Carry a big stick, or no stick at all

Punishment and Endowment Heterogeneity in the Trust Game

Supplementary Material

This supplementary material is divided in two sections. The first one (Appendix A) presents the experimental instructions and some screenshots (in Spanish) of our experiment. The second one (Appendix B) contains the derivatives for our lemma and supplementary econometric analyses of our data for investors and allocators, which support the findings discussed in our manuscript.

APPENDIX A:

INSTRUCTIONS [*]

This is an experiment to study decision-making. The instructions are simple and if you follow them carefully you will get an amount of money in cash at the end of the experiment in a confidential manner. All through the experiment you will be treated anonymously. Neither the experimenters nor the people in this room will ever know your particular choices or the amount of money that you get. Talking is forbidden during the experiment. If you have any questions, raise your hand and remain silent. You will be attended as soon as possible.

The experiment has 8 rounds, divided into 2 blocks of 4 rounds. These instructions explain how the experiment unfolds in the first block. At the beginning of the second block, you will be provided with new instructions. At the end of the experiment, one of the two blocks will be randomly selected to pay you. We will convert your gains in ECUs (Experimental Currency Units) during that block to Euros using the rate of 10 ECU= 1€.

In this experiment there are two types of players: A and B. Before starting the experiment, you will be randomly selected either as player A or player B and this type will be kept all through experiment.

In each round, you will be matched with one of the subjects of the other type (i.e., you will be matched with a player B if you are player A, and you will be marched with a player A if you are player B). In each block, you will never be matched with the same person twice. It means that in each block you will take decisions with a different person in each round.

At the beginning of each round, you will get an amount of ECUs that can be either 10 or 40. The amount that you get does not need to coincide with the amount of ECUs received by the other player you are matched with, although you will always know both amounts before taking your decision.

If you are player A, you have to decide the amount of ECUs (if any) to send to player B. The amount of ECUs that you send will be deducted from your initial ECUs and will be triplicated (i.e., we will multiply this amount by 3). The amount of ECUs that you don't send to player B will be yours.

If you are player B, you will get three-times the amount of ECUs that player A sent you. After you know this amount, you have to decide the amount of ECUs (in any) that you want to return to player A. You will keep the ECUs that you do not send to player A plus your initial ECUs.

So, in this block, your gains in each round depend of your decisions in the following way:

Final payoff player A = Initial ECU of A – ECU sent to B + ECUs received from B

Final payoff player B = Initial ECU of B + 3* ECU received from A - ECU sent to A

To check that you have understood the instructions, we ask you to look at the computer screen. First, you will see the logic of the experiment through a numerical example. Next, you will need to compute the final payoffs of an example in which in which the computer chooses numbers randomly the ECUs send by player A and the ECUs returned by player B.

---

[*] This appendix contains the instructions for the sessions in which the possibility of punishment is introduced in the second part of the experiment. Instructions are originally in Spanish.

INSTRUCTIONS

This is an experiment to study decision-making. The instructions are simple and if you follow them carefully you will get an amount of money in cash at the end of the experiment in a confidential manner. All through the experiment you will be treated anonymously. Neither the experimenters nor the people in this room will ever know your particular choices or the amount of money that you get. Talking is forbidden during the experiment. If you have any questions, raise your hand and remain silent. You will be attended as soon as possible.

This second block has a total of 4 rounds, in which you keep being player A or B. In each round, you will be matched with a person of the other type that changes across rounds. Thus, if you are player A (B), you will be matched in each round with a different player B (A). As in the first block, at the beginning of each round you will get an amount of ECUs that can be 10 or 40 ECUs.

Each round in this block hast two stages. The **first stage** is identical to the first block. If you are player A, you have to decide the amount of ECUs (if any) to send to player B. The amount of ECUs that you send will be deducted from your initial ECUs and will be triplicated (i.e., we will multiply this amount by 3). The amount of ECUs that you don't send to player B will be yours.

