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An ultimatum game with multidimensional response strategies

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Abstract

We enrich the choice task of responders in ultimatum games by allowing them to independently decide whether to collect what is offered to them and whether to destroy what the proposer demanded. Such a multidimensional response format intends to cast further light on the motives guiding responder behavior. Using a conservative and stringent approach to type classification, we find that the overwhelming majority of responder participants choose consistently with outcome-based preference models. There are, however, few responders that destroy the proposer's demand of a large pie share and concurrently reject their own offer, thereby suggesting a strong concern for integrity.

Keywords: Ultimatum; Social preferences; Incomplete information; Experiments

JEL Classification: C72; C91; D63; D74

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1. Introduction

Previous research has shown that, contrary to self-interested monetary payoff-maximizing behavior, many responders in the standard ultimatum game (UG) are unwilling to accept positive, but meager and "unfair" offers (for surveys see Roth, 1995; Camerer, 2003; Güth and Kocker, 2014). Extensive work has been devoted in the last thirty years to understand the motivations behind the responders' deviation from self-interested behavior. The reasons that have been put forward include (i) negative reciprocity (Gintis, 2000; Bowles and Gintis, 2004; Cox and Deck, 2005), (ii) equality concerns (Loewenstein et al., 1989; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000), (iii) spite or envy (Kirchsteiger, 1994; Levine, 1998) (iv) wounded pride (Straub and Murnighan, 1995; Yamagishi et al., 2012), (v) anger or disapproval (Sanfey et al., 2003; Xiao and Houser, 2005).

Several variants of the standard UG have been studied in order to discriminate among these reasons. In these variants, the decision of the responder can be either only self-damaging—like in the impunity game (e.g., Bolton and Zwick, 1995; Yamagishi et al., 2009; Yamagishi et al., 2012) or only other-damaging—like in the punity game (e.g., Güth and Huck, 1997; Huck, 1999; Casal et al., 2012).[1] Thus, in both types of games, a responder who wants to convey his disapproval for the offer made by the proposer has a single action at his disposal: either rejecting his own money or destroying the proposer's money. What will the responder do if he is allowed to perform both actions simultaneously and independently the one from the other? The new format of the UG proposed here separates the responder's decision concerning his own allocation from his decision concerning the proposer's allocation.[2]

In the new UG, there are two players: a proposer and a responder. The proposer suggests a division of an amount of money (the 'pie'), and the responder makes two decisions: he decides whether or not to collect the money allocated to him, *and* whether or not to sanction the proposer by destroying the money that he demanded for himself. Only if the responder

[1] The punity game has been called "spite game" by Huck (1999) and "envy game" by Casal et al. (2012). A further variant of the UG is the dictator game, which is actually a one person decision task granting the responder no veto power at all.

[2] Multidimensional choice data facilitate the inference of motives from observed choices as posited by the "revealed preference" approach (for a more thorough discussion of this issue see Güth and Kocher, 2014).

accepts the offer and does not destroy the proposer's demand, the money is divided as suggested. If the responder rejects the offer and destroys the proposer's demand, neither player receives any money. If the responder accepts the offer made to him but destroys what the proposer demanded for himself, the responder gets the offered money and the proposer earns nothing (the responder does not damage himself, just the other). If the responder rejects his share of the pie but does not destroy the proposer's demand, the responder earns nothing and the proposer obtains what he demanded (the responder does not damage the other, just himself). The binary parallel responses of the standard UG are still feasible options, but are complemented by two asymmetric ways of expressing disapproval for a meager, though positive, offer. Will the responder adopt a costly action for himself if he can express his disapproval via destroying the proposer's demand?

Clearly, a selfish payoff-maximizing responder should never reject a positive offer, and he should be indifferent between destroying and not destroying the proposer's demand. All outcome-based models—that focus on distributional concerns—make the same prediction as the self-regarding preferences model concerning the rejection of the own offer,[3] but yield different predictions concerning the destruction of the proposer's demand. Specifically, an inequity averse responder may destroy what the proposer demanded depending on his distaste for inequality. An envious and spiteful responder, who enjoys reducing the other's payoff, should destroy whatever the proposer wants to keep for himself. An efficiency-minded or altruist responder should tolerate a proposer's self-serving behavior since the non-destruction decision increases the payoff sum. Even though all the above models predict that the responder should never "burn" his own money, psychological variables may lead the responder to walk away from it if, by this means, he can convey his anger and/or keep his moral integrity intact (for views consistent with this conjecture see, e.g., Xiao and Houser, 2005; Yamagishi et al., 2009; Yamagishi et al., 2012).

Letting responders in the new format of the UG game make two independent and separate decisions, and comparing these decisions with those taken

[3] Extreme inequity aversion can, of course, justify rejecting over-generous offers (in the limit a responder may just accept the equal split). We assume that there is no such extreme preference.

by responders who can either only damage themselves (impunity game) or only damage the proposer (punity game) allows us to better understand the motives guiding responder behavior.

To make complete strategies observable and, thus, to gain a deeper insight into the motives underlying the responders' choices, we implement a random pie size and rely on the strategy method (Selten, 1967). This means that both proposers and responders have to submit complete strategies for the game before the pie is randomly selected and revealed to proposers with probability 1 (i.e., with certainty) and to responders with a very small probability. Earlier experiments investigating standard UGs with incomplete information have observed that responders reject offers more frequently when there is no doubt that the offer is unfair, while they avoid punishing a proposer who might have made a fair offer (see, e.g., Mitzkewitz and Nagel, 1993; Güth et al., 1996; Rapoport and Sundali, 1996; Güth and Huck, 1997; Huck, 1999). In the spirit of Hoppe and Schmitz (2013), we allow the responder to gather information about the pie size at a small positive cost. Selfish responders should never invest into information; neither should do spiteful and efficiency-minded responders. Only equity concerns and mere curiosity justify gathering costly information. To test whether curiosity is an important drive for investing in information (as suggested by, e.g., Litman, 2005, or Di Nocera et al., 2014), we also run the dictator game where the responder is a recipient deciding only on whether to gather costly information or not.

