

Supplementary Materials for:
Enforcement of Contribution Norms in
Public Good Games with Heterogeneous
Populations

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Abstract

This document contains supplementary materials for the paper *Enforcement of Contribution Norms in Public Good Games with Heterogeneous Populations*. It is organized in the following way: Section 1 consists of a sample of the instructions used in the experiment, Section 2 contains detailed descriptive statistics of each treatment and the results of various statistical comparisons, and Section 3 presents robustness checks for the norm-elicitation technique used in the paper.

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1 Experimental Instructions

Original instructions are in Dutch. These are the instructions given to high types in the UMB treatment with punishment. Instructions used in the other treatments and for low types are similar and available upon request.

Introduction

This experiment is divided into different periods. There will be 10 periods in total. During all 10 periods, the participants are divided into groups of three. Therefore, you will be in a group with 2 other participants. The composition of the groups will remain the same during all of the experiment.

Each period consists of two stages. In the first stage, you have to decide how many tokens you contribute to a group project. In the second stage, you will learn how much the other members of your group contributed to the project.

The first stage

At the beginning of each period each participant in your group receives 20 tokens. We will refer to these tokens as the initial endowment.

In the first stage you decide how to use your initial endowment. You have to choose how many tokens you want to contribute to a group project and how many of them to keep for yourself. You can contribute any amount of your initial endowment to the group project. How many tokens you contribute is up to you. Each other group member will also make such a decision. All decisions are made simultaneously. That is, nobody will be informed about the decision of the other group members before everyone made his or her decision.

Earnings in the first stage

Your earnings in tokens, in each period, are the sum of two parts:

- The number of tokens that you kept for yourself.
- Your income from the group project. This income equals:

[multiplication factor] \times sum of contributions of all group members to the project

The projects' multiplication factor is determined as follows: in each group, *one of the group members will have a multiplication factor of 0.75* and the other *two group members will have a*

multiplication factor of 0.5. Before the experiment started each desk was assigned a multiplication factor equal to either 0.5 or 0.75. Therefore, by randomly assigning the yellow cards, each participant was randomly assigned to one of these values. The multiplication factor will be the same for all the 10 periods. *You will be the group member who has a multiplication factor of 0.75.*

Notice that, for each token which you keep for yourself you earn 1 token. If instead you contribute this token to the group project, then the total contribution to the project will rise by one token. Your income from the group project will rise by 0.75 tokens. Moreover, the other group members' income from the project will rise by 0.5 tokens. Your contribution to the group project therefore also raises the income of the other group members. For each token contributed to the project the total earnings of the group will rise by 1.75 tokens. Note that, you also earn tokens for each token contributed to the group project by the other group members. For each token contributed by any member you earn 0.75 tokens.

In summary, your earnings in tokens at the first stage of a period are equal to:

$$20 - \text{your contribution} + \text{your multiplication factor} \times (\text{sum of contributions})$$

After everyone has made his or her decision the first stage ends.

Example for the first stage

Here is an example that illustrates how the earnings in tokens are calculated in the first stage of each period. The numbers used in the example are arbitrarily chosen.

You are in a group with two other participants (group member 1 and group member 2). Each participant's multiplication factor equals: you = 0.75, group member 1 = 0.5, group member 2 = 0.5. Suppose that, you contribute 15 tokens to the group project, group member 1 contributes 5 tokens to the group project, and group member 2 contributes 10 tokens to the group project. The earnings in tokens of each of the participants are given by:

$$20 - \text{tokens contributed} + \text{multiplication factor} \times \text{sum of all contributions}$$

In your case this equals: $20 - 15 + 0.75 \times (15 + 5 + 10) = 27.5$ tokens.

For group member 1 this equals: $20 - 5 + 0.5 \times (15 + 5 + 10) = 30$ tokens.

For group member 2 this equals: $20 - 10 + 0.5 \times (15 + 5 + 10) = 25$ tokens.

The second stage

At the beginning of the second stage, everyone in the group will see how much each of the other group members contributed to the project as well as their earnings from the first stage. The

decision each group member has to make in the second stage is to either reduce or leave equal the earnings of each other group member. Reducing other group members' earnings can be done by spending tokens. The other group members can also reduce your earnings if they wish to. All decisions are made simultaneously. That is, nobody will be informed about the decision of the other group members before everyone made his or her decision.

More concisely, in this stage, you must decide whether and if yes how many tokens you want to spend to reduce the earnings of the other two group members. If you want to reduce another member's earnings, you do that by allocating deduction points. For each deduction point that you allocate to another group member his or her earnings are reduced by 3 tokens and your own earnings are reduced by 1 token. If you do not wish to change the earnings of another group member then you must allocate 0 deduction points to him or her. Note, that you will not be allowed to reduce the earnings of a group member to less than zero.