If you are player B, you will get three-times the amount of ECUs that player A sent you. After you know this amount, you have to decide the amount ECUs (in any) that you want to return to player A. You will keep the ECUs that you do not send to player A plus your initial ECUs.

These decisions determine your provisional payoffs.

Provisional payoff player A = Initial ECU of A – ECU sent to B + ECUs received from B

Provisional payoff player B = Initial ECU of B + 3* ECU received from A - ECU sent to A

In the **second stage** of the round, and after being informed of the provisional playoffs, the player A will be asked to take a second decision. This second decisions consists in choosing the number of **points** (if any) to send to player B. Each point that player A sends to player B will reduce the player A's payoff in 1 ECU. Per each point that player B receives from player A, the player B's payoffs will be reduced in 3 ECUs.

Your **final payoffs** will be then computed as follows:

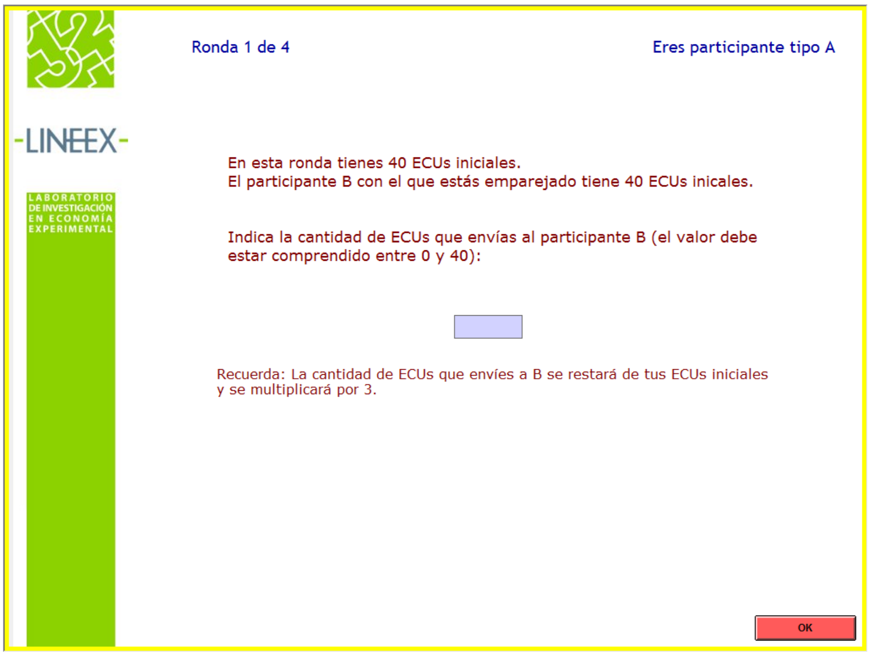
Final payoff player A = Provisional payoff player A – points sent by A

Final payoff player B = Provisional payoff player B– 3*points sent by A

To check that you have understood the instructions, we ask you to look at the computer screen. First, you will see the logic of the experiment through a numerical example. Next, you will need to compute the final payoffs of an example in which in which the computer chooses numbers randomly the ECUs send by player A and the ECUs returned by player B.

