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An Experimental Study of the Envy Game

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Abstract

Envy is often the cause of mutually harmful outcomes. We experimentally study the impact of envy in a bargaining setting in which there is no conflict in material interests: a proposer, holding the role of residual claimant, chooses the size of the pie to be shared with a responder, whose share is exogenously fixed. Responders can accept or reject the proposal, with game types differing in the consequences of rejection: all four combinations of (not) self-harming and (not) other-harming are considered. We find that envy leads responders to reject high proposer claims, especially when rejection harms the proposer. Notwithstanding, maximal claims by proposers are predominant for all game types. This generates conflict and results in a considerable loss of efficiency.

JEL classification: D63, D74, C91, C72.

Keywords: Social Preferences, Conflict, Experimental Economics, Bargaining.

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1 Introduction

Envy is undoubtedly a strong motivational force and often the reason for mutually harmful conflict outcomes. Envy may, of course, concern aspects which cannot be changed, e.g. when we envy others' good looks, intellectual, artistic, or physical capabilities. Here we do not focus on these aspects but on avoidable differences. As often in (experimental) economics, we rely on avoidable discrepancies in monetary success. That such discrepancies trigger negative emotions and reactions has inspired the concept of inequ(al)ity aversion (e.g., Loewenstein *et al.*, 1989; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), while some theoretical studies postulated envy as the main reason for many experimental findings (e.g., Kirchsteiger, 1994; Levine, 1998).[1]

Here we are not mainly concerned with the definition of envy but rather with how robust the observation of envy is. Feelings of envy, and negative reactions triggered by them, are mainly observed in situations where deviating from equal payoffs helps one party but harms the other. This is not true for the interaction setting studied here (i.e., the Envy Game) where a proposer chooses — within bounds, of course — how much both parties can earn together. A proposer choosing a larger pie increases her residual without reducing the agreement payoff of the responder which is exogenously fixed. This, however, may result in an avoidable payoff inequality. Do we observe envy in such a setting? Or, alternatively, will responder participants be more efficiency inclined and tolerate the self-serving behavior by proposers since it increases the payoff sum?

Previous experiments show that when the payoff of the decision maker, who can choose among alternative allocations for a counterpart, is fixed, choices are more influenced by efficiency concerns than by envy (e.g., Charness and Rabin, 2002; Engelmann and Strobel, 2004). Gueth *et al.* (201x) support this finding experimentally for the Generosity Game, in which the share of the proposer is exogenously fixed and the responder is the residual claimant. In this experiment

[1] To experience envy means to suffer from being worse-off than others and not from payoff differences per sé.

most proposers chose the largest pie size even when this made them earn less.

In our experiment, the residual claimant is the proposer who chooses a pie size from which the responder receives a fixed share. The responder can either accept or reject the choice of the proposer. We experimentally manipulate the consequences that the choice of the responder has for her own payoff and for the payoff of the proposer. Specifically, a rejection choice can have negative payoff consequences for both, for none, or for only one of the two players. We find that envy plays an important role in shaping the behavior of responders, who tend to reject "greedy" claims by the proposer. The frequent rejection of large pies, when this is payoff relevant, results in inefficient outcomes. Thus, envy may have detrimental social consequences even without conflict over scarce resources, in the sense that one can, to some extent, favor one party without having to harm the other party.

In section 2.1, we define the envy game formally and introduce its four variants, implemented as four experimental games. After describing the details of the experimental protocol and stating our main hypotheses in section 2, the experimental data are described, tested, and discussed in section 3. Section 4 concludes.

2 Method

2.1 Interaction Structure

We investigate behavior in a two-player bargaining game, labeled *Envy Game*. We refer to the proposer as Player X and to the responder as Player Y. The decision process consists of two stages: in the first stage, Player X chooses the pie size $\Pi \in \{\Pi \in \mathbb{N} : \underline{\Pi} \leq \Pi \leq \overline{\Pi}\}$ and Player Y is given a fixed share of the pie equal to κ, where $0 < \kappa < \underline{\Pi} < 2\kappa < \overline{\Pi}$. Player X is the residual claimant receiving $\Pi - \kappa$. In the second stage, Player Y determines $\delta(\Pi) \in \{0, 1\}$, with $\delta(\Pi) = 0$ meaning *rejection* and $\delta(\pi) = 1$ meaning *acceptance*. When $\delta(\Pi) = 1$, the payoffs directly follow from the decisions in the first stage, with the payoff of Player X equal to $\pi_x = \Pi - \kappa$ and that of Player Y equal to $\pi_y = \kappa$. When Player Y sets $\delta(\Pi) = 0$, the consequences of Player Y's choice are experimentally manipulated. The rejection choice may be self-damaging and/or other-damaging. When the choice is self-damaging, Player Y loses her share κ of Π and earns nothing. When the choice is other-damaging, Player X loses her share of Π and earns nothing. By combining these two dimensions we obtain the following four alternative game types.

- In game type (V)*oice only*, the payoffs are the same as for $\delta(\Pi) = 1$, i.e., all what happens is that Player X learns that Player Y has rejected her choice of Π, meaning that Y can only voice her anger. Player Y's choice is neither self-damaging nor other-damaging.

