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Framing in a threshold public goods experiment with heterogeneous endowments☆

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ABSTRACT

In cooperative endeavors among economically heterogeneous parties, the contribution decisions can often be framed in different ways. But do such framing differences affect behavior? We report the results of a laboratory experiment on threshold public goods with heterogeneous endowments and different frames. Four treatments frame two variables, each in one of two ways: the contribution metric is expressed either in absolute terms or relative to endowments, and the contribution choice is framed as either keeping or contributing some of one's endowment. Subjects can exchange proposals and counterproposals. Our results reveal a broad consensus that high endowed subjects contribute more in absolute terms than the low endowed, which we trace to subjects' reported distributive preferences. Both high and low endowed subjects contribute about two-thirds of their endowments in all treatments – save when the metric is framed as "contributing" in "absolute" terms: then the low endowed contribute significantly more, around 80%. This last result suggests the possibility that the most frequently used frame in public good experiments induces higher contributions among the less affluent than economically equivalent alternate frames.

1. Introduction

Cooperation yields mutual benefits in enumerable social endeavors, including in the family, workplace, government, NGOs, and international agreements. Nevertheless, people often disagree, sometimes fiercely, about how much each party should contribute to such endeavors. For example, in wage negotiations between firms and labor unions, both sides prefer

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to avoid costly strikes or lockouts but have conflicting interests over wages and benefits. Even if all countries prefer an international environmental agreement to be reached, their interests conflict over who should cut their emissions most. Throughout the ongoing Eurozone crisis, EU member states share the goal of preventing a Euro collapse but differ in their views of how to cover the costs of the rescue operation. Although every member of a household prefers clean dishes, each might prefer that someone else wash the dishes. In situations like these, arguments about burden-sharing tend to focus on differences in parties' endowments, and, correspondingly, to frame contributions in different ways. For example, in the case of international negotiations to protect the environment, the contribution metric can be framed as a percentage of one's endowment (e.g., emission reductions in proportion to GDP) or in absolute terms (e.g., emission reductions in tons). Similarly, decisions can be framed so as to focus either on "contributing" to the shared goal or on each party's private benefit by avoiding contribution and "keeping" (some part of) its endowment.

The present study reports the results of a laboratory experiment that jointly explores these effects of framing and heterogeneous endowments in a threshold public good game. Public good games are a widely employed framework for theoretical and empirical analysis of cooperation (e.g., see Ledyard, 1995; for a survey of early contributions, and Chaudhuri, 2011; for much of the subsequent work). Nevertheless, no previous study, to our knowledge, jointly analyzes the effects of such framing differences on public goods with endowment heterogeneity.

Our experimental design incorporates various features of the above-mentioned examples. To mirror differences in affluence, we vary experimental endowments between subjects, half of them receiving twice as much as the others. Such endowment heterogeneity sets up possibilities for frames to have differential effects on contributions. Specifically, we frame contributions along two dimensions: the contribution metric is framed either as absolute amounts or in relative terms as percentages of subjects' endowments, whereas the choice is framed as either how much to contribute to the public good or how much to keep of one's endowment. This results in four treatments that cross the Metric variable (Absolute or Relative) with the Choice variable (Contribute or Keep) in our 2×2 factorial design.

Since we are interested in burden-sharing, we employ a public good game with a threshold, defining the minimum total burden to be shared. When contributions reach this threshold, there is a discrete jump in group benefits. Whereas the dominant strategy in a linear public good game is to contribute nothing, note that the threshold aspect of a public good game makes it a coordination game: everyone prefers the public good be provided, but there are multiple Nash equilibria generating provision of the public good, each involving different individual burdens.

In standard theory, *focal point effects* (Schelling 1960; Ch. 3) refer to a supposed attraction to particularly simple or otherwise salient equilibria in coordination games. Treatment effects in our experiment, if any, could be due to an effect of frames on focal points. For example, the mathematically simplest burden-sharing rule in the current experiment is based on the metric of contribution, which varies across frames. A further possibility is that contributions are driven in part by distributive preferences, such as fairness, and that frames affect the interpretation of distributive rules and, therefore, contributions. For example, if subjects consider equality to be fair, then framing contributions in absolute terms could prompt more equal *amounts* contributed whereas framing contributions in relative (i.e., percentage) terms could produce more equal *shares* contributed.

Additional features of the design are similarly inspired by the aforementioned examples. First, in contrast to most threshold public good experiments (see Croson and Marks, 2000), excess contributions are not wasted in our study. Although a minimum level of total contributions might be needed to reach an international agreement or to avoid a labor conflict, excess efforts can often improve the public good's quality or quantity: environmental quality improves and the firm prospers. Second, as in real world negotiations, a type of communication is possible. In the experiment, there are multiple "rounds" of distinct targeted outcomes, and within each round, proposals and counter-proposals can be made, as with multiple rounds of negotiations over international environment agreements. Third, parties do not incur the cost of proposed contributions, if the threshold is not met (save a small penalty reflecting negotiation costs). This seems quite natural for a negotiation process involving communication: in the case of a strike, previously communicated wage offers are no longer binding; in the case of an international environmental agreement, offers made during the negotiation process become void, if total pledged emission cuts fall short. Finally, since negotiating parties often motivate their favored burden-sharing claims based on distributive preferences such as fairness, we elicit and analyze these subject attitudes in a post-experimental questionnaire.