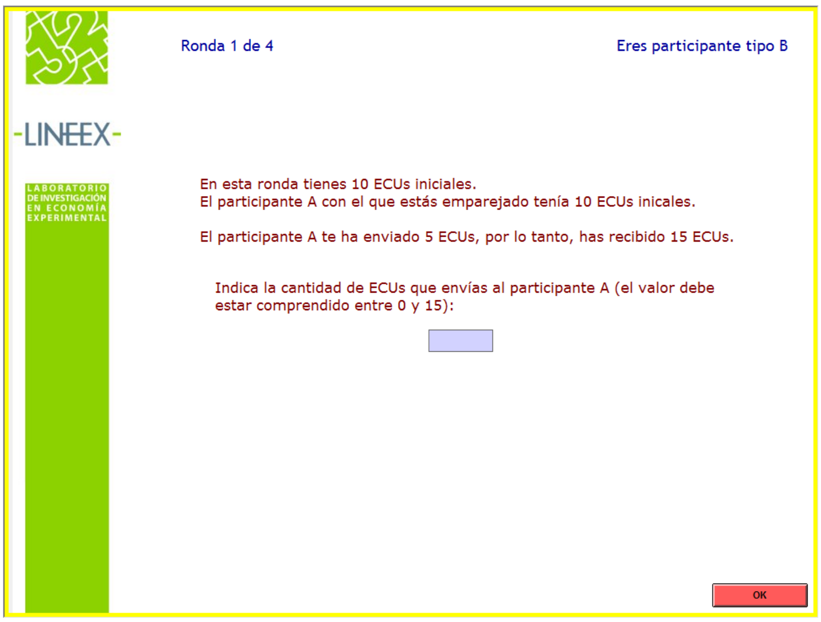
SCREENSHOTS

I. The investor's Behavior: Trust



Investors were informed on this screen: "In this round you have 40 ECUS. The player you are matched with has 40 ECUS". Then, investors had to "Indicate the amount of ECUs to send to player B (the amount must be between 0 and 40)". Investors chose the desired transfer using the blue box. The text below the box reminds subjects that "the amount that you send will be reduced from your initial ECUs and multiplied by the 3"

II. The allocator's behavior: Trustworthiness



Investors were informed on this screen about the initial endowments (as explained for the case of investors). In the third line, the text states: “Player A sent you 5 ECUs, therefore you have received 15 ECUs. Indicate the amount that you want to send to player A (the amount must be between 0 and 15)”.

III. Earnings

The screenshot below informed player A about their initial ECUs, the amount sent to B, the ECUs received and the final earnings in that round. Player B faced a similar screen.

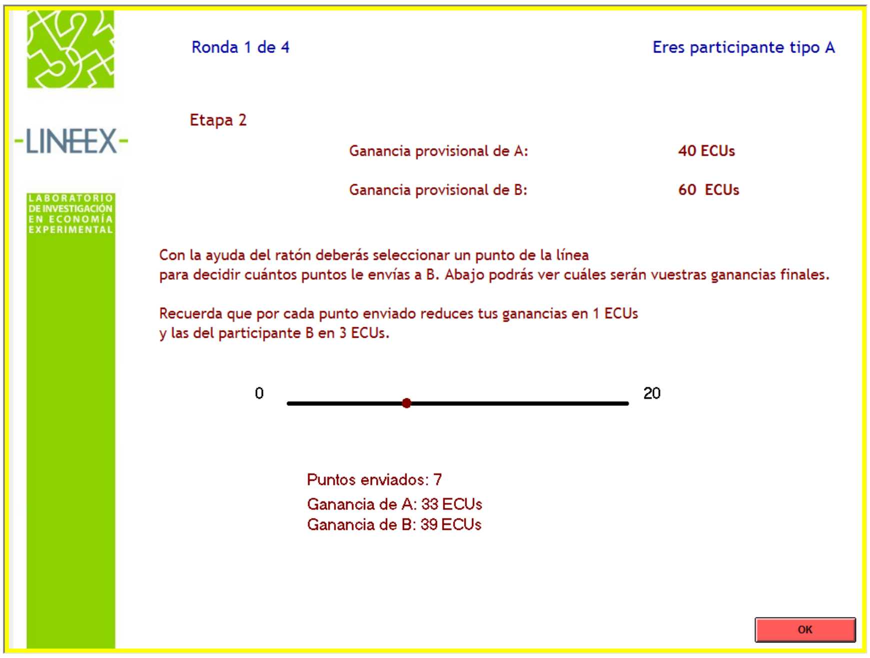
We decided to inform subjects about their earnings at the end of each round because in the punishment treatment, this information must be available for investors to decide whether to punish or not. With our design, we wanted to avoid that subjects received more information (feedback) in the treatment with punishment.

IV. The investor's behavior: Punishment

In the punishment treatment subjects were first informed about the amount that they had earned during the trust game (i.e., before the punishment-phase was played).