- In game type (I)*mpunity*, X's payoff is equal to $\pi_x = \Pi - \kappa$. The payoff of Y is equal to $\pi_y = \delta(\Pi)\kappa$, so that in case of $\delta(\Pi) = 0$, Player Y earns nothing. Y's choice is self-damaging but not other-damaging.

- In game type (P)*unity*, X's payoff is equal to $\pi_x = \delta(\Pi)(\Pi - \kappa)$, while Y's payoff is equal to $\pi_y = \kappa$. Thus, when $\delta(\Pi) = 0$, Player X earns nothing. Y's choice is not self-damaging but other-damaging.

- In game type (U)*ltimatum*, the payoffs of Y and X are defined by $\pi_x = \delta(\Pi)(\Pi - \kappa)$ and $\pi_y = \delta(\Pi)\kappa$, respectively. In case of $\delta(\Pi) = 0$, both players earn nothing. Y's choice is both self-damaging and other-damaging.

Our game types relate to familiar modifications of the Ultimatum Game, where the proposer suggests how to share a given pie and the responder accepts or not the proposal. The subgame-perfect equilibrium or solution by once repeated elimination of dominated strategies is for the proposer to offer the smallest positive amount possible and for the responder to accept all positive offers. However, individuals seem to be strongly influenced by equity concerns. Typically, offers are between 30% and 50% of the endowment and offers smaller than 20% are rejected in about half of the cases (Camerer, 2003).

In a modification of the Ultimatum Game, the Impunity Game (Bolton and Zwick, 1995), only the payoff of the proposer is equal to zero after a rejection, allowing responders to sanction unfair allocations without cost. Finally, the relevance of "voice" is testified by Xiao and Houser (2005). In an ultimatum experiment in which responders can also communicate their feelings to proposers, less rejections of unfair offers are observed than in a standard ultimatum experiment. Thus, pure "voice rejection" in the Ultimatum Game may suffice to express one's anger due to an unfair offer.

2.2 Behavioral Predictions

To generate some qualitative behavioral predictions for the four variants of the Envy Game, we use a version of Charness and Rabin (2002)'s model of distributional preferences.[2] We distinguish four prototypical types in terms of social preferences, namely *selfish, difference-averse, welfare-enhancing*, and *competitive*. First, we focus on Player Y whose behavior, unlike that of Player X, is not affected by strategic considerations, but is genuinely driven by allocational considerations. Behavioral predictions are obtained for all game types in which rejection has real payoff consequences.

A selfish Player Y is going to accept any Π in game types I and U, where rejection is self-damaging. This type of Player Y is indifferent between acceptance and rejection in game types P and V, as rejection is either purely other-damaging or payoff irrelevant.

A difference-averse Player Y is going to accept any $\Pi \leq 2\kappa$ because her welfare is positively affected by a higher payoff for X in this region. However, when $\Pi > 2\kappa$ the predicted behavior of Y varies across experimental games. In game type I, all choices of Π are accepted, even if they create a disadvantageous inequality for Y. In game type P, stronger envy should lead to a lower rejection threshold in terms of Π. In contrast, a stronger sense of guilt should induce a

[2]See Appendix B for details about the model and for the derivation of behavioral predictions.

higher rejection threshold.[3] When envy dominates, pie choices much larger than 2κ will be rejected. In game type U, whether Π is accepted or rejected depends only on envy: the stronger is envy, the smaller is the rejection threshold for Π.

For a Player Y inclined to enhance welfare, higher payoffs, both for herself or for the other, are always desirable. Such a Player Y will thus accept any Π.

A competitive Player Y benefits from an increase in her own payoff and suffers from an increase in the payoff of the other. In game type I, in which rejection is purely self-damaging, a player of this type will accept any Π. In game type P, any Π will be rejected. In game type U, a Player Y is going to accept any Π, with $\Pi \leq 2\kappa$. However, when $\Pi > 2\kappa$ rejections become likely.

In game type V, where punishment has no real consequences, it could be argued that behavior should be close to behavior observed for game type P. Players Y may still punish Players X although punishment is just symbolic. At the same time, rendering the punishment payoff irrelevant may add some noise to the choices of Players Y, as testified by previous studies on the impact of real incentives in experiments (e.g., Camerer and Hogarth, 1999).

Concerning Player X, the allocational preferences considered here predict $\Pi = \overline{\Pi}$ for each game type. The full exploitation of residual claimant's rights originates from the monotonicity assumption that underlies the model considered. However, when strategic considerations are taken into account, deviations from $\Pi = \overline{\Pi}$ may be observed. In particular, smaller Π sizes may be observed in P and U, game types in which envy may induce Player Y to punish a "greedy" Player X.

2.3 Participants and Procedures

The Experiment was run in Jena (Germany) at the laboratory of the Max Planck Institute of Economics. The Participants were undergraduate students of the Friedrich Schiller University of Jena recruited using the ORSEE system

[3] A difference-averse player experiences envy when facing a disadvantageous allocation and guilt when facing an advantageous allocation.