Remember that, for every deduction point you receive from other group members, your earnings will be reduced by 3 tokens (but never below zero). Every participant can spend up to a maximum of 10 tokens (i.e. allocate 10 deduction points) on each group member in each period.

After everyone has made a decision, you will be informed how many deduction points you received from the other group members and also what your total earnings in tokens for that period are. Note that you do not get to know how individual group members spend their deduction points. In other words, you will only be informed of the total amount of deduction points allocated to you by the other two group members. You will not know how many deduction points each individual group member allocated to you.

Examples for the second stage

Here are some arbitrarily chosen examples that illustrate how your final earnings are calculated. You, group member 1 and group member 2 are all members of the same group.

Example 1: Suppose that after the first stage you have earnings that are equal to 30 tokens. In the second stage you decide to allocate 3 deduction points to group member 1 (this reduces group member 1's earnings by 9 tokens) and 0 deduction points to group member 2 (this does not change group member 2's earnings). After all have made their decision, you learn that the others allocated you a total of 4 deduction points. In this case, your total earnings in tokens in this period are given by:

$$\begin{aligned} & (\text{Your first stage earnings} - 3 \times \text{deduction points allocated to you})^* \\ & - \text{deduction points you allocated} \end{aligned}$$

* If the number between brackets is negative then replace it with zero.

In this example, your earnings are equal to: $(30 - 3 \times 4) - 3 = 18 - 3 = 15$ tokens.

Example 2: Suppose that after the first stage you have earnings that are equal to 18 tokens. In the second stage you decide to allocate 4 deduction points to group member 1 (this reduces group member 1's earnings by 12 tokens) and 6 deduction points to group member 2 (this reduces group member 2's earnings by 18 tokens). After all have made their decision, you learn that the others allocated you a total of 8 deduction points.

In this case, your earnings are equal to: $(18 - 3 \times 8) - 10 = 0 - 10 = -10$ tokens.

Note that $18 - 3 \times 8 = -6$, since this is a negative number it is replaced by zero.

Negative earnings

It is, in principle, possible that you make negative earnings in a period. However, you can always avoid this by not spending any tokens in the second stage (that is, by not allocating any deduction points to the other members). Hence, you can always avoid negative earnings with certainty through your own choices.

Summary

In summary, your earnings in tokens in each period are equal to:

$$\begin{aligned} & (\text{Your initial endowment} - \text{your contribution to the project} \\ & \quad + 0.75 \times (\text{sum of contributions}) \\ & \quad - 3 \times \text{total deduction points received from others})^* \\ & - \text{amount of deductions points you allocated to others} \end{aligned}$$

* If your earnings up to this point are negative then replace them with zero

2 Descriptive Statistics

Tables 1 through 4 summarize the average amount contributed to the public good per period in each treatment. Contributions are reported in absolute terms and relative to the endowment. Standard deviations of group averages are presented in parentheses. In heterogeneous treatments, averages are also presented for high and low types.

In treatments without punishment, average contributions over all periods in absolute and relative terms are highest in UMB, followed by UUE, URE, and finally by EQUAL. However, Kruskal-Wallis tests do not reject the null hypothesis that the average absolute and relative contributions come from the same population (absolute, $p = 0.103$; relative, $p = 0.163$). The same is true if we concentrate on the second half of the game (Kruskal-Wallis tests; absolute, $p = 0.315$; relative, $p = 0.380$).

If we look at the difference in contributions between high types and low types in treatments without punishment, we find it to be relatively small. In URE high types contribute 2.60 points more than low types, in UUE it is 1.57 points more, and in UMB it is 1.24 points more. If we test whether these differences are statistically significant, we find a significant result in UMB, a weakly significant result in URE, and no significant result in UUE (one-sided Wilcoxon signed-rank tests, $p = 0.025$, $p = 0.064$, and $p = 0.232$). Relative to the endowment, low types contribute slightly more than high types in both URE and UUE. However, this difference is only weakly significant in URE and is not significant in UUE (two-sided Wilcoxon signed-rank tests, $p = 0.090$ and $p = 0.249$). Lastly, if we compare the contributions of each type across treatments using data from all periods, we do not find them to be significantly different (Kruskal-Wallis tests; for low types $p = 0.409$ for both absolute and relative contributions; for high types $p = 0.797$ for absolute contributions and $p = 0.077$ for relative contributions).

