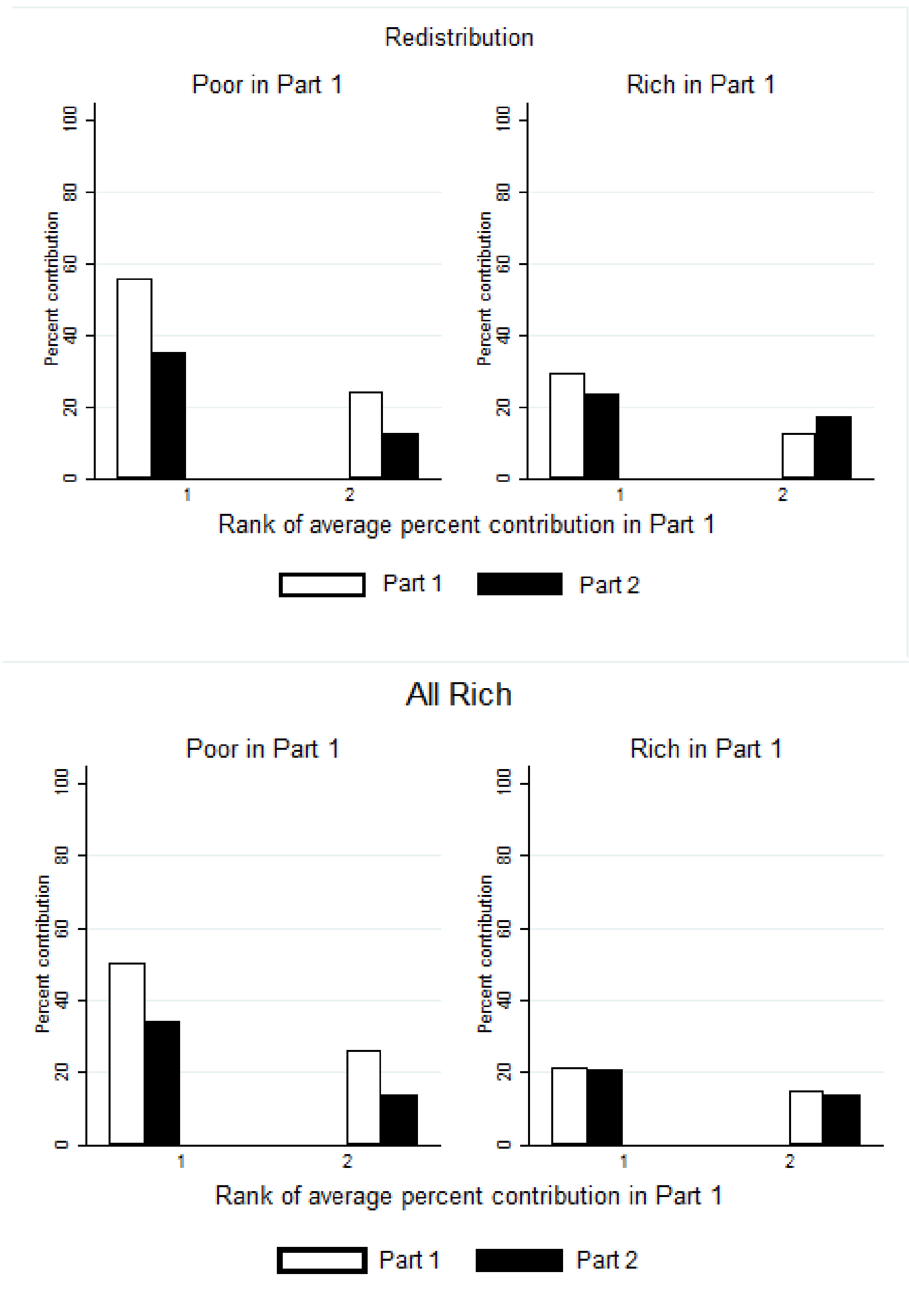


Figure A6 shows that the higher contributors in Part 1 remain the higher contributors in Part 2. This is true for both endowment levels, and both treatments.

For the poor, the proportional drop in percent contributions relative to Part 1 is similar for both individuals in groups, i.e., their response to changes in endowments does not differ based on contribution behaviour in Part 1.

For the rich in *Redistribution*, the higher (lower) contributor in Part 1 lowers (increases) percent contributions in Part 2. Thus, the response to redistribution appears to affect rich members differently. However, the proportional change in Part 2 relative to Part 1 is similar in absolute value. Thus, percent contributions of both (former) rich members in *Redistribution* is similar in Part 2.

Neither of the rich members appear to change their contribution behaviour between Parts in *AllRich*. Their contributions are similar to one another in both Part 1 and Part 2. Here, changes in endowments of *other* group members do not affect contributions at all.