We find that groups mostly succeed in reaching the threshold, often by a substantial margin. Subjects tend to agree that High endowed subjects should contribute more in absolute terms to the public good than Low endowed, a robust finding across all frames. Our results point to subjects' distributive preferences as the reason for this. In relative terms, both High and Low endowed subjects in all treatments contribute roughly equal shares, about two-thirds of their endowments, save in one case: when the metric is framed as "contributing" in "absolute" terms, the Low endowed contribute significantly more, around 80%. Thus, the most common practice used in public good experiments, namely framing contributions in terms of absolute amounts contributed, induces the "poor" to contribute significantly more than other economically equivalent ways of framing the choice, at least in the threshold public good context studied here.

The remainder of this paper proceeds as follows. Section 2 presents related literature, and section 3 details the experimental design and procedures. Section 4 presents and analyzes the results, and Section 5 concludes.

2. Related literature

Here we discuss previous studies, focusing on those most closely related to the main features in our design.[1] First, various framing effects, i.e., effects of seemingly inconsequential differences in presentation, have been studied in previous public goods games. Nevertheless, to our knowledge, none involves exactly our Metric and Choice frames, let alone crosses the two in a full factorial design. Indeed, with respect to the Metric frame, we are unaware of any public good experiments that employ a "relative" frame, let alone contrast it with an "absolute" frame, despite the prominence of such comparisons of contributions to endowments in, for example, negotiations over international cooperative agreements. The Choice frame in our experiment also appears to be unique, although differences in wording in other studies might be seen as priming a similar focus on the interests of the self vs. those of the group. For example, one of the three significant framing effects in Cookson (2000) is an "I" vs. "we" frame. Rege and Telle (2004) report a weak effect of language explicitly designed to prompt social norms vs. neutral language. Messer et al. (2007) find that contributions vary depending on whether the default setting is giving or not giving, and Andreoni (1995) finds significant effects of positive versus negative framing on contributions (see also Khadjavi and Lange 2015).

Second, previous public good experiments have come to differing conclusions about the effects on contributions of heterogeneous endowments. Buckley and Croson (2006) and Cherry et al. (2005) find that differently endowed subjects contribute approximately equal absolute amounts in a simple linear public good game with an absolute contribute frame. On the other hand, Rapoport and Suleiman (1993) and Bernard et al. (2013) study threshold public goods and find that high endowed contribute more than low endowed. The different structure of the studies provides a possible explanation for their differing results: the two former studies are linear public good games, which correspond to Prisoners' Dilemmas, whereas the latter studies are made into coordination games by thresholds. Some studies reporting unequal contributions by endowment, e.g., van Dijk et al. (2002) and Hofmeyr et al. (2007), employ relatively small differences in endowments. Our results suggest such differences are robust to larger endowment heterogeneity.

A further question about unequal contributions by endowment is whether the relative generosity of rich subjects represents a "house money effect," i.e., an experimental artifact associated with the fact that the rich receive their higher endowments as a windfall.[2] The experiment of Cherry et al. (2005) finds little effect of the origin of heterogeneous endowments, i.e., whether windfall or earned; in fact, their results point, if anything, toward greater generosity by the rich when their endowments are earned. In any case, the kind of situations that motivated the current study often involve endowments that are bestowed rather than earned – for example in the case of international cooperation among parties at different levels of economic development, who can be viewed as having had the good or bad luck of being born in a rich or poor country, respectively.

Third, previous survey studies suggest that distributive preferences are important for real world public goods. For example, Lange et al. (2010) conclude from a survey of real negotiators in climate policy that support for burden sharing rules is based on self-interest and fairness considerations. To explore such motives in an experimental setting, we elicit subjects' distributive preferences, aiming to explore possible roles in explaining any framing effects or endowment-based effects on contributions.

Finally, communication has been found to have favorable effects on cooperation in public good experiments, e.g., Dawes et al. (1977) and Isaac et al. (1989) identify positive effects of cheap talk. Indeed, previous studies find that making one's own contributions (or intended contributions) common knowledge has a favorable impact on cooperation even in linear public good experiments with no threshold (Messer et al., 2007; Tavoni et al., 2011). On the other hand, Bochet et al. (2006) find that the favorable effects of communication depend on face-to-face communication. An open question we examine is whether individual suggestions about others' contributions affect subject contributions in the present context.

3. Design and procedures

The experiment proceeds as follows. Instructions are handed out and read out loud before the experiment begins.[3] From the start, subjects are randomly assigned to be one of four members, numbered 1–4, of a group. The experiment is double-blind, i.e., subjects are anonymous and decisions cannot be personally associated with individuals by the experimenter or fellow subjects. Subjects 1 and 2 receive a low endowment (L) of 40 Norwegian kroner (NOK), and subjects 3 and 4 receive a high endowment (H) of NOK 80.[4] Member numbers, and thus endowments, are kept fixed throughout the session as is the make-up of the groups, i.e., we employ a "partner" design. In each round, subjects face a decision about how much to keep for themselves and how much to contribute to a "group project," i.e., the public good. Subjects propose contributions

[1] Previous studies have shown that public good contributions can be affected by other factors, such as performance on a task and inequality in the distribution of benefits (Balafoutas et al., 2013), endowment inequality and communication (Tavoni et al., 2011), the type of punishment (Noussair and Tan 2011), different time horizons (Milinski et al., 2011), threshold uncertainty (McBride 2010) and private vs. common information about thresholds (Fischbacher et al., 2011).

[2] We are grateful to a referee for raising this question.

[3] Given the high level of English fluency among Norwegian students, all instructions were in English, a practice that has been employed in other economics experiments conducted in Norway, such as Cappelen et al. (2013).