In treatments with punishment, mean absolute contributions over all periods are highest in UUE, followed by EQUAL, URE, and then UMB. The highest mean relative contributions are found in EQUAL, followed by UUE, UMB, and then URE. However, once again Kruskal-Wallis tests do not reject the null hypothesis that absolute and relative contributions come from the same distribution (absolute, $p = 0.323$; relative, $p = 0.263$). The same is true in the last five periods of the game (Kruskal-Wallis tests; absolute, $p = 0.156$; relative, $p = 0.315$). Compared to treatments without punishment, we find that punishment produces a significant increase in contributions in EQUAL, UUE, and URE, and a weakly significant increase in UMB (one-sided Mann-Whitney U tests $p = 0.002$, $p = 0.027$, $p = 0.004$, and $p = 0.077$).

In treatments with punishment, there are evident differences in contributions between high types and low types. In UUE high types contribute 12.36 points more than low types, in UMB they contribute 3.51 points more, and remarkably in URE they contribute 1.85 points less. If we test whether high types contribute significantly more, we find a significant result in UUE and a weakly significant result in UMB (one-sided Wilcoxon signed-rank tests, $p = 0.014$ in UUE, $p = 0.087$ in UMB, and $p = 0.962$ in URE). In contributions relative to the endowment, low types contribute considerably more than high types in URE and slightly more in UUE. This difference is significant in URE and is not significant in UUE (two-sided Wilcoxon signed-rank tests, $p = 0.018$ and $p = 0.600$). Lastly, if we compare the contributions of each type across treatments using data from all periods, we do not find a significant difference in the case of low types (Kruskal-Wallis tests; $p = 0.359$ for both absolute and relative contributions), but we do in the case of high types: we can reject the hypothesis that relative contributions across the three treatments come from the same distribution and the same can be said for absolute contributions, albeit weakly (Kruskal-Wallis tests; $p = 0.016$ for relative contributions and $p = 0.058$ for absolute contributions).

Tables 5 through 8 summarize the average number of punishment points that a subject assigns to others per period in each treatment. Note that each low type can punish both one high type and one low type. Hence, to observe the total number of points assigned to others by low types, one must add the first two columns of Tables 6-8. Standard deviations of group averages are presented in parentheses. In unequal treatments, averages are also presented depending on the type of the subject doing the punishing and type of the subject receiving it.

The average amount of punishment over all periods is highest in URE, followed by UMB, UUE, and finally by EQUAL. However, a Kruskal-Wallis test does not find that these differences in punishment are statistically significant ($p = 0.700$). The same is true if we use data only from the second half of the game (Kruskal-Wallis test, $p = 0.534$).

If we look at punishment depending on types, we find that in all unequal treatments low types punish other low types less than they punish high types, and that high types punish low types more than low types punish high types. However, if we check whether any of these differences is statistically significant, we find that only in UMB high types punish low types significantly more than low types punish high types (or than low types punish other low types; two-sided Wilcoxon signed-rank tests, $p = 0.046$ and $p = 0.046$), none of the other differences is statistically significant (two-sided Wilcoxon signed-rank tests, $p > 0.116$). Lastly, we do not find any significant differences if we compare how the amount of punishment depending on types

differs across treatments (Kruskal-Wallis tests; for low types punishing low types $p = 0.406$; for low types punishing high types $p = 0.744$; for high types punishing low types $p = 0.556$).

Table 1: Average contributions in Equal

Note: Mean absolute and relative contribution to the public good per period. Standard deviations are in parentheses.

<i>Period</i>	WITHOUT PUNISHMENT			
	ABSOLUTE		RELATIVE	
	<i>overall</i>		<i>overall</i>	
1	10.67	(4.29)	0.53	(0.21)
2	9.05	(5.25)	0.45	(0.26)
3	5.14	(3.04)	0.26	(0.15)
4	3.10	(2.29)	0.15	(0.11)
5	3.00	(2.61)	0.15	(0.13)
6	2.52	(2.08)	0.13	(0.10)
7	2.71	(2.74)	0.14	(0.14)
8	2.67	(2.59)	0.13	(0.13)
9	2.24	(2.86)	0.11	(0.14)
10	1.00	(1.43)	0.05	(0.07)
All	4.21	(2.00)	0.21	(0.10)
Last 5	2.23	(2.11)	0.11	(0.11)
	WITH PUNISHMENT			
1	12.83	(3.53)	0.64	(0.18)
2	13.94	(4.07)	0.70	(0.20)
3	15.94	(4.22)	0.80	(0.21)
4	15.39	(3.96)	0.77	(0.20)
5	17.28	(2.59)	0.86	(0.13)
6	17.50	(2.98)	0.88	(0.15)
7	15.83	(4.20)	0.79	(0.21)
8	16.83	(3.93)	0.84	(0.20)
9	16.83	(3.70)	0.84	(0.18)
10	14.89	(6.82)	0.74	(0.34)
All	15.73	(2.86)	0.79	(0.14)
Last 5	16.38	(4.02)	0.82	(0.20)

Table 2: Average contributions in URE

Note: Mean absolute and relative contribution to the public good per period. Standard deviations are in parentheses.