Section 2 describes the rules of the new UG, and Section 3 offers some behavioral predictions. After describing the experimental set-up in more detail in Section 4, the experimental data are presented and discussed in Section 5. The final Section 6 concludes with a summary of the most important findings.

2. The multidimensional response format

To avoid any misunderstanding we summarize the rules of the new UG. Let X denote the proposer and Y the responder. The monetary pie Π can be either large, Π_L, or small, Π_S, each with probability 1/2. While the two potential values of Π and their prior probabilities are commonly known, only proposer X learns the actual pie size. Responder Y has a small probability

$\underline{p}$ of being informed about Π; with complementary probability $\overline{p}$ $(= 1 - \underline{p})$ responder Y is not informed about Π, where $\overline{p} > \underline{p}$. The extensive form of the game consists of the following five decision stages:

1. Nature chooses the size of the pie Π with probability $\frac{1}{2}$ for $\Pi = \Pi_L$ and $\frac{1}{2}$ for $\Pi = \Pi_S$, where $\Pi_L > \Pi_S > 0$.

2. Knowing $\Pi \in \{\Pi_L, \Pi_S\}$ proposer X makes an offer y (> 0) to Y, thereby demanding $\Pi - y$ for himself. The possible offers are restricted to the set $(0, \Pi_S)$, so that they cannot reveal the pie size.

3. Knowing y and having a small chance $\underline{p}$ of being informed about Π, responder Y decides whether to invest in information or not. If Y invests, he increases the probability of knowing Π from $\underline{p}$ to $\overline{p}$. We impose $0 < \underline{p} < \overline{p} < 1$ so that even if Y decides to better inform himself about Π, he cannot be sure to learn it. Information is costly: if Y invests and learns the pie size, he has to pay a small cost c.

4. Nature determines whether Y is informed about Π or not according to the probabilities implied by Y's investment decision.

5. Being informed of Nature's move, and thus either knowing Π if so determined or not knowing Π, responder Y makes two choices:
   (i) he can accept or reject the offer y by choosing $\delta(y) \in \{0, 1\}$, where $\delta(y) = 0$ means rejection and $\delta(y) = 1$ means acceptance;
   (ii) he can destroy or not destroy the residual $\Pi - y$ that X demands for himself by choosing $\rho(y) \in \{0, 1\}$, where $\rho(y) = 0$ means destruction and $\rho(y) = 1$ means non-destruction.

Hence, the new UG separates the usual acceptance decision of the responder into two components: what to do with y, and what to do with $\Pi - y$.

The monetary payoffs of X and Y are, respectively:

$$\pi_X = \rho(y) \cdot (\Pi - y) \qquad \text{and} \qquad \pi_Y = \delta(y) \cdot y - c \cdot \mathbb{1}$$

where $\mathbb{1}$ is an indicator taking on the value 1 if Y invests in information and actually learns the pie size, 0 otherwise.

3. Behavioral predictions for the responder

Let $u_Y(\pi_Y, \pi_X)$ denote responder Y's utility function, which we assume to depend on Y's own and X's monetary payoffs, and to be (at least locally) differentiable. We derive behavioral predictions for the following outcome-based preferences: selfishness (SEL), inequity aversion (IA), spitefulness (SPITE), altruism (ALTR), and efficiency (or welfare maximization) (EFF).

3.1 *Acceptance/rejection decision*

All the preference types that we consider assume that Y's utility increases with his own payoff, i.e., they assume $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_Y} > 0$. Hence, the responder is better off by choosing $\delta(y) = 1$ instead of $\delta(y) = 0$ whatever the pie size and independently of the ρ-decision (i.e., destruction or non-destruction).[4]

If a responder opts for $\delta(y) = 0$, therefore walking away from his own money, this reflects a motive different from the previously discussed ones. For instance, such self-damaging choice may be caused by anger or by a desire to keep moral integrity intact.

3.2 *Destruction/non-destruction decision*

Turning to the choice of $\rho(y)$, i.e., of whether to destroy the money of the proposer or not, different preference models yield different predictions.

SEL types do not care about π_X, i.e., $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_X} = 0$. Thus, they are indifferent between destruction and non-destruction of $\Pi - y$.

ALTR and EFF types are concerned for the welfare of the other, meaning that for them $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_X} > 0$ holds true. These types should never destroy X's money: they prefer $\rho(y) = 1$ over $\rho(y) = 0$ both when informed and when uninformed about Π.

SPITE types, with $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_X} < 0$, should destroy X's money both when informed and when uninformed about the pie size.

For IA types, predictions depend on how much they dislike inequality. IA preferences are such that $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_X} > 0$ in case of advantageous inequality (i.e., if $\pi_X < \pi_Y$), and $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_X} < 0$ in case of disadvantageous inequality (i.e., if $\pi_X > \pi_Y$). Hence, assuming that an IA responder optimally accepts

[4] We assume that inequity aversion is not so dominant as to induce a responder to burn his own money in the case of an extremely favorable offer $y > \Pi - y$.

a given y when he is informed about the pie size, he should destroy the proposer's money iff

$$u_Y(y - c \cdot \mathbb{1}, 0) > u_Y(y - c \cdot \mathbb{1}, \Pi - y)$$

where $\Pi \in \{\Pi_L, \Pi_S\}$. Based on this condition, we can make three predictions regarding the destruction decisions of this type of responder in case he knows Π:

(i) if the offer y (minus the potential investment cost c) exceeds half of the pie, an IA responder should not destroy what X demands for himself;