B. Theoretical considerations: Contributions in unequal groups

B1. Reciprocity and endowment inequality: the case for income transfers

Positive contributions in spite of incentives to free-ride have long intrigued researchers. The idea that positive contributions might result from individuals reciprocating the positive contributions of others is an early, and enduring, explanation for observed behaviour. A 'principle of reciprocity' applied to contributions to public goods was first formulated by Sugden (1984).[3] The principle dictates that in each possible (hypothetical) subgroup with at least one other person, individuals are 'obliged to' contribute at least the minimum of: (a) his/her preferred contribution level for every member of the subgroup including him/herself, as long as the others are contributing at least as much, and (b) the minimum contribution of the others in the subgroup. An individual's decision problem with such reciprocity constraints can be stated as

$$\max_{g_i} (e_i - g_i) + m \sum_{j=1}^{n} g_j$$

$$\text{subject to } g_i \geq \min\{g_{il}^O, g_{jl} \ \forall j \in l\} \forall l \text{ and } g_i \leq e_i,$$

where g_{il}^O is the member's preferred (optimal) contribution level for all members (including him/herself) in each sub-group l to which the member can belong. In our linear public goods setting, assuming a monotonic relationship between wealth and utility, Croson (2007) shows that a group member's preferred contribution is the entire endowment (the group payoff-maximizing contribution) *as long as public good provision is socially optimal for the subgroup*, i.e., as long as a unit contribution to the public good generates a return greater than one to the members of the subgroup.

Sugden (1984) shows that, with reciprocal agents, any symmetric contribution profile (including zero and full contributions) is a Nash equilibrium of the game. Thus, positive contributions to the public good can be rationalised by reciprocity, even in repeated settings. The resulting outcome in groups becomes a coordination problem.[4] Croson (2007) (in a repeated public goods game) and

[3] More general theories of reciprocity, and fairness, capture a variety of strategic interactions among individuals – for example, see Rabin (1993). We use the model of Sugden (1984) as it directly applies to our setting.

[4] Recent work examining inequality in payoffs in coordination games has found conflicting evidence as to whether inequality leads to better coordination within groups (Gueye et al., 2020) or whether groups coordinate better on equality-dominant equilibria (Feldhaus et al., 2020).

Romano and Balliet (2017) (in a one-shot prisoner's dilemma) test the ability of several theoretical models to explain cooperative behaviour – altruism, commitment and reciprocity – and only find support for Sugden's (1984) model of reciprocity.

We extend the principle of reciprocity to cooperation in unequal groups. We implement inequality by introducing two types – 'poor' and 'rich' – of group members, with $e_{rich} > e_{equal} > e_{poor}$, where $e_{equal} = (e_{rich} + e_{poor})/2$. To avoid issues of minority or majority subgroups (Oxoby and Spraggon, 2013), we assume that there are initially an equal number of poor and rich members, i.e., there are *n*/2 members of each type in a group. We assume that a subgroup must consist of at least $\left(\frac{n}{2}+1\right)$ members to make contributions optimal in that subgroup. We call such a subgroup a *minimal effective subgroup* (MES). Thus, neither the rich nor the poor members can, on their own, form a coalition that can efficiently provide the public good. Crucially, cooperation requires at least one poor member's presence in any subgroup that can sustain positive contributions to the public good.[5]

Proposition B1: *Controlling for total resources available to a group with reciprocal members, the set of equilibria is strictly smaller in unequal groups than in equal groups. In particular, equal groups permit more efficient equilibria that are not achievable in unequal groups.*

Proof: Since no member is obliged to contribute more than the lowest contribution in the subgroup, the poor member's endowment forms a binding constraint on the contributions that can be achieved in any subgroup. Thus, the most efficient equilibrium that can be achieved in an unequal group is where every member contributes e_{poor}. This constraint is not present in equal groups, i.e., equal groups can achieve higher cooperation levels (up to e_{equal}) than can unequal groups. Reciprocity, by expanding the set of achievable equilibria, permits higher cooperation in equal groups than in unequal groups. ■

Note that Proposition B1 relies on the interpretation that reciprocity applies to *absolute* contribution levels by individuals. Another potential interpretation is that reciprocal agents are instead obliged to match the *percentage* (of endowment) contributed by others in the subgroup. If

[5] Some formulations of reciprocity consider the whole group as the only relevant subgroup (e.g., Croson, 2007). Our setting allows for natural coalitions along the lines of income. Hence, we consider the full reciprocity model with different possible subgroups, particularly because in our setup, efficiency requires cooperation across income groups. That is, the MPCR is parameterised such that $m(n/2) < 1$, but $m(n/2 + 1) > 1$.

the latter interpretation were right, inequality would have no effect on contributions to linear public goods as the rich and poor would contribute the same percentage of their respective endowments. Thus, full efficiency can be achieved in unequal groups.