(Greiner, 2004). The computerized experiment was programmed and conducted using the z-Tree software (Fischbacher, 2007).

Upon their arrival at the laboratory, participants were randomly allocated to cubicles inhibiting interaction with other participants. Participants were left four minutes to read the instructions individually and after that instructions were read aloud to establish common knowledge.[4] Participants could privately ask for clarifications and had to answer a questionnaire checking their understanding of the instructions.

A total of 128 participants took part in the experiment, half of them randomly assigned to role X and the other half to role Y. Participants were exposed to two distinct game types over two experimental rounds, with no feedback in between. Specifically, 32 participants were assigned to the sequence $V \rightarrow I$, 32 participants to the sequence $I \rightarrow V$, 32 participants to the sequence $P \rightarrow U$, and 32 participants to the sequence $U \rightarrow P$. Thus, each game type (V, I, P, and U) was played first in one session.

Players X could choose a pie size Π in the range from €8 to €24 and the fixed share κ of Player Y was set equal to €6. Participants received a fee of €2.50 for showing up on time.

3 Results

3.1 Data Pooling

Before presenting a detailed analysis of the behavior of Players X and Y, we check whether it is possible to pool the data for the same game type, irrespectively of whether it was played first or second.

Table 1 reports on the average Π chosen by Players X for each game type and for both orders.

[Table 1 about here]

[4]For a translated version of the instructions see Appendix A

To test whether there are spillovers from one game type to the other, we check whether the same Player X changed her choice of Π from one game type to the other. If the number of changes is not statistically different when the order of game types changes, we conclude that order does not matter and feel entitled to pool data for the same game type.

Both when comparing alternative orders for V and I and for P and U, no statistical difference is observed in the frequency of changes from one game type to the other (Fisher's Exact Test, p-value=1.00 for both comparisons). Henceforth, we pool data for Player X, irrespectively of the order in which they were elicited.

For Player Y we follow a similar strategy to identify possible order effects. Table 2 reports on the average rejection rate (%) for each game type and for both orders.

[Table 2 about here]

To test whether there are spillovers from one game type to the other, we compute the differences between the choices reported by the same Player Y in the two game types. Both when comparing V and I and P and U, the number of changes in behavior does not statistically differ for different elicitation orders (Pearson's Chi-squared test, p-values=0.086 and p-values=0.364, respectively). Thus, also for Player Y, the analysis reported below is conducted by pooling data.

3.2 Player Y

Figure 1 displays the rejection rate for each potential Π proposed by Player X in the four experimental games.

[Figure 1 about here]

As shown by the figure, rejection rates are smaller when rejection is self-damaging than when it is not. When rejection is other-damaging, higher rejection rates are observed for higher Π, with the highest rejection rate in P

for $\Pi = 24$. When rejection is purely symbolic (V), a more erratic pattern is observed, as suggested by the "more noise hypotheses". Finally, when rejection is purely self-damaging (I), very few rejections are observed. Statistically significant differences in the rejection profiles are detected only when comparing game types in which rejection is self-damaging (I and U) with game types in which rejections are not self-damaging (V and P).[5]

Result 1 *For higher claims of Player X, rejections are frequently observed when they are other-damaging. Rejections are either more erratic or almost absent when rejection is symbolic or self-damaging.*

Result 1 suggests that payoff consequences are an important determinant of Player Y's decision. In light of the behavioral predictions of Section 2.2, Result 1 suggests that envy is an important motivational factor, although heterogeneity in behavior is observed. That not all players are motivated by envy is demonstrated by the fact that pies $\Pi > 18$ are accepted by about half of the participants in P.

To gain in the understanding of Player Y's behavior, a regression analysis is presented in Table 3. The dependent variable in the generalized linear mixed model is the decision of Player Y to accept or reject the proposed pie size Π. Concerning the explanatory variables, the consequences of the rejection are captured by two dichotomous variables, *Self harming* and *Other harming*. The former is equal to 1 when rejection entails no earnings for Player Y and equal to 0 otherwise. The latter is equal to 1 when rejection entails no earnings for Player X and equal to 0 otherwise. Pie size Π is captured by the variable *Pie size*. In our estimation we also control for the interactions between the consequences of rejection and the pie size Π. Finally, some background control variables are taken into account: *Age*, measures the age of Player Y in years;

[5] A Wilcoxon signed rank test is employed when comparing V and I and P and U. The p-values for these comparisons are 0.002 and 0.001, respectively. A Wilcoxon rank sum test is employed when comparing V and U and I and P. The p-values for these comparisons are 0.024 and < 0.001, respectively. For all other comparisons, a Wilcoxon rank sum test is employed and all p-values are > 0.062.

Econ, captures whether Player Y is a student of Economics or not; *Female*, controls for gender.[6]

In Table 3, we present three distinct estimations for distinct intervals of Π. The intervals capture alternative levels of inequity: over the interval 8–12 choices of X are more than fair; over the interval 13–18 choices of X are moderately unfair; over the interval 19–24 choices of X are unfair.