[4] At the time of the first experimental sessions, 1 USD ≈ 6 NOK.

Table 1
Experimental design.

		Choice	
		Contribute	Keep
Metric	Absolute	AC, $n = 64$	AK, $n = 72$
	Relative	RC, $n = 64$	RK, $n = 56$

Notes: Instructions and decisions were framed in terms of the metric of contribution (absolute, relative) and in terms of the choice involving either contributing to a project or keeping some of one's endowment. The contents of cells are treatment acronyms and numbers of observations.

for themselves as well as for each of the other three members of their group. The proposal for themselves is binding, but proposals for others are not. Thus, we will call the former proposals "contributions" and the latter proposals "suggestions." Subjects can try out different proposals and observe the payoff consequences for all members of up to three different sets of proposals before submitting. After everyone has submitted their proposals, all group members are informed of all *submitted* proposals (i.e., proposals that members try out before submitting their final proposals are not communicated).

In order to familiarize subjects with the experiment, they are first presented with three numerical examples and then complete an unpaid practice round. This is followed by four rounds, all of which are paid, i.e., subjects receive the sum of earnings from all four paid rounds. The practice round is identical to the four subsequent paid rounds, save for the decisions being hypothetical, i.e., the hypothetical stakes are the same as the later real ones, they submit and receive proposals, and the results are communicated at the end of the round.

If aggregate contributions (i.e., the sum of binding proposals submitted from each of the four group members) in a given round equal NOK 120 or more (i.e., one half of the aggregate endowments of NOK 240), the group project is implemented: in this case, all contributions are doubled by the experimenters, shared equally by all group members, and the round ends. Thus, a subject's earnings in a successful round are calculated as the individual endowment minus the subject's contribution plus one half of the sum of all contributions to that subject's group (including any possible contributions that exceed the threshold).

Within each round, there are up to three opportunities, or "periods," to submit proposals. The proposals submitted by every member are communicated to every other member in each period, regardless of whether the threshold is met in that period. If the sum of binding proposals submitted in the first period equals or exceeds NOK 120, there are no more periods, the round ends and the group project is implemented. If, however, this sum falls short of NOK 120, there is a second period for all members to submit proposals. If the sum of binding proposals then equals NOK 120 or more, the round ends. If not, subjects have a third and final opportunity to submit proposals. If the total contributions now reach the threshold of NOK 120, the project is implemented; if not, the project is not implemented, and subjects earn their initial endowments in that round minus a penalty of NOK 10.[5] The experiment then continues to the next round.

The four frames we study correspond to four treatments in our between-subjects design, i.e., each subject participates in only one treatment. These are summarized in Table 1 along with treatment acronyms and numbers of subjects, which averaged 64 per treatment plus or minus 8 due to differences in show-up rates. The "Metric" treatment variable is comprised of the Absolute and Relative frames. In the Absolute contribution frame, the instructions, threshold, examples and proposals are expressed in absolute terms, i.e., the absolute number of NOK. In the Relative contribution frame, these same values are stated as percentages of respective subject endowments.

The "Choice" treatment variable consists of the Contribute and Keep frames. In the Contribute frame, the instructions, examples and proposals are expressed in terms of contributing to the group project, whereas in the Keep frame, these same choices are expressed as a matter of how much to keep of each member's endowment.

The Metric and Choice variables are crossed to create a 2×2 factorial design. This means, for example, that the AC treatment expresses values as absolute amounts contributed (the most common frame in public good experiments), whereas the RK expresses values as percentages kept of endowments. Apart from these differences in frames, the experimental procedures are identical in all treatments. The experimental protocol, including instructions, appears in Appendix A.

In an unincentivized post-experimental questionnaire, subjects are asked questions about socio-economic and demographic variables. It also elicits three types of distributive preferences, viz., what subjects consider *fair*, what they would impose if they could *dictate* contributions, and what they think each subject *should* contribute.[6] The "dictate" and "should" questions permit any values in the feasible range, i.e., 0–40 for Low and 0–80 for High. For the fairness question, each subject is asked to select one set of proposals out of a possible three that he considers most fair. Each of these three distributions (A, B and C), which are illustrated in Table 2, just meets the threshold and corresponds to equality according to at least one of the frames. Distribution A involves equal amounts contributed, or 30 each for Low and High, and corresponds, therefore, to

[5] The penalty strengthens the incentives to implement the project. It also ensures that, if the two High endowed subjects contribute 60 NOK each, thus sharing the required threshold contribution of 120 NOK equally, they are strictly better off than if the project fails. The Low endowed always benefit from the project being implemented.

[6] These questions seek to distinguish different levels of distributive preferences from a narrow concept of fairness to broader notions of distribution, as suggested by Johansson-Stenman and Konow (2010, see section 5.3). They also allow for different types of distributive preferences, e.g., Durante et al. (2014).

Table 2
Standards of equality by frame.

		Amounts contributed by equality frame (NOK)		
		A Equal amounts contributed (AC)	B Equal shares contributed/kept (RC, RK)	C Equal amounts kept (AK)
Endowment	High (NOK 80)	30	40	50
	Low (NOK 40)	30	20	10

Table 3
Project success rates.