The screen was very similar to the one in section III, with the exception that the last sentence concerned “provisional earnings in that round” (instead of “final earnings in this round”)

Once subjects receive this information, investors were allowed to send “points” to allocators, as it is shown below:



To facilitate the computation of the final payoffs, the investor decided the points to be sent to the allocator using an slider bar that ranged from 0 to P*, as explained in the main text of the paper. By moving the bar, the investor received information about the final distribution of payoffs associated to her choice. The investor could move the sliding bar as many times as she wanted; her decision had to be confirmed by clicking the button "ok" at the bottom of the screen.

APPENDIX B

This appendix provides a more formal definition for the capacity of punishment and presents the partial derivatives of the capacity of punishment with respect to the level of endowments. We also provide further results on the econometric analysis. The investor's behavior is analyzed in Section I (Table 1.B, Table 2.B, Table 3.B), and the allocator's behavior in Section II (Table 4.B, Table 5.B, Table 6.B). Results on efficiency are reported in Section III (Table 7.B).

Capacity of Punishment

Equation (6) in the Section 2 of the paper defines the maximum the share of the allocator's interim payoffs that the investor can destroy:

$$(6)\ \frac{\lambda \cdot \pi^a}{\pi^b} = \frac{\lambda \cdot (e_a - X + Y)}{(e_b + 3X - Y)}$$

In our analysis, we shall use the investment ratio ($x := X/e_a$) as the measure of trust (see Smith, 2011; Johnson and Mislin, 2011), and the return ration (y := Y/X) as the measure for trustworthiness. If we rewrite equation (6) in terms of these variables we may obtain a formal definition for the *capacity of punishment* (CP).

Definition. *The* capacity of punishment *refers to the maximum share of allocator's interim payoff* π^b *that the investor can destroy after she trusts by sending a proportion x of her endowment and receives back a return ratio y from the allocator*.

$$(7)\ CP(e, \lambda; x, y) = \frac{\lambda \cdot \pi^a}{\pi^b} = \frac{\lambda \cdot (1 - x + yx)}{(e_b/e_a + 3x - yx)}$$

Notice that the inverse of the capacity of punishment captures how costly is for the investor to destroy the allocator's payoff completely; i.e., the value of ($\pi^b/\lambda\pi^a$) determines the share of the interim payoffs π^a that the investor would need to make $\pi^b = 0$. In that vein, our measure for the capacity of punishment can be related to its cost and credibility. When the capacity of punishment is high, the investor can destroy the allocator's payoff with a small share of her own payoff, therefore the threat of punishment is much more credible.

Our formula for the capacity of punishment shows that the level of endowments (e_a and e_b), the level of trust (x) and the return ratio (y) are important variables at stake. By simply taking derivatives we can see that the investor will reduce the credibility of her punishment by trusting, but a higher return ratio will make *cheaper* for her to destroy the allocator's payoff completely. For any given (*x,y*) what crucially determines the capacity of punishment is the level of endowments.

Lemma. *Consider two distributions of endowments* $e = (e_a, e_b)$ *and* $e' = (e'_a, e'_b)$*. If the level of trust (x) and the level return ratio (y) are the same in both cases then:*

$$CP(e, \lambda; x, y) \gtreqless CP(e', \lambda; x, y) \text{ if and only if } (e_a/e_b) \gtreqless (e'_a/e'_b)$$

This lemma allows us to rank different capacities of punishment depending on the level of endowments. To show the result, we simply take derivatives in equation (7).