[Table 3 about here]

For the interval 8–12, Table 3 shows that it is less likely to observe a rejection when rejection is payoff-relevant than when it is not, in particular when the cost of rejection is borne by Player Y. Similarly, for the moderately unfair interval 13–18, rejection is less likely when it is payoff relevant than when it is not. However, the likelihood of a rejection increases as Π increases when the damages of rejection are harming Player X. Also for the interval 19–24, larger pies are more likely rejected.

Result 2 *For fair and unfair choices of Player X, rejection is chosen more parsimoniously when it bears payoff consequences. As soon as the unfairness of the allocation increases with pie size* Π*, more rejections are observed when the negative consequences of rejection are borne by Player X.*

3.3 Player X

Figure 2 provides a description of the frequency (%) of each pie size Π for the four experimental games.

[Figure 2 about here]

In each game type most Players X choose the maximal Π and no Player X chooses a pie size $\Pi < 12$. However, when the rejection is payoff damaging for

[6] In an exploratory analysis, a model with interactions between *Self harming* and *Other harming* was also estimated. However, this model did not provide a better fit than the one reported here and was also inferior in terms of AIC and BIC measures. Thus, we report here only the model with single interactions.

X, the amount of choices close to the equal split $\Pi = 12$ increases. The shift in the distribution of Π seems to be stronger for game type P. When testing for the number of choices that are equal to max Π, game type P statistically differs both from V and I (Fisher's Exact Test, p-value= 0.011 and p-value= 0.032, respectively).

Result 3 *The large majority of Players X choose the maximal* Π. *However, in game type* P*, in which rejection is other-damaging but not self-damaging, the maximal* Π *is chosen less frequently than in game types* V *and* I*, in which rejection is not other-damaging.*

The choice that maximizes the expected payoff of X, given the choices of Y, differs from $\Pi = 24$ only for P. Here, the choice with the highest expected value is $\Pi = 23$, with expected earnings equal to €8.5. Players X seem to anticipate the high rejection rates in P, but only partially adapt their behavior. In the other games, most Players X choose the maximal $\Pi = 24$.

3.4 Agreements

As shown above, Players X do not fully anticipate the rejection patterns of Players Y and mostly choose the maximal Π. Table 4 provides a representation of the number of agreements achieved and of the consequences of disagreement in terms of actual earnings in the experiment.

[Table 4 about here]

The highest number of rejected choices is observed in P, which is also the game registering the highest losses in terms of payoffs. For P and U, a statistically significant loss with respect to the most efficient monetary outcome is observed (Wilcoxon signed rank test, both $p - values < 0.001$). For V and I, no significant deviation from the most efficient monetary outcome is registered (Wilcoxon signed rank test, p-value=0.371 and p-value=0.097, respectively).

Result 4 *When rejection is other-damaging, Players Y tend to punish greedy choices of Players X. This generates significant welfare losses. Interestingly, welfare losses are higher when they are entirely borne by Player X than when they are shared by both players.*

4 Conclusion

Previous studies propagated the role of envy, in itself or as a component of inequity aversion, based on findings for situations in which there is a trade-off between the payoff of one party and that of its counterpart (for a review of such results see Camerer, 2003). In the Envy Game players are locally not competing for scarce resources, notwithstanding envy has important detrimental consequences, both individually and socially. A comparison of our results with those of Gueth *et al.* (201x) suggests that envy is not simply triggered by outcome inequalities, as predicted by consequentialist or allocation-based models (e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), but is also affected by the process leading to the disadvantageous allocation. When the disadvantageous situation is created by the suffering decision maker herself, like in Gueth *et al.* (201x), envy seems to be dominated by efficiency concerns. When the disadvantageous situation is imposed by another party, like in the Envy Game, envy seems to beat efficiency seeking. This finding may help us to understand real-life interactions and will hopefully improve the modeling of social preferences.