Period implemented	Treatment (implementation percentage by period)			
	AC	RC	AK	RK
First period	84	80	67	93
Second period	9	9	15	2
Third period	5	8	14	2
Failed	2	3	4	3
Number of possible projects	64	64	72	56

equality in the AC treatment frame. Distribution B states contributions of 20 for Low and 40 for High, which produces equal shares contributed and corresponds to equality in the RC frame. Since equal shares contributed is equivalent to equal shares kept, Distribution B also corresponds to equality in the RK frame. Finally, Distribution C corresponds to equality in the AK frame and involves equal amounts kept, i.e., 30 each for both Low and High or, in terms of the amounts contributed that are displayed in Table 2, 10 for Low and 50 for High. Of course, adjustments are made according to treatment in the wording (contributed/kept) and in the values of all three distributions (amounts/percentages).

The experiment was conducted at the Oeconlab at the University of Oslo with computers using Z-tree software (Fischbacher 2007). Subjects were recruited from the undergraduate population through a website and class announcements. There were twelve sessions, three for each of the four treatments, involving a total of 256 student subjects recruited from various colleges and majors at the University of Oslo. There were 20–28 subjects in each session. All sessions were conducted February and March of 2010, except the RK sessions, which took place September 2015. With no show up fees, the earnings, which resulted from the four paid rounds, were all salient and averaged NOK 413 per subject, or about US$ 60, for sessions lasting about 90 min.

4. Results and analysis

This section reviews and analyzes the results on the two types of proposals in this study, viz., the contributions, i.e., the binding and implemented proposals on subjects themselves, and the suggestions, i.e., the amounts subjects propose other members of their group contribute.

4.1. Contributions

The large majority of the 256 possible projects in all treatments was implemented (97% overall); indeed, most succeeded in the first period. As can be seen from Table 3, however, the rate and speed of success differed across treatments. Whereas 93% were implemented already in the first period the Relative Keep (RK) treatment, this drops significantly to 67% in Absolute Keep (AK) treatment ($p < 0.01$, *t*-test).[7]

Fig. 1A and B illustrate average contributions for payoff-relevant periods (i.e., the binding proposals for oneself in successful periods and in the last period of failed rounds). These are broken down by endowment, High (H) or Low (L), and treatment (AC, RC, AK and RK). The upper panels display the results in absolute terms as NOK, and the lower panels show the same values but expressed as percentages of endowments.

The differences in absolute contributions by endowment are striking: contributions from H subjects exceed those from L subjects by substantial amounts across all treatments. Average absolute contributions by H subjects are close to 50 in all cases; contributions by L subjects, however, are highest in the Absolute Contribute treatment and lowest in the two Keep treatments. Perhaps equally striking is the similarity of contributions in relative, or percentage, terms across both endowment groups and treatments. All groups contribute 60–70% of their endowments, except for the low endowed in the Absolute Contribute treatment, who stand out by contributing almost 80%. In order to examine jointly the magnitude and significance of the effects of treatments and endowments, we turn now to regression analysis.

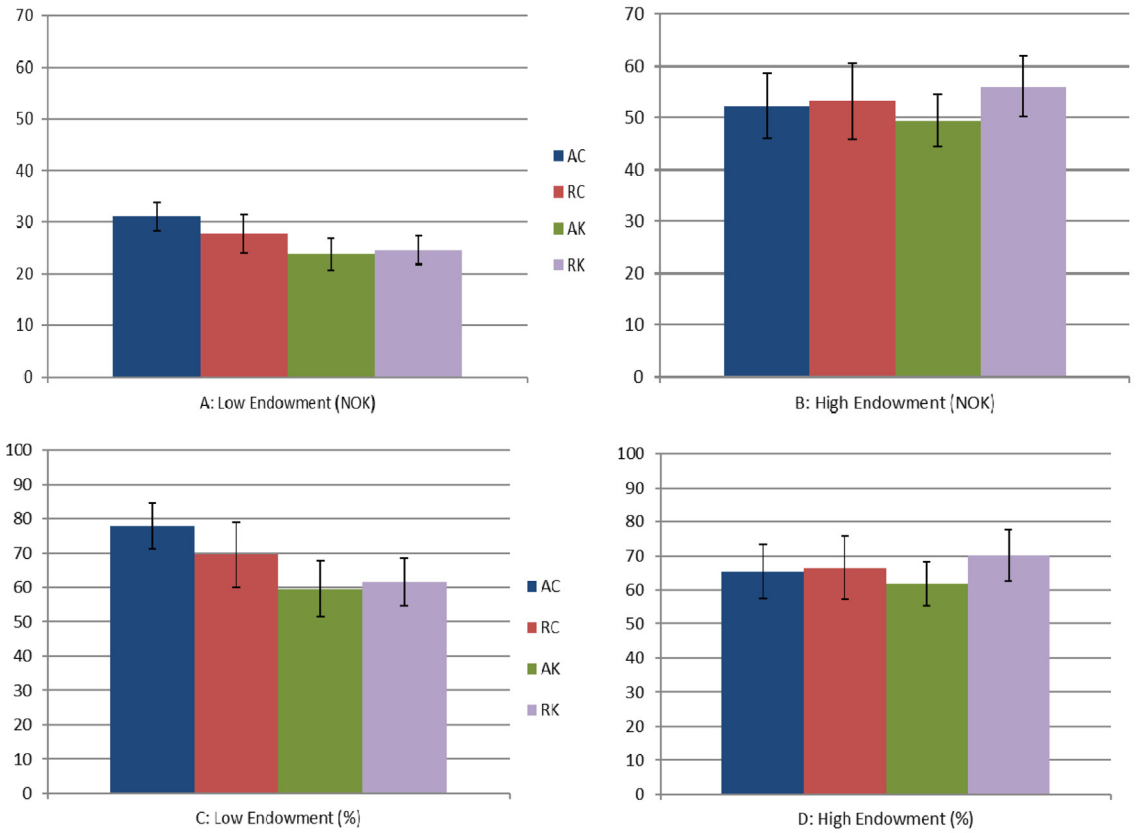

Fig. 1. Mean contributions.
Notes: The upper panels (A, B) express contributions in absolute terms as NOK, and the lower panels (C, D) as percentages of endowments, both for payoff-relevant periods. The left panels refer to contributions of Low endowed subjects and the right panels to those of High endowed subjects. Error bars indicate 95% confidence intervals.