WITHOUT PUNISHMENT												
<i>Period</i>	ABSOLUTE						RELATIVE					
	<i>low</i>		<i>high</i>		<i>overall</i>		<i>low</i>		<i>high</i>		<i>overall</i>	
1	9.43	(3.19)	17.29	(3.68)	12.05	(2.45)	0.47	(0.11)	0.43	(0.09)	0.46	(0.11)
2	11.00	(3.86)	13.57	(6.27)	11.86	(3.48)	0.55	(0.14)	0.34	(0.16)	0.48	(0.14)
3	8.93	(4.32)	12.57	(6.55)	10.14	(4.75)	0.45	(0.19)	0.31	(0.16)	0.4	(0.19)
4	8.71	(5.07)	12.57	(4.79)	10.00	(3.46)	0.44	(0.17)	0.31	(0.12)	0.4	(0.17)
5	8.86	(4.05)	10.00	(10.00)	9.24	(4.82)	0.44	(0.18)	0.25	(0.25)	0.38	(0.18)
6	7.21	(4.35)	6.86	(7.8)	7.10	(5.28)	0.36	(0.20)	0.17	(0.19)	0.30	(0.20)
7	5.43	(6.00)	7.29	(5.59)	6.05	(5.37)	0.27	(0.23)	0.18	(0.14)	0.24	(0.23)
8	5.21	(3.2)	3.00	(4.40)	4.48	(2.92)	0.26	(0.12)	0.08	(0.11)	0.2	(0.12)
9	2.71	(2.77)	7.86	(8.09)	4.43	(3.16)	0.14	(0.11)	0.20	(0.20)	0.16	(0.11)
10	0.64	(0.90)	3.14	(7.47)	1.48	(2.35)	0.03	(0.06)	0.08	(0.19)	0.05	(0.06)
All	6.81	(2.97)	9.41	(3.94)	7.68	(2.67)	0.34	(0.15)	0.24	(0.10)	0.31	(0.11)
Last 5	4.24	(2.52)	5.63	(4.22)	4.70	(2.42)	0.21	(0.13)	0.14	(0.11)	0.19	(0.10)
WITH PUNISHMENT												
1	15.36	(3.57)	9.57	(7.50)	13.43	(3.89)	0.77	(0.15)	0.24	(0.19)	0.59	(0.15)
2	14.93	(3.89)	12.14	(5.79)	14.00	(3.21)	0.75	(0.14)	0.30	(0.14)	0.60	(0.14)
3	15.21	(5.64)	13.57	(5.38)	14.67	(5.19)	0.76	(0.22)	0.34	(0.13)	0.62	(0.22)
4	15.57	(3.54)	13.57	(7.48)	14.90	(3.33)	0.78	(0.13)	0.34	(0.19)	0.63	(0.13)
5	15.64	(3.12)	12.86	(6.84)	14.71	(4.15)	0.78	(0.15)	0.32	(0.17)	0.63	(0.15)
6	14.64	(5.26)	11.86	(8.07)	13.71	(5.24)	0.73	(0.21)	0.30	(0.20)	0.59	(0.21)
7	14.50	(5.37)	14.29	(6.73)	14.43	(5.71)	0.73	(0.23)	0.36	(0.17)	0.60	(0.23)
8	15.50	(4.88)	12.57	(8.44)	14.52	(5.92)	0.77	(0.23)	0.31	(0.21)	0.62	(0.23)
9	15.07	(5.76)	16.86	(3.18)	15.67	(4.78)	0.75	(0.22)	0.42	(0.08)	0.64	(0.22)
10	12.07	(7.97)	12.71	(8.50)	12.29	(7.30)	0.60	(0.31)	0.32	(0.21)	0.51	(0.31)
All	14.85	(3.63)	13.00	(5.43)	14.23	(4.09)	0.74	(0.18)	0.33	(0.15)	0.60	(0.16)
Last5	14.36	(5.47)	13.66	(5.97)	14.12	(5.57)	0.72	(0.27)	0.34	(0.15)	0.59	(0.23)

Table 3: Average contributions in UUE

Note: Mean absolute and relative contribution to the public good per period. Standard deviations are in parentheses.