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5 Figures

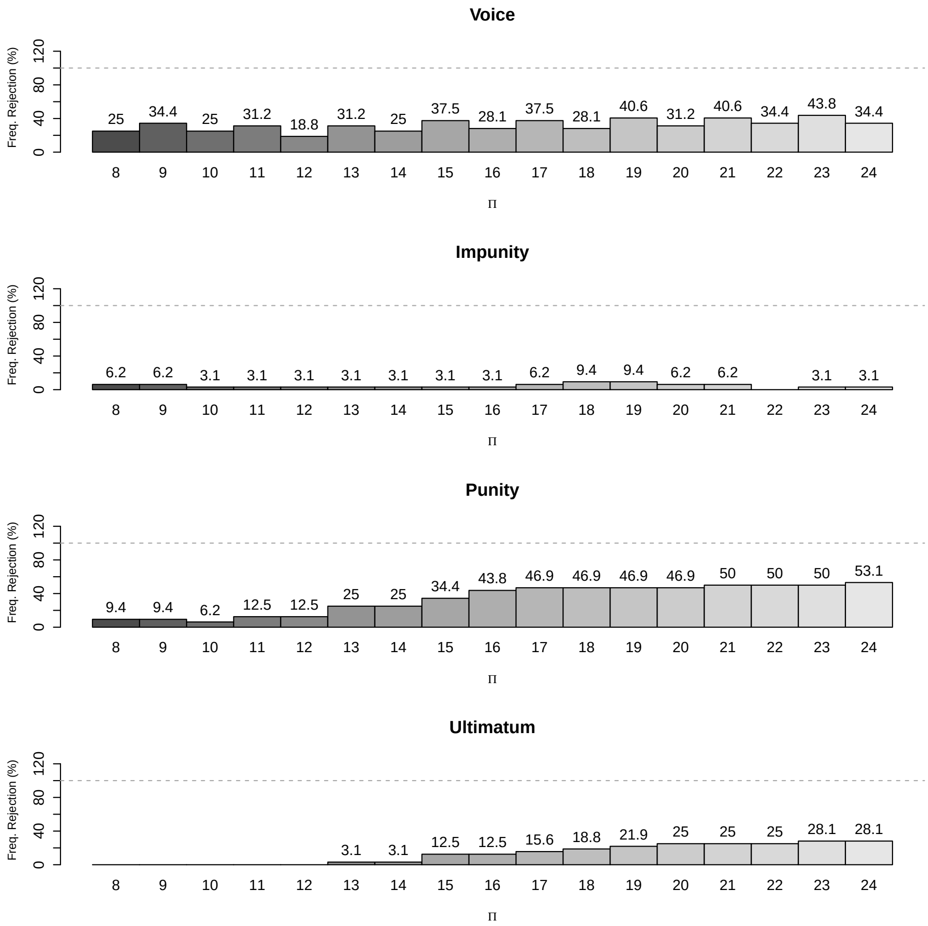

Figure 1: Choices of Players Y

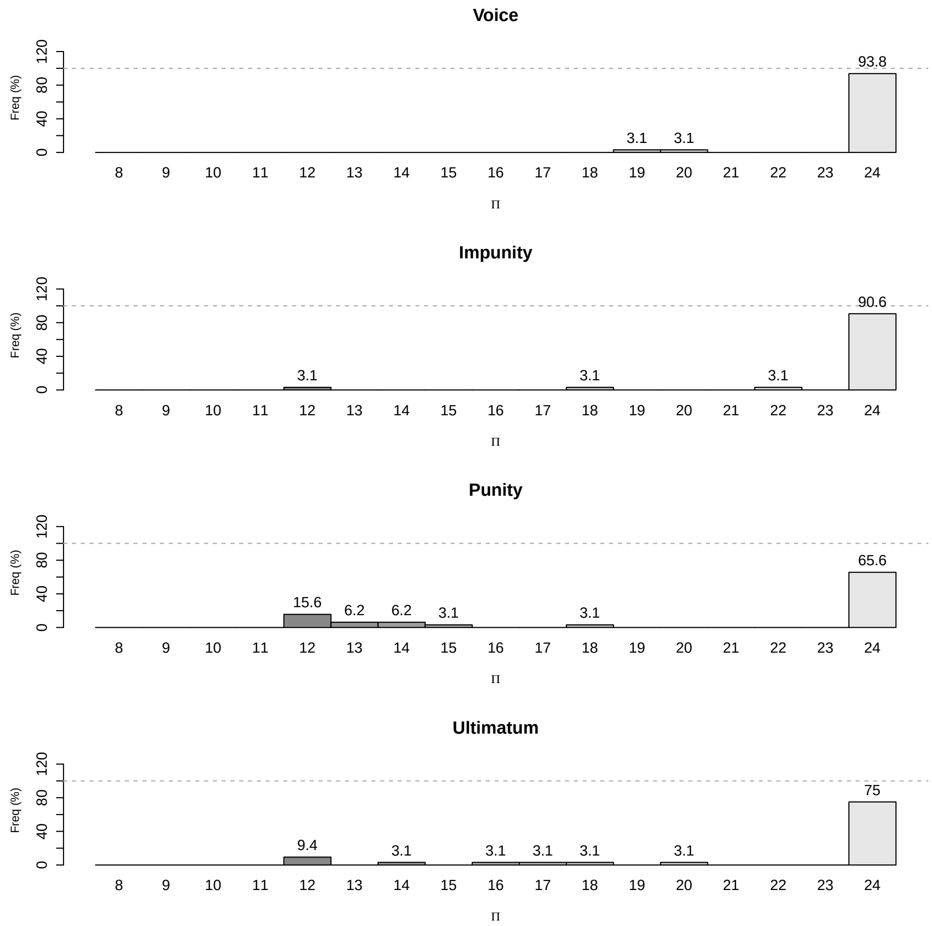

Figure 2: Choices of Players X

6 Tables

Table 1: Average Π depending on order of game type

Game type	First	Second
V	23.438	24.000
I	22.875	23.875
P	20.438	20.250
U	21.438	22.125

Table 2: Average rejection rate (%) depending on order of game type

Game type	First	Second
V	30.5	33.8
I	9.2	0.0
P	36.4	30.5
U	11.0	14.7

Table 3: Choices of Player Y (Generalized linear mixed model)