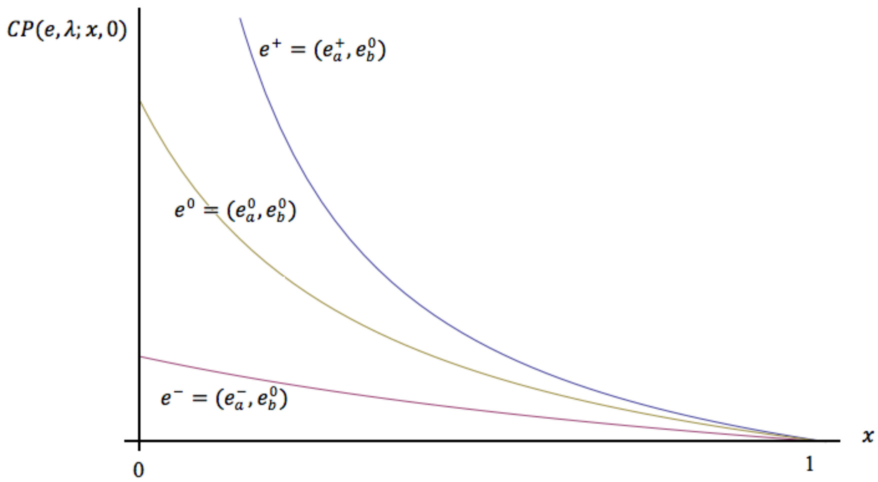
$$\frac{\partial CP(e, \lambda; x, y)}{\partial e_a} = \frac{-\lambda\ (1 + (y-1)x)}{e_b\ (e_b/e_a + 3x - yx)^2} > 0$$

$$\frac{\partial CP(e, \lambda; x, y)}{\partial e_b} = \frac{e_a\ \lambda\ (1 + (y-1)x)}{{e_b}^2\ (e_b/e_a + 3x - yx)^2} < 0$$

We then observe that the investor's capacity of punishment increases (decreases) with the investor's (allocator's) endowment, certeris paribus.

To illustrate this graphically, consider the worst possible scenario for the investor in which she trusts sending x but receives nothing back form the allocator ($y = 0$). The next figure plots the investors' capacity of punishment for each possible value of x in $[0, 1]$. We consider three different distributions of endowment satisfying $e_a^- < e_a^0 = e_b^0 < e_a^+$.

Figure. Capacity of punishment for different level of endowments



It is not difficult to see that for any level of trust x, it is always the case that the higher the value of e_a compared with e_b, the higher is the proportion of the allocator's endowment the investor can destroy.

Demographics and Data breakdown

	Investors	Allocators	Total
Women	0.54	0.56	0.55
	(0.50)	(0.50)	(0.50)
Age	22	21.94	21.97
	(2.57)	(3.37)	(2.99)
Trust	0.17	0.17	0.17
	(0.37)	(0.37)	(0.37)
N	48	48	96

The subject's gender is a dummy variable that takes the value 1 for women. The subject's age vary between 18 and 36 years. The GSS variable refers to the attitudinal survey question: "Generally speaking, would you say that most people can be trusted or that you cannot be careful in dealing with people" (1 if most people can be trusted, 0 otherwise). Standard errors in brackets.

I. The investor's Behavior

Table 1.B. Maximum-likelihood estimates of a random effects model that estimates the level of trust and controls for unobserved individual heterogeneity.

Dependent Variable: level of trust (X/e_a)				
	CP_{LOW} (10,40)	(40,40)	(10,10)	CP_{HIGH} (40,10)
Period	-0.043	0.009	-0.045	0.014
	(0.049)	(0.020)	(0.040)	(0.047)
Net earnings t – 1	-0.008*	-0.004	0.010*	0.015*
	(0.005)	(0.005)	(0.006)	(0.009)
PUN	0.012	-0.006	-0.001	0.091**
	(0.058)	(0.030)	(0.055)	(0.040)
Women	-0.218***	-0.103**	-0.178*	-0.112
	(0.050)	(0.051)	(0.105)	(0.069)
Age	0.0003	8.27e-05	-0.015	0.006
	(0.012)	(0.010)	(0.013)	(0.011)
GSS	0.150	0.084**	0.225***	-0.006
	(0.092)	(0.042)	(0.080)	(0.082)
Constant	0.417	0.121	0.760***	-0.010
	(0.278)	(0.234)	(0.293)	(0.286)
σ_u	0.107	0.062	0.225	0.169
σ_e	0.301	0.157	0.237	0.182
ρ	0.113	0.134	0.474	0.464