<i>Period</i>	WITHOUT PUNISHMENT											
	ABSOLUTE						RELATIVE					
	<i>low</i>		<i>high</i>		<i>overall</i>		<i>low</i>		<i>high</i>		<i>overall</i>	
1	9.33	(3.53)	22.50	(17.82)	13.72	(5.79)	0.47	(0.16)	0.56	(0.45)	0.50	(0.16)
2	10.25	(4.97)	16.67	(18.89)	12.39	(7.45)	0.51	(0.24)	0.42	(0.47)	0.48	(0.24)
3	8.42	(8.13)	13.33	(14.02)	10.06	(8.98)	0.42	(0.35)	0.33	(0.35)	0.39	(0.35)
4	10.25	(8.65)	11.67	(7.53)	10.72	(7.99)	0.51	(0.34)	0.29	(0.19)	0.44	(0.34)
5	10.67	(9.30)	5.83	(8.01)	9.06	(8.28)	0.53	(0.36)	0.15	(0.20)	0.40	(0.36)
6	8.42	(7.49)	6.17	(8.01)	7.67	(6.91)	0.42	(0.29)	0.15	(0.20)	0.33	(0.29)
7	6.08	(6.23)	6.17	(8.01)	6.11	(6.11)	0.30	(0.25)	0.15	(0.20)	0.25	(0.25)
8	4.92	(7.25)	4.83	(5.49)	4.89	(5.31)	0.25	(0.25)	0.12	(0.14)	0.20	(0.25)
9	4.50	(6.05)	3.33	(8.16)	4.11	(6.51)	0.23	(0.26)	0.08	(0.20)	0.18	(0.26)
10	2.00	(4.00)	0.00	(0.00)	1.33	(2.67)	0.10	(0.13)	0.00	(0.00)	0.07	(0.13)
All	7.48	(5.94)	9.05	(7.42)	8.01	(5.76)	0.37	(0.30)	0.23	(0.19)	0.32	(0.24)
Last 5	5.18	(5.50)	4.10	(4.29)	4.82	(5.00)	0.26	(0.27)	0.10	(0.11)	0.21	(0.22)
WITH PUNISHMENT												
1	11.42	(5.79)	27.50	(15.08)	16.78	(8.34)	0.57	(0.30)	0.69	(0.38)	0.61	(0.30)
2	14.08	(6.13)	28.50	(15.35)	18.89	(8.71)	0.70	(0.32)	0.71	(0.38)	0.71	(0.32)
3	14.58	(6.97)	21.83	(17.84)	17.00	(10.09)	0.73	(0.36)	0.55	(0.45)	0.67	(0.36)
4	12.08	(8.60)	23.83	(16.62)	16.00	(11.19)	0.60	(0.42)	0.60	(0.42)	0.60	(0.42)
5	14.33	(6.87)	23.67	(16.27)	17.44	(9.36)	0.72	(0.34)	0.59	(0.41)	0.68	(0.34)
6	15.33	(6.06)	31.67	(10.33)	20.78	(7.17)	0.77	(0.28)	0.79	(0.26)	0.77	(0.28)
7	15.92	(6.00)	30.83	(11.14)	20.89	(7.56)	0.80	(0.29)	0.77	(0.28)	0.79	(0.29)
8	15.58	(6.25)	29.17	(13.20)	20.11	(8.18)	0.78	(0.31)	0.73	(0.33)	0.76	(0.31)
9	15.42	(6.41)	30.00	(11.40)	20.28	(7.92)	0.77	(0.30)	0.75	(0.29)	0.76	(0.30)
10	14.33	(6.53)	19.67	(19.20)	16.11	(8.55)	0.72	(0.30)	0.49	(0.48)	0.64	(0.30)
All	14.31	(6.11)	26.67	(12.41)	18.43	(8.03)	0.72	(0.31)	0.67	(0.31)	0.70	(0.30)
Last 5	15.32	(5.96)	28.27	(11.53)	19.63	(7.61)	0.77	(0.30)	0.71	(0.29)	0.75	(0.29)

Table 4: Average contributions in UMB

Note: Mean absolute and relative contribution to the public good per period. Standard deviations are in parentheses.