(ii) if, for a given y, an IA responder destroys $\Pi - y$ when knowing that $\Pi = \Pi_S$, then he should destroy it also when knowing that $\Pi = \Pi_L$ because $u_Y(y - c \cdot \mathbb{1}, 0) > u_Y(y - c \cdot \mathbb{1}, \Pi_S - y)$ implies $u_Y(y - c \cdot \mathbb{1}, 0) > u_Y(y - c \cdot \mathbb{1}, \Pi_L - y)$;

(iii) if, for a given y, an IA responder does not destroy the money when knowing that $\Pi = \Pi_L$, he should not do so when knowing that $\Pi = \Pi_S$. Indeed, if $y - c \cdot \mathbb{1} < \Pi_S - y$, then $u_Y(y - c \cdot \mathbb{1}, 0) < u_Y(y - c \cdot \mathbb{1}, \Pi_L - y)$ implies $u_Y(y - c \cdot \mathbb{1}, 0) < u_Y(y - c \cdot \mathbb{1}, \Pi_S - y)$; otherwise (i.e., if $y - c \cdot \mathbb{1} > \Pi_S - y$) prediction (i) applies and the IA responder should never destroy X's demand.

Compared to the other types, the IA type can make different optimal destruction choices depending on whether $\Pi = \Pi_S$ or $\Pi = \Pi_L$. This is crucial when considering what an IA responder should do with $\Pi - y$ when he does not know Π. In such a case, given y, this type of responder compares his utility from destroying $\Pi - y$ with the expected utility from not destroying $\Pi - y$, and opts for destruction iff

$$\begin{aligned} u_Y(y - c \cdot \mathbb{1}, 0) \quad > \quad & p(\Pi_L|y) u_Y(y - c \cdot \mathbb{1}, \Pi_L - y) + \\ & \big(1 - p(\Pi_L|y)\big) u_Y(y - c \cdot \mathbb{1}, \Pi_S - y) \end{aligned} \tag{1}$$

where $p(\Pi_L|y)$ is the updated probability that the pie is large given that the proposer offered y.[5] We can now make three further predictions about an IA responder's destruction decisions in case he does not know Π.

(iv) If the offer y is so low that an IA responder wants to destroy $\Pi - y$

[5] In the standard UG, on the equilibrium path, the posterior probabilities equal the prior ones.

both when $\Pi = \Pi_L$ and when $\Pi = \Pi_S$, that is if $u_Y(y - c \cdot \mathbb{1}, 0) > u_Y(y - c \cdot \mathbb{1}, \Pi_S - y) > u_Y(y - c \cdot \mathbb{1}, \Pi_L - y)$, then inequality (1) is true and this type of responder should destroy even when uninformed about Π.

(v) If the offer y is 'fair' enough to prevent destruction of $\Pi - y$ for both potential values of Π, that is if $u_Y(y-c\cdot\mathbb{1}, \Pi_S - y) > u_Y(y-c\cdot\mathbb{1}, \Pi_L - y) > u_Y(y - c\cdot\mathbb{1}, 0)$, then inequality (1) does not hold and an IA type should not destroy even when uninformed about Π.

(vi) If the offer y is such that an IA responder prefers not to destroy $\Pi - y$ when $\Pi = \Pi_S$ and to destroy it when $\Pi = \Pi_L$, that is if $u_Y(y - c \cdot \mathbb{1}, \Pi_S - y) > u_Y(y - c\cdot\mathbb{1}, 0) > u_Y(y - c\cdot\mathbb{1}, \Pi_L - y)$, then an IA responder should choose the action with the highest expected utility.

Because we use the strategy method, we observe a sequence of destruction decisions for each responder and are thus able to detect whether behavior agrees with these predictions or not.

3.3 *Decision to gather costly information about* Π

SEL, SPITE, ALTR, and EFF types should never be willing to invest in information.[6] Predictions about the investment decision of the IA type are more complex and different cases must be worked out. In a nutshell, an IA responder should invest in information only when his destruction decisions depend on the size of the pie, in the sense that he prefers to destroy $\Pi - y$ for $\Pi = \Pi_L$ and not to do so for $\Pi = \Pi_S$.

Notwithstanding these predictions, there exists factors that may induce the responder to gather costly information about the pie size. One of such factors is curiosity that, for instance, helps to dispel uncertainty which may be perceived as unpleasant (see, e.g., Litman, 2005; Di Nocera et al., 2014).

4. The experimental design

4.1 *The implemented games*

We experimentally implement four different games. In all games, it is commonly known that X has to propose an offer y to Y, and that Y's initial decision is whether or not to gather costly information, thereby increasing

[6] For details about the predictions in this subsection we refer the reader to Appendix A.

the chances of learning the pie size. The games vary in the decision power of responder Y.

- In the new UG (explained in Section 2), responder Y chooses both $\delta(y) \in \{0,1\}$ and $\rho(y) \in \{0,1\}$, i.e., whether he collects y or not as well as whether he destroys $\Pi - y$ or not. This game thus elicits multi-dimensional choice data from responder participants.
- The punity game (PG) presupposes $\delta(y) = 1$ and restricts Y to choosing between $\rho(y) = 0$ (i.e., destruction of $\Pi - y$) and $\rho(y) = 1$ (i.e., non-destruction of $\Pi - y$). Therefore, X's and Y's payoffs are $\pi_X = \rho(y) \cdot (\Pi - y)$ and $\pi_Y = y - c \cdot \mathbb{1}$, respectively. The responder is forced to collect what X offered to him and decides whether to harm X or not.
- The impunity game (IG) presupposes $\rho(y) = 1$ so that Y only chooses between $\delta(y) = 0$ (i.e., acceptance of y) and $\delta(y) = 1$ (i.e., rejection of y). The payoff of X is $\pi_X = \Pi - y$, and the payoff of Y is $\pi_Y = \delta(y) \cdot y - c \cdot \mathbb{1}$. While X earns what he demanded for himself, Y may not accept offer y.
- Finally, imposing $\delta(y) = \rho(y) = 1$, the game becomes a dictator game (DG) where Y can only choose whether he wants to invest in costly information or not. DG allows us to capture pure curiosity.