Previous findings suggest that agents focus on absolute contributions rather than on percent contributions. The empirical evidence provides support for the prediction in Proposition B1. Cooperation and efficiency are lower in unequal groups, and rich members contribute a smaller percentage of their endowment to the public good than do the poor (e.g., Hargreaves Heap et al., 2016).[6] Thus, we argue, and proceed on the basis, that reciprocity applied to *absolute* contributions is the more appropriate interpretation of the constraints on agents' cooperation decisions.

Lemma B1: *Holding total group resources constant, any reduction in inequality in groups with reciprocal agents permits more efficient equilibria.*

Equilibria with contributions above e_{poor} are now attainable.[7] The set of equilibria expands through two channels. First, the lower endowment of the (former) poor is no longer a constraint on the contributions of the (former) poor *and* the (former) rich; the (former) rich, through reciprocal obligations despite now lower endowments, can increase their contributions above e_{poor}. Second, and perhaps more important, the preferred contributions of the poor also increase. Note that these preferred contributions are those that the poor would like themselves *and other* group members to contribute. An increase in the contributions of the poor increases the obligations of the rich group members.

Reciprocity suggests a solution to the problem of under-provision in unequal groups – income transfers that eliminate or reduce inequality in endowments allow groups the possibility of achieving outcomes that are more efficient. For instance, a guaranteed minimum income may free up time and resources to contribute to community welfare and health programmes, and/or allow poorer families to send children to cultural and sports activities in school. Such increased

[6] Hargreaves Heap et al. (2016) find that rich group members contribute more than do poor group members in absolute terms. Thus, their findings are not exactly in line with the equilibrium predictions of reciprocity, where all members contribute the same absolute amount. However, their findings show that observed behaviour is a lot closer to this prediction than one where all group members contribute the same percentage of their endowment.

[7] Note that if total group resources are held constant, *any* reduction in inequality implies an increase in the endowment of at least one poor member. Here, we focus on full redistribution where the endowments of all poor members increase. We discuss the case of increase for a subset of the poor in Section 3. In both cases, reciprocity permits higher cooperation.

investments of time and resources confer positive externalities on communities at large. Further, these investments increase the value of public programmes to the rich as well, who then reciprocate with increased effort on their part. Reciprocity thus predicts that income transfer schemes potentially raise investment in the public good by *both* poor and rich individuals, and thus efficiency. We experimentally test this prediction.

B2. Inequity-aversion and endowment inequality: the ineffectiveness of income transfers

A popular model that explains positive contributions to public goods is one where agents have inequity averse preferences (Fehr and Schmidt, 1999). However, we show that inequity averse preferences cannot explain contributions to public goods in settings with income inequality. Agent i receives utility from his/her own monetary payoff π_i, but receives disutility from *any* difference between his/her own payoff and that of other agents. Agent i's utility is given by

$$u_i(\pi_1, \dots, \pi_n) = \pi_i - \frac{\alpha_i}{n-1}\sum_{\substack{j=1 \\ j\neq i}}^{n} \max\{\pi_j - \pi_i, 0\} - \frac{\beta_i}{n-1}\sum_{\substack{j=1 \\ j\neq i}}^{n} \max\{\pi_i - \pi_j, 0\}$$

where α_i is agent i's disutility from disadvantageous inequality and β_i is his/her disutility from advantageous inequality, with $\alpha_i > \beta_i$ and $\beta_i \in [0,1]$. When there is equality in endowments across group members ($e_i = e\ \forall\ i = 1, 2, \dots, n$), Fehr and Schmidt (1999) show that if a sufficiently large subset of group members are sufficiently averse to inequality ($\alpha_i + \beta_i > 1$), any symmetric contribution profile within this subset is an equilibrium (Proposition 4). If all group members are sufficiently averse to inequality, i.e., $\alpha_i + \beta_i > 1\ \forall\ i = 1, 2, \dots, n$, any symmetric contribution profile in the entire group is an equilibrium. Both zero and full contribution by all group members are included in the set of equilibria. In any equilibrium, payoffs are equal for all group members. The equilibria can be Pareto ranked, with zero contributions and full contributions being, respectively, the least and most efficient equilibria.

We extend the model to the case where there is inequality in endowments. We consider situations where groups are composed of equal numbers of two types of members, poor and rich. Hence, groups have an even number of group members. To focus on the best-case scenario, and for simplicity, we assume that all agents, poor and rich, are sufficiently averse to inequality. As above, in any equilibrium, payoffs are equalised across all group members. As in the symmetric case, there are multiple equilibria with unequal agents.

Proposition B2: *With inequity averse agents, any contribution profile where* $e_{rich} - g_{rich} = e_{poor} - g_{poor}$ *is an equilibrium of a linear public goods game with inequality in resource endowments.*

Proof: The condition $e_{rich} - g_{rich} = e_{poor} - g_{poor}$ ensures that contributions leave the same amounts in the private accounts of both poor and rich group members, i.e., earnings from the private accounts are the same for poor and rich group members. Earnings from the public good are, by definition, the same for all group members regardless of endowments. Thus, final earnings are equalised across all group members. ■

Proposition B2 implies that full contribution by all group members remains an equilibrium of the game when there is inequality in endowments. In this equilibrium, private earnings are zero for all group members while everyone receives the same earnings from the public good. However, symmetric contribution profiles are *not* equilibria in the presence of endowment inequality. Any symmetric contribution profile implies greater private earnings for the rich than for the poor.