WITHOUT PUNISHMENT												
<i>Period</i>	ABSOLUTE						RELATIVE					
	<i>low</i>		<i>high</i>		<i>overall</i>		<i>low</i>		<i>high</i>		<i>overall</i>	
1	11.79	(5.15)	11.43	(4.54)	11.67	(3.16)	0.59	(0.16)	0.57	(0.23)	0.58	(0.16)
2	11.07	(5.37)	12.71	(4.79)	11.62	(4.81)	0.55	(0.24)	0.64	(0.24)	0.58	(0.24)
3	11.21	(5.51)	13.57	(7.48)	12.00	(5.97)	0.56	(0.30)	0.68	(0.37)	0.60	(0.30)
4	9.50	(6.95)	11.71	(6.82)	10.24	(5.87)	0.47	(0.29)	0.59	(0.34)	0.51	(0.29)
5	9.14	(7.01)	10.43	(7.68)	9.57	(6.93)	0.46	(0.35)	0.52	(0.38)	0.48	(0.35)
6	8.86	(6.88)	10.86	(6.72)	9.52	(6.43)	0.44	(0.32)	0.54	(0.34)	0.48	(0.32)
7	8.71	(8.48)	9.00	(9.11)	8.81	(8.67)	0.44	(0.43)	0.45	(0.46)	0.44	(0.43)
8	10.07	(7.76)	7.43	(7.72)	9.19	(7.61)	0.50	(0.38)	0.37	(0.39)	0.46	(0.38)
9	4.86	(3.38)	6.29	(7.87)	5.33	(4.45)	0.24	(0.22)	0.31	(0.39)	0.27	(0.22)
10	1.07	(1.69)	5.29	(7.45)	2.48	(2.72)	0.05	(0.14)	0.26	(0.37)	0.12	(0.14)
All	8.63	(4.96)	9.87	(5.18)	9.04	(5.01)	0.43	(0.25)	0.49	(0.26)	0.45	(0.25)
Last 5	6.71	(5.08)	7.77	(7.18)	7.07	(5.73)	0.34	(0.25)	0.39	(0.36)	0.35	(0.29)
WITH PUNISHMENT												
1	7.83	(4.97)	12.67	(5.39)	9.44	(3.31)	0.39	(0.17)	0.63	(0.27)	0.47	(0.17)
2	10.58	(4.38)	14.50	(5.24)	11.89	(3.15)	0.53	(0.16)	0.73	(0.26)	0.59	(0.16)
3	10.75	(5.14)	15.00	(4.82)	12.17	(4.08)	0.54	(0.20)	0.75	(0.24)	0.61	(0.20)
4	10.92	(6.03)	15.17	(4.88)	12.33	(4.71)	0.55	(0.24)	0.76	(0.24)	0.62	(0.24)
5	12.00	(5.26)	15.50	(5.21)	13.17	(4.24)	0.60	(0.21)	0.77	(0.26)	0.66	(0.21)
6	12.17	(5.96)	13.33	(4.55)	12.56	(5.26)	0.61	(0.26)	0.67	(0.23)	0.63	(0.26)
7	11.58	(5.56)	15.00	(5.80)	12.72	(4.64)	0.58	(0.23)	0.75	(0.29)	0.64	(0.23)
8	12.00	(6.44)	15.83	(5.23)	13.28	(5.65)	0.60	(0.28)	0.79	(0.26)	0.66	(0.28)
9	12.08	(6.36)	14.33	(7.39)	12.83	(6.19)	0.60	(0.31)	0.72	(0.37)	0.64	(0.31)
10	9.33	(5.00)	13.00	(7.85)	10.56	(5.42)	0.47	(0.27)	0.65	(0.39)	0.53	(0.27)
All	10.93	(4.87)	14.93	(4.97)	12.09	(4.23)	0.55	(0.24)	0.72	(0.25)	0.60	(0.21)
Last 5	11.43	(5.46)	14.30	(5.61)	12.39	(5.17)	0.57	(0.27)	0.72	(0.28)	0.62	(0.26)

Table 5: Average punishment in Equal

Note: Mean punishment points assigned by each subject per period. Standard deviations are in parentheses.

<i>Period</i>	<i>low</i> → <i>low</i>	
1	2.00	(1.48)
2	1.89	(1.57)
3	1.06	(1.34)
4	0.78	(0.66)
5	0.61	(0.93)
6	0.61	(0.74)
7	1.61	(2.55)
8	0.94	(1.69)
9	0.61	(0.68)
10	0.67	(1.33)
All	1.08	(0.73)
Last 5	0.89	(0.84)

Table 6: Average punishment in URE

Note: Mean punishment points assigned by each subject per period. Standard deviations are in parentheses.

<i>Period</i>	<i>low</i> → <i>low</i>		<i>low</i> → <i>high</i>		<i>high</i> → <i>low</i>		<i>overall</i>	
1	0.07	(0.19)	1.29	(1.25)	0.86	(1.57)	1.19	(1.23)
2	0.86	(1.84)	0.36	(0.56)	2.71	(3.09)	1.71	(2.15)
3	0.57	(0.93)	1.07	(1.06)	0.43	(0.79)	1.24	(1.26)
4	0.57	(1.02)	1.21	(1.91)	2.14	(3.76)	1.90	(1.91)
5	0.43	(0.79)	1.43	(1.81)	0.57	(1.51)	1.43	(1.46)
6	0.64	(1.11)	2.29	(2.88)	1.57	(2.15)	2.48	(2.78)
7	0.79	(1.35)	1.00	(1.83)	1.00	(1.83)	1.52	(1.39)
8	0.21	(0.39)	1.71	(1.91)	0.57	(1.51)	1.48	(1.44)
9	0.50	(0.87)	0.50	(1.32)	0.71	(1.50)	0.90	(1.29)
10	1.00	(1.91)	0.86	(1.49)	1.86	(3.76)	1.86	(2.38)
All	0.56	(0.56)	1.17	(1.08)	1.24	(1.29)	1.57	(1.05)
Last 5	0.63	(0.84)	1.27	(1.28)	1.14	(1.52)	1.65	(1.45)

Table 7: Average punishment in UUE

Note: Mean punishment points assigned by each subject per period. Standard deviations are in parentheses.