The predictions about the responders' behavior—developed in Section 3 for new UG—apply also to IG (as to $\delta(y)$) and to PG (as to $\rho(y)$). Hence, the identified responder types should not behave differently across games. Yet, differences between games may be detected if motives other than those mentioned above guide behavior. Specifically, if negative emotions (such as anger or disapproval) induce responders to reject unfair offers in order to punish proposers, then responders may be less likely to choose a costly action for themselves when they can convey their feelings in less harmful ways. In a standard UG, Xiao and Houser (2005) observed that unfair offers are accepted significantly more often if responders can send a message to the proposer concurrently with their decisions. It follows that acceptance rates may be higher in new UG than in IG because, in the former game, responders can express their disapproval by destroying the proposer's money, without having to harm themselves.

It has been claimed that the rejection of small ultimatum offers is motivated by the desire to preserve integrity and to commit to a certain behavior (see, e.g., Yamagishi et al., 2009; Yamagishi et al., 2012). Since morality needs to be practiced before being taught, preservation of one's own integrity and protection of one's own reputation may induce responders who destroy the proposer's money in new UG to reject their offer as well. Conversely, in PG, responders must accept any offer and do not face a challenge to their integrity when wiping out the proposer's money. These kinds of moral motivations may engender higher destruction decisions in PG than in new UG.

4.2 *Experimental procedures and parameters*

The experiment was programmed in z-Tree (Fischbacher, 2007) and conducted in the experimental laboratory of the Max Planck Institute of Economics (Jena, Germany). The participants—undergraduate students from the Friedrich-Schiller University of Jena—were recruited using Greiner's (2004) ORSEE software. Upon entering the laboratory, they were randomly assigned to visually isolated computer terminals and received written instructions (reproduced in Appendix B) which were later on read aloud by a research assistant. The experiment started only after each participant had correctly answered a series of control questions and had gone through two practice periods.[7]

Overall, we ran twelve sessions with a total of 378 participants. In each session, half of the participants were randomly assigned to be proposers X and the other half were responders Y. Three sessions were devoted to each one of the games presented in Section 4.1. One PG session involved 28 participants, one IG session 30 participants, and each of the other ten sessions had 32 participants. This yields 48 independent observations for each of the two parties in new UG as well as in DG, and 47 (46) independent observations for each party in IG (PG).

In all four games, the two potential pies Π_L and Π_S amounted to 95 and 55 ECU, respectively (with 5 ECU = €1). For both pie sizes, the offers to Y were restricted to the set $y \in \{5, 25, 45\}$ ECU, so that the equal split was

[7] The practice periods did not involve any interaction. Their sole aim was to familiarize the participants with the situation (no payments were associated with them).

never a viable option.[8] As for the probabilities of informing Y about the pie, we set $\underline{p} = 0.10$, and $\overline{p} = 0.90$. Hence, investing in information increased the chances of learning the pie size by 80 percentage points. The cost that Y had to pay if he invested into information and actually learned the pie size was 3 ECU.

For the sake of gathering more informative data, we elicited response behavior of both X and Y via the strategy method, i.e., both proposers and responders were required to write complete strategies. Thus, proposer X had to choose an offer $y \in \{5, 25, 45\}$ for each of the two possible pies. In all four games, responder Y had first to indicate, for each of the three possible offers, whether he would invest in information or not. Since—regardless of his investment decision—Y might not learn the pie size, his subsequent δ-choices and/or ρ-choices had to be made for each one of the three possible offers, $y = 5$, $y = 25$ and $y = 45$, and each one of the three possible scenarios concerning the pie, namely $\Pi_L = 95, \Pi_S = 55$, and $\Pi = (U)$nknown. Hence, Y had to make 21 choices (three investment decisions, 9 δ-choices, and 9 ρ-choices) in new UG, 12 choices (three investment decisions and 9 ρ-choices) in PG, 12 choices (three investment decisions and 9 δ-choices) in IG, and 3 investment choices in DG.

At the end of each session, it was randomly determined whether the pie was 95 ECU or 55 ECU. For the actual offer y, the program checked whether responder Y invested into information or not, and then determined whether Y had to be informed about the pie or not. Only if the random draw indicated that he had to learn Π, Y was informed about X's payoff. Otherwise, Y just learnt his own payoff. Proposer X always learned his own payoff as well as Y's decisions and payoff.

Each session lasted about 75 minutes. Average earnings (including a €3 show-up fee) were €12.83 and €7.25 for X and Y, respectively.

[8] By this we avoid a natural focal point and can observe the responders' decisions when the offers can never favor them (in the case of $\Pi_L = 95$) and when the offers can favor either them or the proposers (in the case of $\Pi_S = 55$).

Table 1: Average acceptance and destruction rates for each feasible offer and each possible pie scenario by game type.

Acceptance rates–New UG

	$\Pi_S = 55$	$\Pi_L = 95$	$\Pi = U$
$y = 5$	83.33	77.08	79.17
$y = 25$	100.00	95.83	95.83
$y = 45$	100.00	100.00	100.00

Acceptance rates–IG

	$\Pi_S = 55$	$\Pi_L = 95$	$\Pi = U$
$y = 5$	89.36	89.36	89.36
$y = 25$	100.00	97.87	100.00
$y = 45$	100.00	100.00	100.00

Destruction rates–New UG

	$\Pi_S = 55$	$\Pi_L = 95$	$\Pi = U$
$y = 5$	66.67	79.17	70.83
$y = 25$	2.08	47.92	14.58
$y = 45$	4.17	2.08	4.17

Destruction rates–PG

	$\Pi_S = 55$	$\Pi_L = 95$	$\Pi = U$
$y = 5$	69.57	82.61	76.09
$y = 25$	10.87	60.87	32.61
$y = 45$	8.70	13.04	15.22

Note: "$\Pi = U$" stands for the scenario in which the pie is unknown to the responders.