Lemma B2: *With inequality averse agents who have unequal endowments, symmetric contribution profiles are not equilibria of the game.*

Lemma B2 implies that, unlike in equal groups, the Nash equilibrium profile of zero contributions is not an equilibrium. In this case, a group member's final earning is equal to his/her endowment. With inequality in endowments, this implies earnings are unequal. Further, in any equilibrium, the rich must contribute more to the public good than the poor. Note that there is an equilibrium where the poor contribute zero; in this equilibrium, the rich contribute $g_{rich} = e_{rich} - e_{poor} > 0$. However, there is no equilibrium where the rich contribute zero.

Corollary B1: *With inequity-averse agents who have unequal endowments, zero contributions by all is not an equilibrium.*

Corollary B2: *With inequity-averse agents who have unequal endowments, in any equilibrium, the rich contribute more to the public good than do the poor.*

Under reciprocity, on the other hand, any equilibrium entails a symmetric contribution profile where the contributions of the poor and the rich are equal. This is because the rich will never be obligated to contribute any more than the contributions of the poor. In the presence of endowment inequality, reciprocity implies that zero contribution by all members is an equilibrium while full contribution by all is not. This is in stark contrast to the predictions of inequity-aversion.

Under inequity aversion, assuming contributions must be discrete (as in our experiment), the number of equilibria in the game with inequality is $(e_{poor} + 1)$; any profile where $g_{poor} \in \{0, 1, 2, \dots, e_{poor}\}$ and the corresponding contribution of the rich is $g_{rich} = e_{rich} - (e_{poor} - g_{poor})$ is an equilibrium. The equilibria can be ranked in terms of efficiency. The least efficient equilibrium is where the poor contribute zero and the most efficient equilibrium is where the poor and the rich contribute their entire endowments.

We now compare equilibria in unequal groups with those in equal groups of the same size with $e_i = e_{equal} \; \forall \; i = 1, 2, \dots, n$ where $e_{equal} = (e_{poor} + e_{rich})/2$, i.e., we keep constant the total resources available in equal and unequal groups. As mentioned above, any symmetric contribution profile is an equilibrium in equal groups with inequity-averse agents. Thus, the number of equilibria in equal groups is $(e_{equal} + 1) > (e_{poor} + 1)$, i.e., equality increases the number of equilibria by $(e_{rich} - e_{poor})/2$. Once again, the equilibria can be ranked; the least (most) efficient equilibrium is where every member contributes zero (fully).

Lemma B3: *Controlling for total group resources, with inequity-averse agents, the set of equilibrium contribution profiles is larger in equal groups than in unequal groups.*

We next explore how the equilibria in equal and unequal groups compare in terms of efficiency.

Proposition B3: *With inequity-averse agents, for every equilibrium in unequal groups, there exists a unique corresponding symmetric equilibrium in equal groups that is equally efficient, i.e., leads to the same level of public good provision.*

Proof: Every equilibrium in unequal groups involves positive contributions to the public good (Corollary B1). The least efficient equilibrium in unequal groups involves contributions only by rich members, where $g_{rich} = e_{rich} - e_{poor}$. In terms of efficiency, the corresponding equilibrium in equal groups is where $g = (e_{rich} - e_{poor})/2$ for all group members.[8] In both cases, total contribution to the public good is $n(e_{rich} - e_{poor})/2$. Every other equilibrium in unequal groups is more efficient, i.e., entails higher total contributions to the public good. For every other possible equilibrium in unequal groups (where contributions of both poor *and* rich are higher), there is an equivalent symmetric equilibrium in equal groups where $g = (g_{poor} + g_{rich})/2$ where $g_{poor} > 0$. Note that this contribution level is feasible in equal groups for any g_{poor} and g_{rich}; each successive equilibrium increases the contribution of *every* group member by one in both equal and unequal groups. In all such equilibria in equal groups, $g > (e_{rich} - e_{poor})/2$. The most efficient equilibrium is the same in both equal and unequal groups; both involve full contribution by all group members, i.e., $g_{poor} = e_{poor}$ and $g_{rich} = e_{rich}$ in unequal groups and $g = (e_{rich} + e_{poor})/2 = e_{equal}$ in equal groups. This exhausts all equilibria in unequal groups. ■

Proposition B4: *All the additional equilibria that become possible in equal groups are <u>less</u> efficient than all the possible equilibria in unequal groups.*