Table 4 presents the results of OLS regression analysis of contributions on all endowment and treatment variables in implemented periods clustered on group level.[8] Consider first regressions 1 and 2, which take the Absolute Contribute treatment as the reference category, i.e., the contributions of Low endowed in the AC treatment are captured by the constant, and contributions of High endowed in the AC treatment are reflected in "High." The use of treatment dummies for both L and H means that the interaction term coefficients measure the treatment effect separately for each endowment group. The dependent variable in regression 1 is absolute contributions in NOK and in regression 2 it is relative contributions (i.e., as percentage of respective endowments). Given the frequently observed pattern of declining average contributions over time in multi-round public good experiments, we also include a variable for Round (with the first paid round coded as zero). This reveals a significant decrease in contributions over time: regression 1 indicates an absolute magnitude of about NOK 1 per round.

From regression 1, we see that the H subjects always contribute significantly more in absolute terms than L subjects; indeed, H contributions are consistently high across treatments. The interaction terms suggest that framing affects L subjects but not H subjects. Specifically, contributions of L subjects in the Absolute Contribute treatment equal about NOK 33 and differ significantly from zero (L being the omitted category). The results in this table are robust to Bonferroni (1935) correction for multiple hypothesis testing. In Table 4, this involves the simultaneous test of all nine parameters, including round and the constant.[9]

[7] The difference between first period implementation of 80% in RC and 67% in AK is also significant ($p = 0.05$, t-test). Other differences are not statistically significant.

[8] We also ran the regressions for this table while controlling for subject expenditures, parents' income and gender. None of the control variables is significant, and the other coefficients are similar to those in Table 4, so we have relegated these regressions to Appendix B, Table A1. Two observations are missing from the second session of the Relative Contribute treatment in this analysis because of a computer glitch during the experiment.

[9] In general, the Bonferroni correction involves the following. With m hypotheses, if we reject individual hypotheses at significance level α, the probability of rejecting at least one will be higher than α and closer to $m\alpha$. Bonferroni showed that if we rejected individual hypotheses at the level α/m, the probability of falsely rejecting any of the m hypothesis is less than α.

Table 4
OLS regressions of contributions.

	(1) Absolute contr.	(2) Relative contr.	(3) Absolute contr.	(4) Relative contr.
Constant	32.80***	0.80***	25.50***	0.62***
	(1.46)	(0.04)	(1.82)	(0.04)
LxAC			7.30***	0.18***
			(2.13)	(0.05)
LxRC	−3.34	−0.08	3.96	0.10
	(2.34)	(0.06)	(2.52)	(0.06)
LxAK	−7.30***	−0.18***		
	(2.13)	(0.05)		
LxRK	−6.51***	−0.16***	0.80	0.02
	(1.95)	(0.05)	(2.16)	(0.05)
High	21.16***	−0.13**	25.65***	0.02
	(3.40)	(0.05)	(3.43)	(0.06)
HxAC			2.81	0.04
			(4.17)	(0.05)
HxRC	0.90	0.01	3.72	0.05
	(4.94)	(0.06)	(4.58)	(0.06)
HxAK	−2.81	−0.04		
	(4.17)	(0.05)		
HxRK	3.81	0.05	6.62	0.08
	(4.43)	(0.06)	(4.03)	(0.05)
Round	−1.10***	−0.02**	−1.10***	−0.02**
	(0.38)	(0.01)	(0.38)	(0.01)
N	1022	1022	1022	1022
adj. R^2	0.39	0.04	0.39	0.04

Notes: The dependent variable in regressions 1 and 3 is absolute contributions in NOK and in regressions 2 and 4 relative contributions (i.e., percentages of respective endowments). The reference category in regressions 1 and 2 is Absolute Contribute; using Absolute Keep as the reference category in 3 and 4 suggests AC is the distinctive frame. Only payoff relevant periods are included, standard errors appear in parentheses, and statistical significance is indicated as * $p<0.1$, ** $p<0.05$, *** $p<0.01$. Standard errors are clustered on group and are, therefore, robust. All parameters retain the same signs and levels of significance after a Bonferroni correction for the simultaneous testing of nine parameters, except Round, which drops one level in significance in all columns. Due to a technical glitch during the experiment, two observations from the RC treatment are not included.