5. Results

5.1 *Responder aggregate behavior*

Table 1 shows the responders' average acceptance rates (two top panels) and destruction rates (two bottom panels) for each possible combination of pie scenarios and offers, separately for each one of the four implemented games. In new UG and IG, virtually all responders accept offers equal to 25 and 45 ECU independently of the pie scenario; the lowest acceptance rate is 95.83% in new UG (46 out of 48 subjects). Acceptance of the 5 ECU-offer is somewhat lower, ranging from 77.08% in new UG when the pie is large (37 out of 48 subjects) to 89.36% in IG whatever the pie scenario (42 out of 47 subjects).

Table 2 reports the results of a random-effect logit model regressing acceptance decisions of the 5 ECU-offer on dummy variables representing the pie scenarios ("Large pie" and "Unknown pie"), the game type ("IG"), and their interactions.[9] The results fail to reject the hypothesis that acceptance rates of the small offer are the same across games and pie scenarios. The only marginally significant effect is a decrease in acceptance rates of the 5 ECU-offer when moving from the small to the large pie in new UG (the

[9] We cannot include dummies for the 25 and the 45 ECU-offers because of the very low variability in the acceptance data.

Table 2: Random-effect logit regression on responder acceptance data (dependent variable: individual acceptance decisions of $y = 5$ ECU; the baseline is new UG when $\Pi = 55$ ECU).

	Coeff.	Std. Err.	z	p-value
(Intercept)	13.753	2.240	6.1394	0.000
Large pie	−3.605	1.893	−1.9042	0.057
Unknown pie	−2.513	1.809	−1.3892	0.165
IG	−2.043	3.554	−0.5750	0.565
Unknown Pie×IG	2.515	3.876	0.6487	0.517
Large Pie×IG	3.607	3.916	0.9211	0.357
$\sigma_c = 23.71(0.107)$				
LR p-value for $H_0 : \sigma_c = 0$: 0.000				
LogLik: -43.1				

coefficient of "Large Pie" is negative and significant at the 10% level). Thus, although we could have expected higher acceptance rates in new UG than in IG—since new UG responders can convey their feelings to the proposer by destroying what he demands, without having to harm themselves—we do not detect significant differences between the two games. The finding of almost no rejection in IG is in line with the results of Bolton and Zwick (1995), but differs markedly from those of Yamagishi et al. (2009) who report nearly 35% rejection rate in IG.

Compared to rejection behavior, destruction behavior shows higher variability (see the two bottom panels of Table 1). Figure 1 permits to better appreciate the effects of pie scenarios and offers on the decisions to destroy $\Pi - y$ in new UG and PG. The labels on the horizontal axis have to be read as follows: the first letter indicates the pie scenario ('S' for small pie, 'U' for unknown pie, and 'L' for large pie); the following number denotes the offer to Y (5, 25, and 45 ECU). The three leftmost data points, for example, refer to the average destruction rates of the proposer's demand in each of the three pie scenarios when $y = 5$ ECU.

Three observations seem worth mentioning. First, with one exception (small pie in new UG when the offer goes from 25 to 45 ECU), average destruction rates generally decrease with increasing offers for any pie scenario

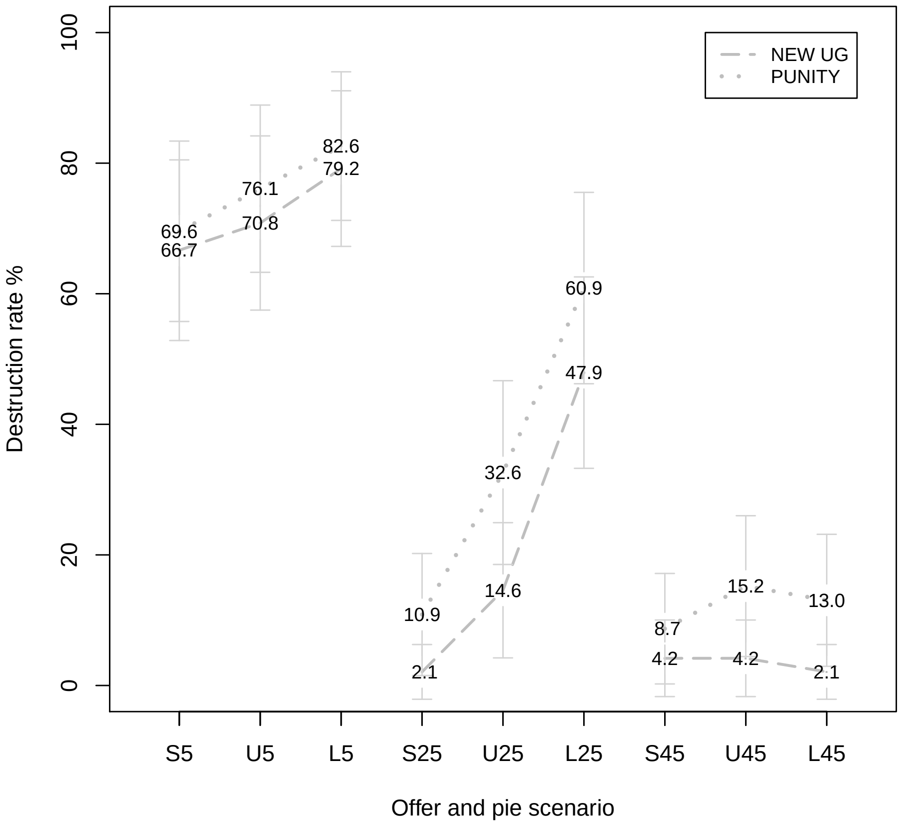

Figure 1: Average destruction rates by pie scenario and offer in new UG and PG. (Legend for the labels on the x-axis: "S5" small pie and $y = 5$; "U5" unknown pie and $y = 5$; "L5" large pie and $y = 5$; "S25" small pie and $y = 25$; "U25" unknown pie and $y = 25$; "L25" large pie and $y = 25$; "S45" small pie and $y = 45$; "U45" unknown pie and $y = 45$; "L45" large pie and $y = 45$.)