Proof: There are more equilibria in equal groups that do not have a corresponding equivalent equilibrium in unequal groups. In Proposition B3, we considered every (symmetric) equilibrium in equal groups where $g \geq (e_{rich} - e_{poor})/2$, each of which has with an equivalent equilibrium in unequal groups. Thus, in all other symmetric equilibria in equal groups, $g < (e_{rich} - e_{poor})/2$. In all such equilibria, including zero contributions, total contribution to the public good is lower than $n(e_{rich} - e_{poor})/2$, which is the total contribution in the least efficient equilibrium in unequal groups. ■

Thus, while the number of equilibria is larger, equal groups only permit more inefficient equilibria than do unequal groups. Indeed, it is possible that the number of additional less efficient equilibria, $(e_{rich} - e_{poor})/2$, is greater than the number of equilibria in unequal groups, $(e_{poor} + 1)$.

Lemma B4: *If* $(e_{rich} - 3e_{poor}) > 2$*, the set of additional less efficient equilibria in equal groups is strictly larger than the set of (more efficient) equilibria in unequal groups.*

The above results suggest that a move from inequality to equality will *<u>not</u>* help groups achieve higher cooperation. If anything, it is likely that such a move can hurt cooperation. Inequity aversion

[8] Recall that, by assumption, *n* is an even number. Hence this contribution profile is possible in equal groups.

thus implies that, controlling for total resources available to the group as a whole, equality in resource endowments can lead to worse outcomes than can inequality.

Example: Inequity-averse agents in equal and unequal groups in our experimental setting

In our experiment, unequal groups are composed of two poor members with endowments of $e_{poor} = 20$ tokens each, and two rich members with endowments of $e_{rich} = 80$ tokens each. Equal groups have four members who each receive an endowment of $e_{equal} = 50$ tokens. The total resources available to both groups are 200 tokens. In both groups, we assume that all members are sufficiently averse to inequality so that we can focus on equilibria that involve all four group members.

In equal groups, any symmetric contribution profile is an equilibrium. There are thus 51 equilibria in equal groups. The equilibria can be Pareto ranked – the least (most) efficient equilibrium is where all members contribute zero (50 tokens). In unequal groups, the least efficient equilibrium is where the poor members contribute zero and the rich members each contribute 60 tokens. The other equilibria (each Pareto superior to the previous one) are the contribution profiles (1, 1, 61, 61), (2, 2, 62, 62), (3, 3, 63, 63), …, (20, 20, 80, 80). There are thus 21 equilibria in unequal groups. In all of them, the rich contribute more than the poor.

Every one of the 21 equilibria in unequal groups has a corresponding equilibrium in equal groups with the same total contribution to the public good. In the equilibrium (0, 0, 60, 60), the total contribution is 120 tokens, which is achieved in equal groups in the equilibrium (30, 30, 30, 30). The equilibrium (4, 4, 64, 64) in unequal groups is equivalent to (34, 34, 34, 34) in equal groups. And so on. The most efficient equilibrium (full contribution) in unequal groups leads to the same level of public good provision (200 tokens) as in the most efficient equilibrium in equal groups.

The condition in Lemma A3 is satisfied with our chosen endowment parameters. Thus, the number of additional equilibria in equal groups is greater than the number of possible equilibria in unequal groups, 30 vs. 21. Each of these additional 30 equilibria in equal groups are Pareto inferior to the 21 equilibria in unequal groups. The most efficient of the additional equilibria is the profile (29, 29, 29, 29) which leads to a total contribution of 116 tokens, which is lower than the total contribution in the least efficient equilibrium in unequal groups.

B3. Conclusion

Thus, under inequity-aversion, a move from inequality to equality through pure redistribution, does not permit any more efficient equilibria. Equality permits many more equilibria that are less efficient. Thus, redistribution is not expected to raise cooperation and is likely to reduce cooperation levels. A move from equality to inequality, i.e., a redistribution of resources that creates inequality, eliminates several inefficient equilibria and, thus, has the potential to push groups towards higher cooperation levels.

This would lead to the hypothesis that cooperation is higher in unequal than in equal groups. Based on previous results in the literature (Cherry et al., 2005; Hargreaves Heap et al., 2016), we believe this to be an unlikely outcome in the experiment. In line with earlier findings, our experimental findings confirm this belief (Result 1). Further, the hypothesis that an equalising redistribution will hurt cooperation in groups runs counter to common intuition, particularly that of policy makers whose actions suggest that they expect redistribution, and inequality reduction in general, to improve outcomes in groups. Hence, we do not pursue inequity-aversion as an avenue for generating further hypotheses.

Instead, we turn to the principle of reciprocity due to Sugden (1984). Reciprocity permits more efficient equilibria in equal groups than in unequal groups, suggesting that an equalising redistribution has the potential to raise cooperation in groups.