<i>Period</i>	<i>low</i> → <i>low</i>		<i>low</i> → <i>high</i>		<i>high</i> → <i>low</i>		<i>overall</i>	
1	0.33	(0.41)	0.75	(0.88)	1.83	(1.83)	1.33	(0.47)
2	0.25	(0.61)	1.50	(2.35)	1.67	(2.88)	1.72	(1.41)
3	0.33	(0.52)	0.92	(1.63)	3.00	(4.82)	1.83	(1.99)
4	0.42	(0.66)	0.00	(0.00)	1.33	(1.63)	0.72	(0.68)
5	1.00	(2.00)	0.75	(0.88)	1.50	(2.35)	1.67	(2.11)
6	0.25	(0.61)	0.50	(0.77)	0.67	(1.63)	0.72	(1.34)
7	0.42	(1.02)	0.58	(1.02)	2.50	(3.89)	1.50	(2.15)
8	0.17	(0.26)	0.50	(1.00)	1.00	(2.45)	0.78	(1.13)
9	0.17	(0.26)	0.08	(0.20)	0.00	(0.00)	0.17	(0.28)
10	0.00	(0.00)	1.50	(2.00)	1.67	(4.08)	1.56	(2.13)
All	0.33	(0.56)	0.71	(0.73)	1.52	(1.54)	1.20	(1.03)
Last 5	0.20	(0.40)	0.63	(0.75)	1.17	(1.72)	0.94	(0.18)

Table 8: Average punishment in UMB

Note: Mean punishment points assigned by each subject per period. Standard deviations are in parentheses.

<i>Period</i>	<i>low</i> → <i>low</i>		<i>low</i> → <i>high</i>		<i>high</i> → <i>low</i>		<i>overall</i>	
1	0.25	(0.42)	0.17	(0.41)	3.67	(4.27)	1.50	(1.35)
2	0.67	(0.88)	0.25	(0.42)	2.50	(2.51)	1.44	(1.13)
3	0.33	(0.41)	0.83	(1.17)	3.00	(2.76)	1.78	(1.61)
4	0.58	(0.66)	0.50	(0.77)	2.50	(3.15)	1.56	(1.38)
5	0.83	(1.13)	0.67	(0.61)	1.67	(1.86)	1.56	(1.13)
6	0.42	(0.38)	1.50	(1.90)	0.50	(1.22)	1.44	(1.31)
7	1.08	(0.97)	0.75	(0.76)	2.00	(1.10)	1.89	(1.34)
8	0.42	(0.80)	0.42	(0.58)	0.67	(1.21)	0.78	(0.78)
9	0.17	(0.41)	0.50	(0.63)	0.67	(1.21)	0.67	(0.56)
10	1.08	(2.01)	2.00	(2.95)	2.67	(1.97)	2.94	(2.82)
All	0.58	(0.43)	0.76	(0.66)	1.98	(1.19)	1.56	(0.79)
Last 5	0.63	(0.54)	1.03	(0.97)	1.30	(0.78)	1.54	(1.00)

3 Additional Data Analysis

In this section, we use variations of the procedure used in the results section to elicit the contribution norm that is most consistent with the observed punishment behavior. As in the main body of the paper, we estimate the following model:

$$p_{ijt} = \beta_{neg} \max[\mu c_{it} - (1 - \mu)c_{jt}, 0] + \beta_{pos} \max[(1 - \mu)c_{jt} - \mu c_{it}, 0] + v_i + \epsilon_{ijt}, \quad (1)$$

where p_{ijt} is the amount of punishment that i allots to j in period t and $\mu \in [0, 1]$ captures the norm of how much subjects expect others to contribute in comparison to their own contribution. We estimate (1) using values of $\mu \in [0, 1]$ in steps of 0.01, and make the restrictions $\beta_{neg} \geq 0$ and $\beta_{pos} \geq 0$. We consider separately the cases: low types punishing high types, low types punishing low types, and high types punishing low types. Below, in Table 9, we report the values μ^* of the best-fitting regressions using the following regressions.