in both games. Secondly, while destruction rates when y equals 45 ECU (three rightmost data points in Figure 1) are on average similar across pie scenarios for both new UG and PG, destruction rates when y equals 5 and 25 ECU (three leftmost and three middle data points, respectively) are sensitive to the pie scenario: responders tend to destroy $\Pi - 5$ and $\Pi - 25$ less often when they know that $\Pi = 55$ ECU than when they know that $\Pi = 95$ ECU. Thirdly, except for the 45 ECU-offer in PG, for any other offer and for both games average destruction rates in the case of unknown pie lie between

Table 3: Random-effect logit regression on responder destruction data (dependent variable: individual destruction decisions of $\Pi - y$; the baseline is new UG when $y = 5$ ECU and $\Pi = 55$ ECU).

	Coeff.	Std. Err.	z	p-value
(Intercept)	0.8664	0.5030	1.7222	0.085
y_{25}	−6.0764	0.6984	−8.7002	0.000
y_{45}	−6.0764	0.6984	−8.7001	0.000
Large pie	1.3875	0.5028	2.7594	0.006
Unknown pie	0.5141	0.4562	1.1269	0.260
PG	1.0465	0.5938	1.7623	0.078
$y_{25}\times$Large pie	3.5343	0.8160	4.3315	0.000
$y_{25}\times$Unknown pie	1.9131	0.7845	2.4387	0.015
$y_{45}\times$Large pie	−1.1230	0.8850	−1.2689	0.204
$y_{45}\times$Unknown pie	0.1878	0.8313	0.2259	0.821
$\sigma_c = 2.564(0.235)$				
LR p-value for $H_0 : \sigma_c = 0$: 0.000				
LogLik: -290.5				

those in the case of small pie and those in the case of large pie.

As to the differences between new UG and PG, Figure 1 makes it apparent that responders are more likely to harm the proposer in PG than in new UG whatever the offer and the pie scenario. The magnitude of the difference, however, is small.

Statistical support for these observations is presented in Table 3, which summarizes the results of a random-effect logit regression. The dependent variable is given by the individual destruction decisions. The baseline condition is new UG when $y = 5$ ECU and the pie is known to be 55 ECU. The explanatory variables are dummies for the feasible offers ("y_{25}" and "y_{45}"), the pie scenarios, and the game type ("PG"). The variables for the pie scenarios and the offers are included separately as main effects and in combination as interaction effects. The estimated model confirms the impression from Table 1 and Figure 1 that, in new UG, destruction rates of X's demand for a small pie are significantly lower when the offer is either 25 or 45 ECU, rather than 5 ECU (the coefficients of "y_{25}" and "y_{45}" are negative and significant). The positive and significant coefficient of "Large pie" implies that

Table 4: Relative (and absolute) frequencies of investment decisions by offer and game type.

y	New UG	PG	IG	DG
5	2.08% (1/48)	0.00% (0/46)	0.00% (0/47)	10.42% (5/48)
25	14.58% (7/48)	17.39% (8/46)	4.26% (2/47)	8.33% (4/48)
45	2.08% (1/48)	8.70% (4/46)	4.26% (2/47)	10.42% (5/48)

new UG responders destroy $\Pi - 5$ ECU significantly more when the pie is large than when it is small. On the other hand, the insignificant coefficient of "Unknown pie" means that no such a difference in destruction rates exists between unknown pie and small pie. There are no significant interaction effects between "y_{45}" and the pie scenarios. Conversely, the coefficients of "$y_{25}\times$Large pie" and "$y_{25}\times$Unknown pie" are positive and significant, corroborating our previous observation that for an offer of 25 ECU responders tend to destroy significantly less the proposer's demanded share when the pie is either large or unknown than when it is small. Finally, the positive, albeit only marginally significant, coefficient of "PG" provides some support for the argument that, compared to responders in new UG, responders in PG may be more willing to destroy what the proposer demanded because such a decision does not eventually require them to reject their own offer in order to preserve their integrity.

Concerning the decision to invest in information, Table 4 reports the percentage (and number) of responders investing in information for each possible offer, separately for each game type. Overall, very few responders invest in information. While the distribution of investment decisions does not vary with the offer in IG and DG, responders in both new UG and PG invest more frequently in information for the 25 ECU-offer than for the other two feasible offers. Whatever the pie size, an offer of 5 (45) ECU may be considered too small (large) to induce investment in information. An offer of 25 ECU, instead, may allow the proposers to pretend fairness (see, e.g., the results by Güth et al., 1996). In the games where unfairness can be punished by destroying the proposer's demanded share of the pie, the responders seem to be more keen to inform themselves about the pie size before harming the proposer. A Fisher exact test confirms that there is a statistically significant difference in investment decisions for the 25 ECU-offer between new UG and

PG on the one hand and IG and DG on the other (p-value = 0.039).