References – Appendix B

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C. Redistribution to create inequality

The findings from *Redistribution* suggest that relatively low contributions observed with inequality persist in later rounds despite inequality reducing redistribution in Part 2 of the experiment. We cannot conclude whether this finding is a result of persistence of behaviour in general, and we find lower contributions in Part 2 because Part 1 of *Redistribution* had inequality, or if this is specifically persistence of low contributions caused by inequality. To answer this question, we conducted a diagnostic treatment *Reverse Redistribution*. In *Reverse Redistribution*, groups experience equality (50, 50, 50, 50) in Part 1 and then a change to endowment inequality (20, 20, 80, 80) in Part 2. If persistence of behaviour alone (independent of equality or inequality) is the explanation for the ineffectiveness of *Redistribution* to increase contributions, then we would see higher contributions persist in Part 2 of *Reverse Redistribution*. However, if contributions in Part 2 of *Reverse Redistribution* are no different than contributions in Part 2 of *Inequality*, then persistence of behaviour across Parts is due to inequality being groups' first experience.

Reverse Redistribution was conducted in Spring 2021 during the Covid pandemic. Thus, the analysis of *Reverse Redistribution* requires this caveat. However, we feel that given the pandemic, the session was conducted in a way to minimize any potential confounds. Sessions were conducted in a large classroom using laptops. Subjects were recruited using ORSEE from the same subject pool as with lab experiments. University classroom Covid protocols were followed. For instance, social distancing was practiced during sign in, wait and during the session. Subjects and experimenters wore masks all the time. Subjects applied hand sanitiser when entering the classroom and laptops were sanitised. Subjects completed a relatively detailed health questionnaire before showing up to the session, and another health questionnaire prior to instructions. The payment procedure was about 10 minutes longer in order to comply with safety protocols. Student subjects who had or were currently taking in-person courses during the semester would be familiar with the Covid classroom protocols.

Figure C1 presents average group contributions over time in the treatments with constant group resources. Table C1 presents summary statistics of group contributions. Contributions in *Reverse Redistribution* are higher than in treatments with inequality in Part 1 (RS $p = 0.0327$ vs. *Inequality* and $p = 0.0179$ vs. *Redistribution*). This confirms that inequality is significantly worse than inequality for contributions to the public good.

However, group contributions are lower than in equal groups in *Equality*, albeit weakly (RS $p = 0.0601$). This difference could be due to the fact that sessions were run at different times and under different circumstances, as mentioned above. Also, other public goods studies with two Parts, but same treatment in Part 1, found group effects in Part 1 (Stoddard et al., 2014; 2021).

Figure C1. Average group contributions with constant resources

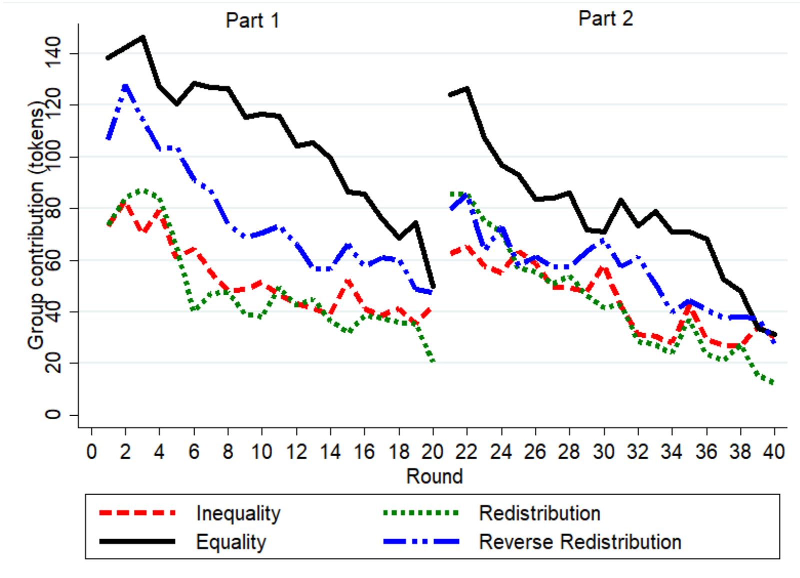

Table C1. Average group contributions

	Obs.	Part 1	Part 2	Signrank test
Inequality	12	52.84	44.51	-1.412
		(32.45)	(28.12)	[0.1579]
Redistribution	12	49.02	44.11	-0.628
		(28.33)	(28.81)	[0.5303]
Equality	10	107.74	77.77	-2.803
		(32.55)	(33.71)	[0.0051]
Reverse	12	77.10	55.15	-2.275
Redistribution		(27.22)	(34.82)	[0.0229]

Total group endowment = 200 tokens in both Parts in all three treatments. Figures in parentheses are standard deviations. Figures in brackets are two-sided p-values corresponding to each Signrank test statistic.