The insignificance of RC and significance and similar magnitude of AK and RK for L subjects seem to suggest that the Keep frame reduces L contributions compared with Contribute, but that the metric frame (i.e., Absolute/Relative) matters less or not at all. Regression 2, where the dependent variable is percentage of respective endowment, confirms this pattern: L subjects in the AC treatment contribute more than any other group, about 80% of their endowment, which is a significantly higher share than L subjects in the AK and AR treatments and also a significantly higher share than H subjects. The results are similar, if we collapse payoff relevant individual contributions and employ a non-parametric Wilcoxon rank-sum test: for low endowed AC is significantly different from both AK ($p<0.01$) and RK ($p<0.01$).[10]

These results suggest that the AC treatment might be distinctive, so we tried specifications that omit AK instead of AC. Regressions 3 and 4 correspond to 1 and 2, respectively, except for this change of reference category. Regression 3 confirms the suspicion: Contributions by L in AK of 25.5 differ significantly from zero, and H contributions in this treatment are almost exactly double this amount. The only significant treatment effect, however, is for L subjects in the AC treatment: they contribute about 7.3 NOK more than L subjects in AK. Regression 4 reveals that the mean contribution is 62%, with no significant differences in relative contributions by endowment or treatment, save one: Low subjects in the Absolute Contribute treatment contribute about 80%, or 18 percentage points more than the reference group. Based on this finding, we use AK as the reference category in the further analysis.

Contributions are constrained in our experiment: remember L subjects can contribute between NOK 0 and 40 and H between NOK 0 and 80. To address possible censoring of data, therefore, we also report the results of Tobit regressions in Table 5.[11] The dependent variable is absolute contributions in NOK, and there are separate regressions for L and H, since these groups have different censor points. OLS regressions appear in columns 1 and 2, and the corresponding Tobit regressions appear in columns 3 and 4, respectively.

[10] For high endowed, the difference between AK and RK is significant ($p=0.03$); otherwise no other difference is significant.
[11] We thank a referee of this journal for prompting us to conduct these tests.

Table 5
OLS and Tobit regression analysis of contributions by endowment.

	OLS		Tobit	
	(1) Low	(2) High	(3) Low	(4) High
Constant (AK)	24.52*** (1.74)	52.13*** (2.85)	26.76*** (2.65)	54.46*** (3.52)
Absolute cont.	7.30*** (2.13)	2.81 (4.17)	12.96*** (3.76)	4.58 (5.29)
Relative contr.	3.95 (2.52)	3.71 (4.58)	6.78 (4.18)	5.57 (5.98)
Relative Keep	0.80 (2.16)	6.62 (4.03)	0.56 (3.18)	8.56 (5.21)
Round	−0.45 (0.39)	−1.75*** (0.62)	−0.67 (0.66)	−2.28*** (0.83)
N	511	511	511	511
adj. R^2	0.05	0.02		

Notes: The dependent variable is absolute contributions (NOK) with separate regressions for L and H subjects. Regressions 1 and 2 are OLS and 3 and 4 are Tobit. Only payoff relevant periods are included. Standard errors, which are clustered on group, appear in parentheses, whereby * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Qualitatively, the Tobit regressions corroborate the main findings from the previous OLS analysis: H subjects contribute more than L, and framing affects only L subjects; specifically, the AC frame stands out. Overall, though, comparison of the Tobit and OLS regressions suggest the constraints did affect contributions quantitatively, mostly on the upper end of the permissible range. Comparing regressions 1 and 3, we see that the framing effect is quantitatively larger in the latter: the coefficient on AC is around NOK 13 in the Tobit regression, compared with about NOK 7 in the OLS analysis. Thus, the estimated contribution of L in the AC treatment is almost NOK 40, which is also consistent with the fact that the median contribution of these subjects is NOK 40. This contrasts with all other treatments, for which the median contributions are at least 25% below the maximum.

The separation of the analysis into L and H also uncovers a new finding: the depressing effect of rounds on contributions is only significant for H subjects, whose contributions fall about 2 NOK per round as opposed to the 1 NOK estimate in Table 4, largely because the constraint is binding on fewer of the more generous H subjects than the more generous L subjects. Nevertheless, aggregate contributions usually remain comfortably above the threshold, which counts against the self-interested Nash prediction for this game. Self-interested actors might initially over-contribute due to incorrect expectations, but we find instead that excess contributions usually remain, even in later rounds when subjects are aware of the comparative generosity of other members of their group.

4.2. Suggestions

Recall that subjects made two types of proposals every period: binding "contributions" for themselves and non-binding "suggestions" for others. The suggestions of all subjects were communicated to all other group members prior to the subsequent period.

Interestingly, the overall pattern of suggestions looks quite similar to what we observe for contributions. Table 6 presents Tobit regressions of suggestions for others. Beginning in column (1) with suggestions to low endowed, there is again a treatment effect in AC: compared to the AK treatment, both H and L suggest substantially higher contributions for the low endowed in the AC frame that remain significant at the 1% level after Bonferroni corrections. The other coefficients in this column, by contrast, do not remain significant after this correction. Regarding suggestions to the high endowed, column (2) indicates that low endowed subjects suggest higher amounts for these subjects than the high endowed do, except in the RK treatment. Nevertheless, these are not significant at conventional levels after correcting for multiple hypothesis testing.

A possible explanation for the similar patterns of contributions and suggestions is that subjects are influenced by others' suggestions when deciding how much to contribute. This does not appear to be the case, however, according to further regressions reported in Appendix B (see Table A2). We are unable to identify statistically significant impacts on contributions of others' lagged suggestions or lagged contributions. Subjects simply do not seem to be swayed by others' suggestions. An alternate explanation for the similar patterns is that certain frames, the Absolute Contribution frame in particular, induce people to expect more of the Low endowed.

Finally and perhaps not surprisingly, subjects tend to suggest greater sacrifice from their same endowment counterparts than they propose for themselves based on results reported in Table A3 of Appendix B: H suggest higher contributions from other H than they contribute themselves, and analogously for L subjects. As discussed above, however, these inflated suggestions seem to be received as cheap talk that does not matter for behavior.