5.2 *Individual acceptance and destruction patterns*

In this section, we analyze individual response strategies in order to check whether they are consistent with the patterns predicted by the preference types discussed in Section 3. According to each of such types, the responders should accept any positive offer. Thus, to verify whether and how often a type is present in our population of new UG responders, we need to look at the destruction patterns of those who always accept the offer (36 out of 48 responder participants).

Table 5 illustrates the observed destruction patterns of these 36 new UG responders and of the 46 PG responders.[10] The nine choices composing each pattern are coded as "1" (non-destruction) or "0" (destruction). The number of observations per pattern in the two games are shown in the columns labeled "New UG" and "PG". The preference type(s) that can justify the corresponding destruction pattern is (are) reported in the last column of the table.

The pattern in the first line of Table 5 (with 1 everywhere) captures universal non-destruction and is consistent with both ALTR/EFF and IA preferences. It is exhibited by 7 (out of 48 or 14.58%) new UG responders and 7 (out of 46 or 15.22%) PG responders. Using a very conservative and stringent criterion, which does not allow for any error, 26 patterns in new UG (54.17%) and 31 patterns in PG (67.39%) can be classified as IA. The most frequent IA pattern (observed 10 times in new UG and 13 times in PG) is: destruction of $\Pi - 5$ for any pie scenario, destruction of $\Pi - 25$ only when $\Pi = 95$ ECU, non-destruction of $\Pi - 45$ for any pie scenario. There is only one pattern consistent with spiteful preferences in each game: the responder participant showing this pattern always destroys what X demanded (see the last line of Table 5).

The investment decisions of the responders classifiable as IA in new UG and PG are in line with this preference type: either IA types do not invest into information or, if they do so, then they condition their destruction decisions on the pie size. Actually, not all 7 (8) new UG (PG) responders

[10] We cannot make any inference about types from the IG acceptance patterns due to the low variability in the data. With five exceptions, we observe $\delta = 1$ for any offer and pie scenario.

Table 5: Responder observed destruction patterns in new UG and PG (new UG data are restricted to Y-participants who always accept).

$y=5$			$y=25$			$y=45$			New UG	PG	Pref. Type
Π_S	Π_U	Π_L	Π_S	Π_U	Π_L	Π_S	Π_U	Π_L			
1	1	1	1	1	1	1	1	1	7	7	ALTR/EFF-IA
1	1	1	1	1	0	0	1	1	1	0	—
1	1	0	1	1	1	1	1	1	5	2	IA
1	1	0	0	1	0	1	0	0	0	1	—
1	0	1	1	0	1	1	0	1	0	1	—
1	0	0	1	1	1	1	1	1	0	1	IA
1	0	0	1	0	1	1	1	1	0	1	—
1	0	0	1	0	0	0	1	1	0	1	—
0	1	1	1	1	1	1	1	1	1	0	—
0	1	0	0	1	0	0	1	0	0	1	—
0	0	0	1	1	1	1	1	1	8	5	IA
0	0	0	1	1	1	1	0	1	0	1	—
0	0	0	1	1	0	1	1	1	10	13	IA
0	0	0	1	0	0	1	1	1	3	7	IA
0	0	0	1	0	0	1	0	0	0	1	IA
0	0	0	1	0	0	0	0	0	0	1	—
0	0	0	0	0	0	1	1	1	0	1	IA
0	0	0	0	0	0	1	0	0	0	1	IA
0	0	0	0	0	0	0	0	0	1	1	SPITE

Note: Π_S, Π_U, and Π_L are the pie scenarios, i.e., 55 ECU, Unknown, and 95 ECU, respectively.
"1" stands for non-destruction, and "0" for destruction.

investing in information for $y = 25$ can be classified to a type because they reject some offers. Yet, 6 of these responders destroy $\Pi - 25$ when $\Pi = 95$ ECU, but not when $\Pi = 55$ ECU. This is line with our conjecture that responders better inform themselves when they are offered 25 ECU in order not to harm a relatively fair proposer (who distributes the small pie).

Let us finally analyze the acceptance and destruction patterns of the 12 new UG responders that do not fall in any of the identified preference types (because they reject some offers). We find that five of these responders (namely 42%) exhibit coherent patterns: whenever they destroy what X demanded, they also reject their own offer. This provides favorable evidence that there exist at least some individuals who value preserving integrity and

Table 6: Absolute distribution of offers by pie size and game type.

	$\mathbf{\Pi_S = 55}$				$\mathbf{\Pi_L = 95}$			
y	newUG	PG	IG	DG	newUG	PG	IG	DG
5	9	7	35	37	7	4	30	27
25	38	39	12	11	13	21	12	14
45	1	0	0	0	28	21	5	7

maintaining self-reputation.

5.3 *Proposer behavior*

Table 6 provides a concise picture of the offers made by X in the four implemented games. It displays the number of proposers offering 5, 25, and 45 ECU, separately for each pie size and game type. Comparing the distributions of the offers across games reveals that proposers behave differently depending on whether they can be harmed by responders or not. As a matter of fact, for both pie sizes, offers in new UG are similar to those in PG, whereas offers in IG resemble those in DG.[11] Additionally, there is a shift in the distribution of offers towards higher values when moving from the small to the large pie. Such a shift is more pronounced in new UG and PG than in IG and DG.

These observations are supported by the results of a random-effect linear regression with individual offers as the dependent variable. Regressors include dummies for the game type and the large pie. The estimates, reported in Table 7, confirm that (i) offers in new UG are not significantly different from those in PG for both pie sizes (the coefficients of "PG" and "Large pie×PG" are not significant), and (ii) offers in IG and DG are significantly smaller than those in new UG irrespectively of the pie size (the coefficient of both "IG" and "DG" is significantly negative, and so is the coefficient of the interaction terms "Large pie×IG" and "Large pie×DG"). Not surprisingly, a Wald test does not reject the joint null hypothesis that offers in new UG and PG are equal (namely "PG = 0" and "Large pie×PG = 0"), nor does it reject the hypothesis that offers in IG and DG are the same (i.e., "IG =

[11] These findings are in line with those of Güth and Huck (1997) and Casal et al. (2012) that also observe differences in offers between games in which the responder can harm the proposer and games where the responder has no such a possibility.