Notes. The set of independent variables include the period, the net earning in the previous round, a dummy variable for possibility of punishment (PUN), and the data collected in the questionnaire regarding the investor's gender, age and the answer to the attitudinal survey question from the General Social Survey (GSS): "Generally speaking, would you say that most people can be trusted or that you cannot be careful in dealing with people?" The robust standard errors take into account matching group clustering and are reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Table 2.B. We report the outcome of pairwise comparisons between the four different distributions using the Wilcoxon signed-rank in Panel A.[1] Hypothesis testing using the χ^2-test after estimating the econometric model in Table 1 in the main text are presented in Panel B. In both panels, we report the value of the statistics for the NOPUN and PUN treatment appear in the grey and the white area respectively.

A. Wilcoxon signed-rank test

	(10,40)	(40,40)	(10,10)	(40,10)
(10,40)	-	3.51***	0.89	3.04***
(40,40)	2.51**	-	2.29**	0.06
(10,10)	0.07	2.38**	-	3.01***
(40,10)	1.14	1.87*	0.63	-

B. χ^2-test after the random-effect model

	(10,40)	(40,40)	(10,10)	(40,10)
(10,40)	-	4.47**	0.01	6.36**
(40,40)	5.64***	-	6.21**	2.03
(10,10)	1.51	3.83*	-	10.6***
(40,10)	3.08*	1.91	0.41	-

The results confirm that without punishment, behavior is primarily driven by the *endowment effect* (Result 2). Trust is not significantly different when the endowment of the investor is low (10 ECUs) or high (40 ECUs), regardless of the endowment of the allocator. However, comparing trust when investors' endowment differs becomes significant. In the case with punishment, the same comparison yields a different result: the proportion of the endowment that the investor sends in (40,10) is statistically different from the behavior in (40,40), but it is not statistically different from the level of trust if the endowment is 10 ECUs.

[1] The results are robust when considering the t-test.

Table 3.B. We can test whether the amount that investors send in the NOPUN and the PUN treatment is the same regardless of the order in which these treatments are implemented. After the estimation of our model in Table 1, we test the null hypothesis H_0: $\alpha_{PUNFIRST} + \alpha_{PUNxPUNFIRST} = 0$ and H_0: $\alpha_{PUNxPUNFIRST} = 0$. The results of the χ^2-test are summarized below:

	Null Hypothesis	χ_1^2 (p-value)
The level of trust in the PUN treatment is the same when the game is played first or second in the session.	H_0: $\alpha_{PUNFIRST} + \alpha_{PUNxPUNFIRST} = 0$	7.32 (0.001)
The level of trust in the NOPUN treatment is the same when the game is played first or second in the session.	H_0: $\alpha_{PUNxPUNFIRST} = 0$	0.81 (0.368)

In the light of these results we can conclude that the highest level of trust is achieved when PUN is the first treatment to be implemented. The level of trust when there is NOPUN is not affected by the order of the treatments.

II. Allocators' Behavior

Table 4.B. Hypothesis testing for the effects of endowment heterogeneity on the return ratio using the χ^2-test after estimating the model in Table 2 (in the main text) –value of the statistics for the NOPUN treatment (grey area) and PUN treatment (white area) respectively.

	(10,40)	(40,40)	(10,10)	(40,10)
(10,40)	-	0.55	0.07	0.02
(40,40)	0.09	-	0.19	0.67
(10,10)	0.13	0.00	-	0.17
(40,10)	3.28*	2.57*	2.15	-

We find that the return ratio does not change within distributions in the NOPUN treatment (p-values > 0.46) so the allocator's behavior is roughly the same in that regard. In the PUN, the return ratio in (40,10) is significantly different (and actually smaller) than the return ratio in the distributions where the investor have a low capacity of punishment (10,40) and (40,40).