	Coeff (Std. Err.)		
Rejection∼	$\Pi \in \{8, \ldots 12\}$	$\Pi \in \{13, \ldots 18\}$	$\Pi \in \{19, \ldots 24\}$
(Intercept)	0.531 (8.398)	-0.634 (6.489)	1.325 (9.450)
Self harming	-3.883 (1.278)**	-6.093 (2.150)**	-1.306 (3.426)
Other harming	-4.250 (2.269)°	-6.037 (2.246)**	-4.208 (3.994)
Pie size	-0.217 (0.222)	0.088 (0.141)	-0.051 (0.155)
Self harming×*Pie size*	-0.142 (0.399)	0.194 (0.232)	-0.267 (0.242)
Other harming×*Pie size*	0.441 (0.351)	0.668 (0.199)***	0.509 (0.240)*
Age	-0.124 (0.328)	-0.092 (0.248)	-0.186 (3.527)
Econ	-1.762 (2.955)	-4.963 (3.885)	-1.881 (3.527)
Female	-1.459 (1.821)	-0.140 (1.358)	0.258 (1.852)
Obs (Subj)	640 (64)	768 (64)	768 (64)
Prob > chi2	< 0.001	< 0.001	< 0.001

***(0.1%);** (1%); *(5%); °(10%) significance level

Table 4: Agreements

	Game type			
	V	*I*	*P*	*U*
Actually accepted Π (%)	68.7	96.9	56.2	71.9
Y's average earnings	6.000	5.812	6.000	4.312
X's average earnings	17.719	17.375	7.188	10.969
Loss of social welfare (%)	1.2	3.4	45.1	36.3

A Instructions (Translation)

Experimental Instructions (General)

[Note: Same for all game types]

Thank you for taking part in this experiment. You receive €2.50 for showing up on time. In addition, a certain amount of money will be paid as a result of the decisions made in the experiment. During the experiment, you are not allowed to talk to other participants. Whenever you have a question, please raise your hand and an experimenter will come to answer your question. Please remain silent and switch off your mobile phone. If you violate these rules, we will have to exclude you from the experiment and all payments. To simplify the reading of the instructions we are going to use the masculine grammatical gender. However, the instructions are to be interpreted as gender neutral.

The experiment is composed of two parts. You receive instructions for the second part only at the end of the first part. In each part you can earn an amount of Euros. However, only one part is going to be randomly selected for the actual payment. You will know which part has been selected for payment only after the experiment. Your final payoff will be paid privately in cash after the experiment.

In this experiment, two participants will interact. The two members of a pair will be randomly assigned to one of two roles: X or Y. Your role is the same in the two parts. Your identity will not be revealed to any other participant. You are informed of the choices of the other in part 1 only at the end of part 2. The other is informed of your choices in part 1 only at the end of part 2.

Experimental Instructions (Round)

Choices

[Note: same for all game types]

Each pair can share a positive amount of Euros. In the following, we shall refer to the monetary amount which X and Y can share as the "pie" and denote it by p. The size of the pie can be between €8 and €24, in steps of €1.

Each X-participant in the pair chooses the size of the pie (p). What Y can get from p is fixed whereas X is the residual claimant. More specifically, the Y-participant can receive the fixed amount €6, while X receives the residual (€$p - 6$).

X-participants choose the size of the pie by selecting the amount in the following table

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	

The Y-participant in the pair can decide whether to accept or reject the choice by the participant X. The participant Y makes her choice for all possible offers before knowing the actual choice made by participant X. Thus, the Y-participant has to fill in the following table:

	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
ACCEPT	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
REJECT	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

An accept or reject choice must be expressed for any potential offer by clicking the corresponding cell. For each column, one cell only must be chosen.

Payoffs

After X-participant and Y-participant made their choices, the payoffs are computed by matching the choice of the X-participant with the corresponding choice of Y-participant. Participants are informed about the choice made by the other at the end of the experiment (when the second part is over).

[Note: this is the version for game type V. Other game types are obtained by changing the instructions accordingly.]

When the Y-participant accepts the choice p of the X-participant, the payoffs are as follows: the X-participant gets €$p-6$, the Y-participants gets €6.

When the Y-participants rejects the choice p of the X-participant, the payoffs are as follows: the X-participant gets €$p-6$, the Y-participant gets €6. Thus, although X will learn that Y has rejected, the rejection by Y has no monetary consequences.

The following table provides a summary of the earnings for each possible choice made by X- and Y- participants.