As in the other treatments, there is a restart effect at the beginning of Part 2 in *Reverse Redistribution* as well. However, the restart is at the same level as in the two treatments with inequality in Part 1. Indeed, group contributions in Part 2 are not very different from those in *Inequality* and *Redistribution*. Tests confirm that the differences are not statistically significant (RS p = 0.3556 vs. *Inequality* and p = 0.4529 vs. *Redistribution*). Group contributions in *Reverse Redistribution* are significantly lower than in *Equality* in Part 2 (RS p = 0.0479).

In conjunction with the results reported in the main text, the findings from this additional treatment suggest that persistence of contribution behaviour is specific to the initial experience of inequality. That is, while higher contributions due to initial equality do not persist in Part 2 with the introduction of inequality, the lower contributions due to initial inequality do persist in Part 2 even after the removal of inequality. The experience of inequality seems to doom groups to low cooperation in the (near) future. Thus, it appears that not *all* old habits die hard, only the bad ones.

D. Experimental instructions

D1. Part 1 – *Equality* and *Reverse Redistribution*

Thank you for coming. This is an experiment about decision-making. 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 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 Dollars at the following rate:

150 tokens = $1

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

The experiment consists of two parts. Instructions for Part 1 are below. You will receive instructions for Part 2 after Part 1 is completed.

PART 1

This part of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part 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 four (4) 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 this part of the experiment. However, you will never know the identities of the others in your group.

At the beginning of each round, each member of each group receives an endowment of tokens. Each group member receives an endowment of 50 tokens.

Your endowment will be the same in each of the 20 rounds.

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.

All participants in your group will simultaneously face the same decision situation.

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 0.4 tokens. Each of the other three members of your group will also earn 0.4 tokens for each token you allocate to the group account. Thus, the allocation of 1 token to the group account yields a total of 1.6 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 0.4 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.

Your earnings in each round =

Earnings from your private account + Earnings from the group account

The following examples are for illustrative purposes only.

Example 1. Your endowment is 50 tokens. The endowments of the other three members of your group are 50 tokens each. 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 50 tokens (= 50 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 each.

Example 2. Your endowment is 50 tokens. The endowments of the other three members of your group are 50 tokens each. Suppose you allocate 25 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 25. Your earnings from this round would be 35 tokens (= 25 tokens from your private account + 0.4*25 = 10 tokens from the group account). The earnings of the other members of your group would be: 60 tokens each (= 50 tokens from his/her private account + 0.4*25 = 10 tokens from the group account).

Example 3. Your endowment is 50 tokens. The endowments of the other three members of your group are 50 tokens each. Suppose that you allocate 50 tokens to the group account. Suppose that each of the other group members allocates 50 tokens to the group account. The total number of tokens in the group account would be 200. Your earnings from this round would be 80 tokens (= 0 tokens from your private account + 0.4*200 = 80 tokens from the group account). The earnings of the other members of your group would also be 80 tokens each (= 0 tokens from their respective private accounts + 0.4*200 = 80 tokens from the group account).

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

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 this part of the experiment.

D2. Part 1 for all other treatments

Part 1 instructions were the same in Inequality, Redistribution, OnePoor, TwoMedium and AllRich.

Thank you for coming. This is an experiment about decision-making. 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 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 Dollars at the following rate:

150 tokens = $1

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

The experiment consists of two parts. Instructions for Part 1 are below. You will receive instructions for Part 2 after Part 1 is completed.

PART 1

This part of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part 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 four (4) 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 this part of the experiment. However, you will never know the identities of the others in your group.

At the beginning of each round, each member of each group receives an endowment of tokens. The endowment can be either 20 tokens, or 80 tokens. Two members of your group receive an endowment of 20 tokens, and the other two members receive an endowment of 80 tokens.

The computer will **randomly** decide which two members of your group will receive the endowment of 20 tokens, and which two will receive the endowment of 80 tokens. You will be told your endowment at the beginning of the experiment. **Your endowment will be the same in each of the 20 rounds.**

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.

All participants in your group will simultaneously face the same decision situation.

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 0.4 tokens. Each of the other three members of your group will also earn 0.4 tokens for each token you allocate to the group account. Thus, the allocation of 1 token to the group account yields a total of 1.6 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 0.4 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.

Your earnings in each round =

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 three members of your group are 20 tokens, 80 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: 20 tokens for the member with an endowment of 20; and 80 tokens for each of the two members with an endowment of 80.

Example 2. Assume that your endowment is 80 tokens. The endowments of the other three members of your group are 20 tokens, 20 tokens and 80 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 56 tokens (= 40 tokens from your private account + 0.4*40 = 16 tokens from the group account). The earnings of the other members of your group would be: 36 tokens for each of the two members with an endowment of 20 (= 20 tokens from his/her private account + 0.4*40 = 16 tokens from the group account); and 96 tokens for the member with an endowment of 80 (= 80 tokens from his/her private account + 0.4*40 = 16 tokens from the group account).