Table 6
Tobit regressions of suggestions.

	(1) Sugg. for Low		(2) Sugg. for High	
Constant	25.88***	(2.22)	56.34***	(3.78)
LxAC	12.95***	(3.70)	16.19**	(6.41)
LxRC	7.45**	(3.31)	12.47**	(5.09)
LxAK			8.99**	(4.50)
LxRK	0.71	(3.02)	2.23	(5.54)
HxAC	10.20***	(3.03)	5.63	(5.86)
HxRC	8.24**	(3.60)	5.20	(6.01)
HxAK	1.63	(1.55)		
HxRK	3.72	(2.95)	5.84	(5.92)
Round	1.21***	(0.44)	1.77**	(0.71)
N	1024		1024	

Note: The dependent variable is suggestions for low endowed in Column (1) and suggestions for high endowed in Column (2), measured in absolute terms (NOK). Variable names in lines indicate whether suggestions were made by high (H) or low (L) endowed. Only payoff relevant periods are included, standard errors appear in parentheses, and statistical significance is indicated as * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are clustered on group. In both columns the omitted variable is the suggestions *from the same type* in treatment AK.

4.3. Motives

Given the evidence above that contributions vary in certain ways with endowment size and framing, we examine whether distributive preferences play a role in this. In the absence of any known differences between subjects other than endowment heterogeneity, subjects might consider as 'fair' an equal sharing of the burden required to reach the threshold. With endowment heterogeneity, however, the question is "equality in what?"

Table 2 in Section 2 presented three possible ways to share the burden of meeting the threshold: equal absolute contributions (A); equal relative contributions (B), corresponding also to equal relative amounts kept; and equal absolute amounts kept (C). It might be the case that subjects are more likely to consider as 'fair' the rule that achieves equality in the contribution metric used in their treatment and that such fairness views influence actual contributions. If so, we would expect to see contributions from the low endowed *declining* from AC to RC/RK to AK, and contributions from high endowed *increasing* in the same order. Nevertheless, support for this idea in the data turns out to be weak at best.

First, as reported above, we do find that L contribute more in AC than in AK, consistent with the hypothesis. Also, suggestions for L are higher in RC than in AK, and still higher in AC. Nevertheless, there is no significant difference whatsoever between AK and RK for Low endowed (either for contributions or for suggestions), and there are no treatment effects for the high endowed, whatsoever.

Second, we do not observe strong treatment effects on reported fairness views. In the post-experimental questionnaire, subjects were asked which of three sets of contributions presented in Table 2 they considered fairest. In choosing one of these three, each subject implicitly chose the fairest contribution for herself (among the three alternatives offered). Specifically, in Table 7, the variable "Fair contribution for self" is the hypothetical contribution by the subject herself, implied by her choice of fairness principle among those in Table 2. Table 7 examines whether the elicited fairness preferences are affected by frames, and if so, whether this can explain treatment effects on actual contributions. Despite some indications of treatment effects on fairness views, the effects are weak at best. Furthermore, fairness views cannot explain the observed treatment effect on contributions. As can be seen from columns (1) and (2) in Table 7, there are no treatment effects on subjects' choice of the fairest contribution for themselves. Several alternative modelling approaches did not affect this result, except for one: as reported in Column (3), the share of subjects choosing *equal amounts kept* (C) as the fairest alternative is significantly lower in AC.[12] Although consistent with the hypothesis discussed above, this finding does not remain statistically significant after correcting for multiple hypotheses.

Given that the treatment effects on fairness views are weak at best, they can hardly explain the observed treatment effect on L's contributions in AC (which does survive a Bonferroni correction). This is confirmed by Column (4) and (5) of Table 7, which report OLS regressions of contributions: although the coefficients for the fairest contribution for oneself are positive for H as well as L subjects, they are not significant. Moreover, the inclusion of this variable does not remove the positive and statistically significant treatment effect of the AC treatment on Low's contributions, which changes little in magnitude.

Recall that the post-experimental questionnaire included two additional questions about broader distributive preferences: what contributions subjects would have chosen, if they could have made them binding on all (Dictate), and what they thought each member should have contributed (Should). We consider now, therefore, regression analysis that includes responses to all three questions on distributive preferences. We return to OLS regressions in order to be able to examine simultaneously effects of distributive preferences not only by treatment but also by endowment (a comparison not possible

[12] Overall, 90% of subjects choose either B or C as the fairest alternative. In the AC treatment, 22% choose C, whereas the average share choosing C in the three other treatments was 44%.

Table 7
Regression analysis of fairness question and contributions.

	(1) Fair contr. for self, Low	(2) Fair contr. for self, High	(3) Share choosing C as fairest	(4) Contribution, Low	(5) Contribution, High
Constant	16.67***	43.06***	0.40***	21.48***	38.23***
	(1.12)	(0.90)	(0.07)	(4.27)	(12.62)
AC	1.458	−1.81	−0.18**	12.44***	5.29
	(1.28)	(1.30)	(0.08)	(3.71)	(5.31)
RC	−0.42	0.38	0.07	6.95*	5.45
	(1.72)	(1.32)	(0.10)	(4.04)	(6.03)
RK	0.12	−0.56	0.04	0.54	8.81*
	(1.48)	(1.90)	(0.10)	(3.14)	(5.23)
Round				−0.67	−2.29***
				(0.65)	(0.83)
Fair contr. for self				0.32	0.38
				(0.21)	(0.25)
N	128	128	256	511	511
adj. R^2			0.029		

Notes: *Fair contr. for self* is defined as the contribution for the subject herself implied by her answer to the question "Which of the following sets of decisions do you think is most fair?", whereby the response alternatives are indicated in Table 2. This is the dependent variable in Column (1) and (2). In Column (3), the dependent variable is the share of subjects who choose C (equal amounts kept in Table 2) as the fairest alternative. All columns report Tobit regressions, except Column (3), which is standard OLS since censoring is not an issue. In Columns (4) and (5), the dependent variable is absolute contributions (NOK). Only payoff relevant periods are included, and standard errors, which are clustered on group, appear in parentheses. Levels of significance are denoted * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The omitted category is AK.