- *Simple*: Same procedure as in the paper’s results section (reproduced here for convenience). Namely, estimating (1) using random-effects Tobit regressions censoring at zero and ten.
- *Additional controls*: Estimating (1) using random-effects Tobit regressions censoring at zero and ten and adding two additional independent variables: first, the period t to control for time trends, and second, the total group contributions $\sum_i c_i$ to control for any differences between high-contributing and low-contributing groups.
- *Only punishers*: Estimating (1) using random-effects Tobit regressions censoring at zero and ten, but using the data only from subjects who punish at least once. Overall, 82.67% of all subjects punish at least once and 17.33% never punish.
- *Binary punishment*: Estimating (1) using random-effects Logit regressions treating punishment as a binary decision (either punish or not).
- *Fixed effects*: Estimating (1) using Tobit regressions censoring at zero and ten and individual-level unconditional fixed effects.

As can be seen, the values of μ^* in EQUAL and URE do not vary at all with the different estimation procedures. In UUE, the values of μ^* vary slightly but stay fairly close to the values implied by a cooperation norm that results in contributions proportional to endowments. In UMB, $\mu_{H \rightarrow L}^*$ stays fairly constant confirming that high types expect to contribute more than low types. $\mu_{L \rightarrow L}^*$ and $\mu_{L \rightarrow H}^*$ vary a bit more although it is always the case that low types expect high types to contribute more than they do.

Table 9: Alternative estimates of μ^*

Note: Values of μ^* obtained when estimating (1) with different procedures.

	simple	additional controls	punishers only	binary punishment	fixed effects
EQUAL					
low→low	0.50	0.50	0.50	0.50	0.50
URE					
low→low	0.50	0.50	0.50	0.50	0.50
low→high	0.50	0.50	0.50	0.50	0.50
high→low	0.50	0.50	0.50	0.50	0.50
UUE					
low→low	0.50	0.50	0.46	0.50	0.48
low→high	0.65	0.64	0.66	0.66	0.61
high→low	0.33	0.34	0.33	0.33	0.33
UMB					
low→low	0.51	0.58	0.50	0.50	0.52
low→high	0.56	0.58	0.51	0.58	0.54
high→low	0.40	0.42	0.40	0.39	0.41

Finally, Figure 1 reproduces, for all our treatments, the punishment pattern that is commonly-observed in homogenous groups. Namely, individuals punishing most those who contribute less than they do and least those who contribute the same amount. In the figure, we present the mean number of punishment points subjects administer to others depending on their relative contributions calculated using each treatment's μ^* (we use the contribution norms elicited with the *simple* specification). Corroborating the regression results presented in the main body of the paper, deviations from each treatment's contribution norm are punished similarly in all treatments.

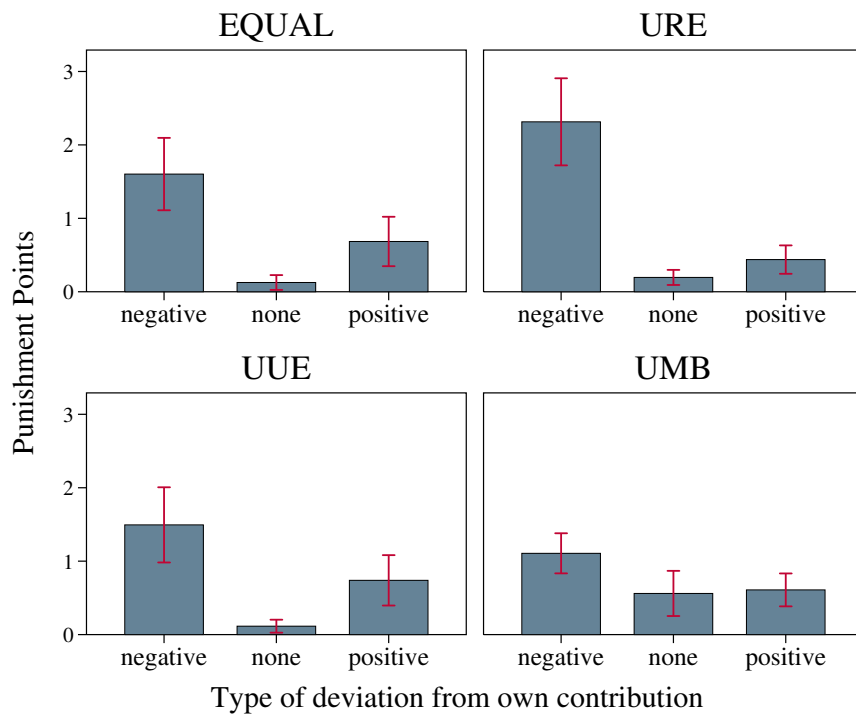


Figure 1: Punishment depending on relative contributions

Note: Mean number of punishment points subjects administer to others depending on their relative contributions calculated using each treatment's μ^* and the *simple* specification. Error bars indicate 95% confidence intervals.