Example 3. Assume that your endowment is 80 tokens. The endowments of the other three members of your group are 20 tokens, 20 tokens and 80 tokens. Suppose that you allocate 80 tokens to the group account. Suppose that each of the two group members 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 200. Your earnings from this round would be 80 tokens (= 0 tokens from your private account + 0.4*200 = 80 tokens from the group account). The earnings of the other members of your group would also be 80 tokens each (= 0 tokens from their respective private accounts + 0.4*200 = 80 tokens from the group account).

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

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 this part of the experiment.

D3. Part 2 – *Equality*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of tokens. As in Part 1, each member receives an endowment of 50 tokens.

The endowments do not change from Part 1 to Part 2. You will receive the same endowment as in Part 1.

Thus, all members of your group receive an endowment of 50 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

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

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.

D4. Part 2 – *Inequality*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of either 20 tokens or 80 tokens. As in Part 1, two members of your group receive an endowment of 20 tokens, and the other two members receive an endowment of 80 tokens.

The endowments do not change from Part 1 to Part 2. You will receive the same endowment as in Part 1. If you received an endowment of 20 tokens in each round in Part 1, you will continue to receive 20 tokens in each round in Part 2. If you received an endowment of 80 tokens in each round in Part 1, you will continue to receive 80 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

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

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.

D5. Part 2 – *Redistribution*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of tokens. Unlike in Part 1, each member receives an endowment of 50 tokens.

The endowments change from Part 1 to Part 2 for all members of your group. The two members who received an endowment of 20 tokens in Part 1 will each receive an endowment of 50 tokens in each round in Part 2. The two members who received an endowment of 80 tokens in Part 1 will each receive an endowment of 50 tokens in each round in Part 2.

Thus, all members of your group receive an endowment of 50 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

Your earnings in each round =

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.

D6. Part 2 – *One Poor*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of either 20 tokens or 80 tokens. Unlike in Part 1, one member of your group receives an endowment of 20 tokens, and the other three members receive an endowment of 80 tokens.

The endowments <u>change</u> from Part 1 to Part 2 for <u>one</u> member of your group. One of the members who received an endowment of 20 tokens in Part 1 will receive an endowment of 80 tokens in each round in Part 2. This member is chosen **randomly** by the computer.

The other members will receive the same endowment as in Part 1. If you received an endowment of 20 tokens in each round in Part 1 (and were not chosen by the computer), you will continue to receive 20 tokens in each round in Part 2. If you received an endowment of 80 tokens in each round in Part 1, you will continue to receive 80 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

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

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.

D7. Part 2 – *Two Medium*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of tokens. Unlike in Part 1, two group members receive an endowment of 50 tokens and the other two group members receive an endowment of 80 tokens.

The endowments <u>change</u> from Part 1 to Part 2 for <u>two</u> members of your group. The two members who received an endowment of 20 tokens in Part 1 will each receive an endowment of 50 tokens in each round in Part 2.

The other members will receive the same endowment as in Part 1. If you received an endowment of 80 tokens in each round in Part 1, you will continue to receive 80 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

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

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.

D8. Part 2 – *All Rich*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of tokens. Unlike in Part 1, each member receives an endowment of 80 tokens.

The endowments <u>change</u> from Part 1 to Part 2 for <u>two</u> members of your group. The two members who received an endowment of 20 tokens in Part 1 will each receive an endowment of 80 tokens in each round in Part 2.

The other members will receive the same endowment as in Part 1. If you received an endowment of 80 tokens in each round in Part 1, you will continue to receive 80 tokens in each round in Part 2.

Thus, all members of your group receive an endowment of 80 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

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

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.

D9. Part 2 – *Reverse Redistribution*

Part 2 of the experiment consists of twenty (20) consecutive decision rounds. Your total earnings from this part will be the sum of your earnings from all these rounds.

You will remain in the same group of four individuals as in Part 1. Again, the composition of the groups will remain the same in each round.

At the beginning of each round, each member receives an endowment of tokens. Unlike in Part 1, two group members receive an endowment of 20 tokens and the other two group members receive an endowment of 80 tokens.

The endowments <u>change</u> from Part 1 to Part 2 for <u>all</u> members of your group. Two <u>randomly chosen</u> members will each receive an endowment of 80 tokens in each round in Part 2. The other two members will each receive an endowment of 20 tokens in each round in Part 2.

Your task is, once again, 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.

All participants in your group will simultaneously face the same decision situation.

Earnings from your private account in each round: You will earn one (1) token for each token allocated to your private account.

Earnings from the group account in each round: 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 0.4 tokens regardless of who made the allocation.

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

Earnings from your private account + Earnings from the group account

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. You will **not** receive information about the individual allocations of the other members of your group.

The same process will be repeated for a total of 20 rounds. Your earnings from earlier rounds cannot be used in the following rounds. You will receive a fresh endowment in each round. Note that your endowment will **not** change from round to round.

At the end of Part 2, you will be paid your earnings from Part 1 and Part 2.