Table 8
OLS regressions of contributions including distributive preferences.

	(1)	(2)
Constant	25.50*** (1.82)	9.51*** (2.75)
LxAC	7.30*** (2.13)	4.77** (2.08)
LxRC	3.96 (2.52)	4.59* (2.38)
LxRK	0.80 (2.16)	−3.49* (2.03)
High	25.65*** (3.43)	6.46* (3.73)
HxAC	2.81 (4.17)	0.10 (2.74)
HxRC	3.72 (4.58)	0.66 (3.07)
HxRK	6.62 (4.03)	1.59 (2.81)
Round	−1.10*** (0.38)	−1.10*** (0.38)
Fair		0.17* (0.09)
Dictate		0.13*** (0.05)
Should		0.40*** (0.06)
N	1022	1022
adj. R^2	0.39	0.53

Notes: The dependent variable is absolute contributions (NOK), the reference category is Low/AK, and only payoff relevant periods are used. Standard errors appear in parentheses, are clustered on group, and statistical significance is indicated as * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Due to a technical error during the experiment, two observations from the RC treatment are missing. *Fair, Dictate and Should* are all responses that refer to the subject's own contributions.

with Tobit given the different censor points for H and L). In Table 8, regression (2) includes responses to the three questions on distributive preferences with respect to one's own allocation, whereas (1) duplicates the results from regression (3) of Table 4 without these questions for comparison.

A comparison of the coefficients of determination for (1) and (2) indicates distributive preferences account for a substantial fraction of variance in contributions. Indeed, the Dictate and Should questions are significant at the one percent level, whereas Fair is marginally significant.[13] Given the high correlations between the three questions, we should not place too much importance on the relative sizes of their coefficients, but rather take them as collectively representing distributive preferences. Nevertheless, these questions do not explain contributions: Low in the AC treatment remains significant, although only weakly so after a Bonferroni correction, whereas no other treatment effect is even marginally significant after Bonferroni corrections. On the other hand, the larger contributions by H subjects are explained by distributive preferences: the coefficient on High falls from 25.65, which is significant at the 1% level, to only 6.46, which is not even marginally significant after a Bonferroni correction. Thus, distributive preferences offer an explanation for the robust finding that high

[13] Since we test the effect of all three fairness variables here, we also adjust for three hypotheses in a Bonferroni correction, but the conclusions about sign and significance remain unchanged.

endowed subjects contribute more than low endowed subjects across all frames. On the other hand, there is little indication that the observed treatment effect on contributions can be explained by a framing effect on subjects' pReferences

5. Conclusions

The results of our threshold public good game with heterogeneous endowments show a clear effect of endowment size on contributions and suggest this is due to distributive preferences. On the other hand, they provide more limited evidence of metric and choice framing on contributions. The treatment that stands out in our experiment is the one framing the contribution metric in terms of absolute amounts contributed, instead of alternative, economically equivalent frames: amounts relative to endowment, absolute amounts kept, or amounts kept relative to endowments. In particular, when the contribution metric is framed in terms of absolute amounts contributed, the low endowed contribute significantly more than with other frames.

One explanation for the observed treatment effects might be that the frame influences morally motivated subjects' beliefs about what is fair or ethically right, and that this in turn affects their behavior. Our data, however, provide no convincing support for this hypothesis. Treatment effects on subjects' reported fairness preferences are not strong, and the weak treatment effects that are present cannot explain the effects we do observe on actual behavior. Since there are multiple equilibria in the game, however, different frames might also suggest different anchoring or focal points, thereby influencing subjects' expectations of others' behavior – which could affect self-interested subjects as well as those with social pReferences

Distributive preferences do not explain the treatment effect on contributions, but it is conceivable that equal sharing serves as a focal point for coordination, specifically, that the treatment affects the most natural equality principle and, thereby, the focal point. One can only conjecture, however, about why only the low endowed are affected: the contributions implied by the three equality principles shown in Table 2 differ more in relative terms for the low endowed than high endowed, which perhaps triggers a stronger psychological response among the former.

Finally, treatment effects could conceivably be due to calculation errors if, for example, subjects think in relative terms and make systematic errors when converting absolute values into percentages. It seems unlikely, however, that this can fully explain our finding that low endowed subjects contribute more with the Absolute Contribution frame. In the AC treatment, the median contribution for Low endowed is 40 NOK, corresponding to these subjects' entire endowment. The alternative of giving everything is easily calculated in all frames.

If contributions are affected by framing, this could have implications outside the laboratory, as well. Situations in the field that share important features of our experiment include labor negotiations, distribution of household chores, and international environmental treaties. In such cases, framing contributions in absolute or relative terms, and in terms of contributing or keeping, might influence beliefs, negotiations' success rates, and the ultimate sharing of burdens. Further research is, therefore, needed to explore the robustness and external validity of our main findings.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jebo.2017.04.006.

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