X chooses	Y accepts		Y rejects	
p	X earns	Y earns	X earns	Y earns
8	2	6	2	6
9	3	6	3	6
10	4	6	4	6
11	5	6	5	6
12	6	6	6	6
13	7	6	7	6
14	8	6	8	6
15	9	6	9	6
16	10	6	10	6
17	11	6	11	6
18	12	6	12	6
19	13	6	13	6
20	14	6	14	6
21	15	6	15	6
22	16	6	16	6
23	17	6	17	6
24	18	6	18	6

B Derivation of Behavioral Predictions

To guide our intuition about behavior in the envy game, we consider a version of Charness and Rabin (2002)'s model of distributional preferences. For Player Y, the "social utility" has the following functional form

$$U_Y(\pi_x, \pi_y) = \begin{cases} (1-\rho)\pi_y + \rho\pi_x & if \;\; \pi_y \geq \pi_x \\ (1-\sigma)\pi_y + \sigma\pi_x & if \;\; \pi_y < \pi_x \end{cases}$$

where ρ, σ are coefficients capturing concerns for other's welfare; π_X and π_Y are the monetary payoffs of the two players.

A general assumption is that the subjects have monotonic preferences so that $\frac{\partial}{\partial \pi_y} U_Y(\cdot) > 0$. This is obtained by assuming $\rho,\ \sigma < 1$. In addition to this, alternative restrictions can be imposed on the parameters ρ and σ to capture different preference structures. Here we consider four alternative social preference types to predict behavior in alternative versions of the Envy Game:

- **Selfish** ($\sigma = \rho = 0$): the utility of a selfish player is strictly increasing in her own payoff and independent of the payoff of the other.
  - Impunity: $\delta(\Pi) = 1\ \forall\ \Pi$
  - Punity: $(\delta(\Pi) = 1|\delta(\Pi) = 0)\ \forall\ \Pi$
  - Ultimatum: $\delta(\Pi) = 1\ \forall\ \Pi$
- **Difference-averse** ($\sigma < 0 < \rho < 1$): the utility of a difference-averse player is decreasing (increasing) in her (other's) payoff when she is better off than the other; the utility is increasing (decreasing) in her (other's) payoff when she is worse off than the other.
  - Impunity: For $\Pi \leq 2\kappa$, the acceptance condition is $(1-\rho)\pi_y + \rho\pi_x > \sigma\pi_x$. This is always true given that $(1-\rho) > 0$ and $\rho > \sigma$. For $\Pi > 2\kappa$, the condition of acceptance is given by $(1-\sigma)\pi_y + \sigma\pi_x > \sigma\pi_x$. This implies that $(1-\sigma)\pi_y > 0$, a condition that is always met given that $\sigma < 0$. Thus, $\delta(\Pi) = 1\ \forall\ \Pi$.
  - Punity: For $\Pi \leq 2\kappa$, the acceptance condition $(1-\rho)\pi_y + \rho\pi_x > (1-\rho)\pi_y$ is always fulfilled as $\rho > 0$. For $\Pi > 2\kappa$, a choice of Π is accepted as long as $(1-\sigma)\pi_y + \sigma\pi_x > (1-\rho)\pi_y$. From this one obtains that $\pi_x < \pi_y + \pi_y\big(\frac{\rho}{-\sigma}\big)$ since $\sigma < 0$. Given that $\pi_x = \Pi - \kappa$, the condition, in terms of Π and of Y's payoff, is $\Pi < 2\kappa + \kappa\big(\frac{\rho}{-\sigma}\big)$. Thus, the stronger the envy, as measured by $|\sigma|$, the lower the rejection threshold of Π. In contrast, a stronger sense of guilt, as measured by ρ, induces a higher rejection threshold. For this game type, the highest Π accepted is defined by the interaction between ρ and σ. However, when envy is stronger than guilt, as it is assumed by other social preference models (e.g., Fehr and Schmidt, 1999), all $\Pi > 3\kappa$ are going to be rejected, independently of the values of ρ and σ.
  - Ultimatum: For $\Pi \leq 2\kappa$, a Π is accepted if $(1-\rho)\pi_y + \rho\pi_x > 0$. Given that $0 < \rho < 1$, any $\Pi \leq 2\kappa$ is going to be accepted. For $\Pi > 2\kappa$, the acceptance conditions is $(1-\sigma)\pi_y + \sigma\pi_x > 0$. In terms of Π the condition can be stated as $\Pi < 2\kappa + \kappa\big(\frac{1}{-\sigma}\big)$. Whether Π is

accepted or rejected depends only on envy: with our parameters, for $\sigma < -6$ all $\Pi > 2\kappa$ are rejected, while for $-1/2 < \sigma < 0$ all $\Pi > 2\kappa$ are accepted.