Table 6.B. We can test whether the return ratio in the NOPUN or the PUN treatment is the same regardless of the order in which treatments are implemented. After the estimation of our model in Table 2 (in the main text), we test the null hypothesis H_0: $\alpha_{PUNFIRST} + \alpha_{PUNxPUNFIRST} = 0$ and H_0: $\alpha_{PUNxPUNFIRST} = 0$. The results of the χ^2-test are summarized below:

	Null Hypothesis	χ^2_1 (p-value)
The return ratio in PUN is the same when the game is played first or second in the session.	H_0: $\alpha_{PUNFIRST} + \alpha_{PUNxPUNFIRST} = 0$	1.80 (0.180)
The return ratio in NOPUN is the same when the game is played first or second in the session.	H_0: $\alpha_{PUNxPUNFIRST} = 0$	1.25 (0.264)

In the light of these results we can conclude for any given treatment PUN or NOPUN, the return ratio is not affected by the order of the treatments (e.g., the return ratio with PUN is roughly the same when PUN is introduced after NOPUN and when PUN is the first treatment to be implemented).

III. Efficiency, final payoffs and punishment behavior

Table 6.B. Final (average) payoffs of investors and allocators in each distribution with and without punishment. We report the p-values for the Wilcoxon-test.

	Distribution			
	CP_{LOW} **(10,40)**	**(40,40)**	**(10,10)**	CP_{HIGH} **(40,10)**
Investor's payoffs				
NOPUN	9.000	36.958	9.270	39.375
PUN	8.375	36.146	10.021	35.687
t-test (t)	0.418	0.652	0.187	0.062
Wilcoxon test (Z)	0.609	0.756	0.567	0.042
Allocator's payoffs				
NOPUN	46.333	55.167	15.604	19.583
PUN	40.875	43.687	10.625	21.750
t-test	0.018	0.033	0.001	0.568
Wilcoxon test (Z)	0.009	0.011	0.000	0.350

Our data suggest that investors do not send a higher proportion of the endowment to allocators except if the capacity of punishment is high (Result 1 in the main text). We have also found that the return ratio is higher with punishment, except when the capacity of punishment is high (Result 5 in the main text). Our results in Table 1D are consistent with these findings. If we look at the allocator's payoffs, for example, we can see that investors are better off in the absence of punishment, except if the capacity of punishment is high. This result can be explained because investors are not more willing to transfer money with punishment in (10,10), (10,40) and (40,40), but allocators are less likely to reciprocate in these distributions (i.e., the return ratio is higher with punishment). Besides, the punishment destroys part of their endowment so that allocators would prefer the situation without punishment. The investor's problem is a little bit different. If they do not have a high capacity of punishment, they do not send more money to allocators, but they receive more money back. This would be beneficial for them by increasing their payoffs. However, allocators use the punishment and end up with a payoff that is similar to the one without punishment.

Table 7.B. Punishing behavior: Spearman correlation coefficients

	Decision to punish (Yes/No)	Amount punish (P)	Relative punish ($P/\overline{\pi}^{a}$)
Return ratio (y = Y/X)	-0.270***	-0.298***	-0.397***
Reciprocity ($Y - X$)	-0.249***	-0.289***	-0.402***
Endowments ($e_a^H - e_b^H$)	0.181	0.143	0.040
Number of obs.	117	117	117

As indicated by the first column, the willingness to punish is affected by the return ratio. In particular, the larger the return ratio ($y = Y/X$), the less likely investors are to punish. Along these lines, investors devote less resources to punish (in terms of the amount of punishment inflicted and the proportion of the interim payoffs they used to punish) the larger the return ratio is. These findings are consistent if we focus instead on the difference between Y and X, which can also be used to measure reciprocity.[2] In line with our findings in the manuscript, the endowment heterogeneity does not seem to affect punishing behavior.

[2] When we investigate punishing behavior and relate it to the level of trustworthiness (Y) the results are also clear-cut. Investors punish less frequently and devote a smaller proportion of their interim payoffs to punish the higher the level of trustworthiness is (r = -0.29, p-value=0.001 and r = -0.48, p-value=0.000, respectively).