- **Welfare-enhancing** ($1 \geq \rho \geq \sigma > 0$): for a player inclined to enhance welfare, a higher payoff for herself (reasonably imposing that $1 > \rho > 0$) or for the other are always desirable because of $\sigma > 0$.
  - *I*mpunity: For $\Pi \leq 2\kappa$, the acceptance condition $(1-\rho)\pi_y + \rho(\pi_x) > \sigma\pi_x$ is always fulfilled as long as $1 > \rho > 0$ and $\rho \geq \sigma$. Similarly, for $\Pi > 2\kappa$, the acceptance condition $(1-\sigma)\pi_y + \sigma(\pi_x) > \sigma(\pi_x)$ is always fulfilled as long as $1 > \sigma > 0$. Thus, $\delta(\Pi) = 1 \ \forall \ \Pi$.
  - *P*unity: For $\Pi \leq 2\kappa$, the acceptance condition $(1-\rho)\pi_y + \rho\pi_x > (1-\rho)\pi_y$ is always fulfilled as $\rho > 0$. Similarly, for $\Pi > 2\kappa$, the acceptance condition $(1-\sigma)\pi_y + \sigma\pi_x > (1-\rho)\pi_y$ is always fulfilled as $\sigma > 0$ and $\rho \geq \sigma$. Thus, $\delta(\Pi) = 1 \ \forall \ \Pi$.
  - *U*ltimatum: For $\Pi \leq 2\kappa$, the acceptance condition $(1-\rho)\pi_y + \rho\pi_x > 0$ is always fulfilled as long as $1 > \rho > 0$. Similarly, for $\Pi > 2\kappa$, the acceptance condition $(1-\sigma)\pi_y + \sigma\pi_x > 0$ is always fulfilled as long as $1 > \sigma > 0$. Thus, $\delta(\Pi) = 1 \ \forall \ \Pi$.
- **Competitive** ($\sigma \leq \rho \leq 0$): the utility of a player with competitive preferences decreases when the payoff of the other increases and increases when her payoff increases.
  - *I*mpunity: For $\Pi \leq 2\kappa$, the acceptance condition $(1-\rho)\pi_y + \rho\pi_x > \sigma\pi_x$ is always fulfilled given the restrictions on ρ and σ. Similarly, for $\Pi > 2\kappa$, the acceptance condition $(1-\sigma)\pi_y + \sigma\pi_x > \sigma\pi_x$ is always fulfilled as long as $\sigma \leq 0$. Thus, $\delta(\Pi) = 1 \ \forall \ \Pi$.
  - *P*unity: For $\Pi \leq 2\kappa$, the acceptance condition $(1-\rho)\pi_y + \rho\pi_x > (1-\rho)\pi_y$ is never fulfilled as $\rho \leq 0$. For $\Pi > 2\kappa$, the acceptance condition $(1-\sigma)\pi_y + \sigma\pi_x > (1-\rho)\pi_y$ implies that a Π is accepted if $\Pi < 2\kappa + \kappa\left(\frac{\rho}{-\sigma}\right)$. Given that $\rho, \sigma < 0$, the condition is never satisfied for $\Pi > 2\kappa$.
  - *U*ltimatum: For $\Pi \leq 2\kappa$, the acceptance condition is $(1-\rho)\pi_y + \rho\pi_x > 0$. In terms of Π and assuming $\rho < 0$, the condition can be stated as $\Pi < 2\pi_y + \pi_y\left(\frac{1}{-\rho}\right)$. The rejection threshold is always bigger than 2κ and, thus, any $\Pi \leq 2\kappa$ is accepted. For $\Pi > 2\kappa$, the acceptance conditions is $(1-\sigma)\pi_y + \sigma(\pi_x) > 0$. In terms of Π and assuming $\sigma < 0$, the condition can be stated as $\Pi < 2\kappa + \kappa\left(\frac{1}{-\sigma}\right)$. Thus, for $\Pi > 2\kappa$, the acceptance of a choice depends upon the strength of envy.

Concerning Player X, the allocational preferences considered here predict the choice of $\Pi = \overline{\Pi}$ for any game type. This is obtained from the fact that $0 < \rho < 1$ (in our game this seems a reasonable assumption also for someone with welfare enhancing preferences). Thus, a Player X has always a positive marginal incentive in increasing her residual claim.

Table 5: Behavioral Predictions for Player Y (Summary)

Game type	Prediction	Π Interval
	Selfish	
I	$\delta(\Pi) = 1$	Π
P	$\delta(\Pi) = \{0, 1\}$	Π
U	$\delta(\Pi) = 1$	Π
	Difference-averse	
I	$\delta(\Pi) = 1$	Π
P	$\delta(\Pi) = 1$	$\Pi \leq 2\kappa$
	$\delta(\Pi) = F\Big(\Pi < 2\pi_y + \pi_y\big(\frac{\rho}{-\sigma}\big)\Big)$	$\Pi > 2\kappa$
U	$\delta(\Pi) = 1$	$\Pi \leq 2\kappa$
	$\delta(\Pi) = F\Big(\Pi < 2\pi_y + \pi_y\big(\frac{1}{-\sigma}\big)\Big)$	$\Pi > 2\kappa$
	Welfare-enhancing	
I	$\delta(\Pi) = 1$	Π
P	$\delta(\Pi) = 1$	Π
U	$\delta(\Pi) = 1$	Π
	Competitive	
I	$\delta(\Pi) = 1$	Π
P	$\delta(\Pi) = 0$	Π
U	$\delta(\Pi) = 1$	$\Pi \leq 2\kappa$
	$\delta(\Pi) = F\Big(\Pi < 2\pi_y + \pi_y\big(\frac{1}{-\sigma}\big)\Big)$	$\Pi > 2\kappa$

Note: $F(\cdot) = 1$ if the condition $(\cdot)$ is fulfilled, otherwise $F(\cdot) = 0$.