Table 7: Random-effect linear regression on proposer data (dependent variable: individual offers; the baseline is new UG when the pie is small).

	Coeff	Std. Err.	t	p-value
(Intercept)	21.667	1.671	12.969	0.000
Large pie	12.083	1.405	8.602	0.000
PG	0.290	2.388	0.121	0.903
IG	−11.560	2.375	−4.867	0.000
DG	−12.083	2.363	−5.114	0.000
Large pie×PG	−1.649	2.008	−0.821	0.412
Large pie×IG	−7.828	1.997	−3.919	0.000
Large pie×DG	−5.000	1.987	−2.517	0.012
R-Squared: 0.408; F(7,370)=36.411, p-value: 0.000				
Effects:				
	var	Std. Dev	share	
idiosyncratic	47.361	6.882	0.354	
individual	86.602	9.306	0.646	
theta	0.5366			

DG" and "Large pie×IG = Large pie×DG"; $\chi^2(4) = 2.911$, p-value=0.573).

6. Concluding remarks

The multidimensional response format of the ultimatum game (or new UG) has helped us to shed some light, in a straightforward fashion, on the motives guiding responder behavior. Notwithstanding its simplicity and stringency, our approach is able to accommodate the behavioral patterns of a majority of responders. In particular, our results indicate that when given the opportunity to destroy what the proposer demanded, more than half of the responders accept what is offered to them and display individual destruction patterns consistent with inequity aversion preferences.

A comparison between the new UG and the punity game (where responders can only decide whether or not to harm the proposer, and are forced to collect their own offer) reveals fewer destruction decisions in the former than in the latter. This finding suggests that there exist individuals who may be confronted with a moral dilemma when they can damage the other, and concurrently—but independently— themselves. Such a dilemma arises from recognizing that for teaching morality to somebody else, one should follow moral standard himself. In the new UG (but not in the punity game), a responder who wants to preserve integrity and maintain self-reputation must be somewhat willing to sacrifice his own money whenever he destroys what the proposer demanded. The unwillingness to reject his own offer leads this type of responder to not destroy the proposer's demand. Evidence in favor of this conjecture comes from the finding that 42% of the responders who reject their own offer in new UG do so if and only if they concurrently destroy the corresponding share of the pie demanded by the proposer.

A further important result of the experiment reported here is that responders who can better inform themselves about the pie size seldom use this opportunity. Mere curiosity does not seem to be a strong motivation for gathering costly information. Rather, the few responders investing in information appear to be driven by a desire to avoid punishing seemingly fair proposers.

The multidimensional response format of the ultimatum game intends to demonstrate how one can render the revealed preferences—or motives—approach more acceptable, e.g., via experimental designs allowing different choices to indicate specific motives.

Appendices

A Derivation of predictions about investment decisions

Let $\rho_T^*(\Pi)$ denote the responder's optimal destruction decision as a function of the pie size, $\Pi = \{\Pi_L, \Pi_S\}$, when either he invests ($T = I$) or he does not invest ($T = \bar{I}$) in information. Let $\rho^*(U)$ be the responder's optimal destruction decision when the pie is unknown. Finally, recall that $p(\Pi_L|y)$ denotes the probability that the pie is large given that the responders observes the offer y.

Assuming that the responder optimally accepts a given offer y, he decides to invest in information if and only if the expected utility of investing exceeds the expected utility of not investing, i.e., if and only if the following equation holds:

$$\bar{p}v^*(I) + (1 - \bar{p})v^*(U) \geq \underline{p}v^*(\bar{I}) + (1 - \underline{p})v^*(U) \tag{A.1}$$

where

- $v^*(I) = p(\Pi_L|y)u_Y\left(y - c, (\Pi_L - y)\rho_I^*(\Pi_L)\right) + (1 - p(\Pi_L|y))u_Y\left(y - c, (\Pi_S - y)\rho_I^*(\Pi_S)\right)$ denotes the expected utility, with optimal destruction decisions, when the subject invests in information and is informed about the pie size;
- $v^*(\bar{I}) = p(\Pi_L|y)u_Y\left(y, (\Pi_L - y)\rho_{\bar{I}}^*(\Pi_L)\right) + (1 - p(\Pi_L|y))u_Y\left(y, (\Pi_S - y)\rho_{\bar{I}}^*(\Pi_S)\right)$ denotes the expected utility, with optimal destruction decisions, when the subject does not invest in information, but, nevertheless, is informed about the pie size; and
- $v^*(U) = p(\Pi_L|y)u_Y\left(y, (\Pi_L - y)\rho^*(U)\right) + (1 - p(\Pi_L|y))u_Y\left(y, (\Pi_S - y)\rho^*(U)\right)$ denotes the expected utility, with the optimal destruction decision, when the responder is not informed about the pie size.

It is worth noting that the responder can separately optimize the destruction decision for the large and the small pie when informed, but he cannot do so when he remains uninformed. Therefore, $v^*(\bar{I})$ is always greater than $v^*(U)$.

Concerning the SPITE, SEL, ALTR, and EFF types it holds true that $\rho_{\bar{I}}^*(\Pi_L) = \rho_{\bar{I}}^*(\Pi_S) = \rho_I^*(\Pi_L) = \rho_I^*(\Pi_S) = \rho^*(U) = \rho^*$ and hence Equation A.1

reduces to

$$p(\Pi_L|y)\left[u_Y\left(y-c,(\Pi_L-y)\rho^*\right)-u_Y\left(y,(\Pi_L-y)\rho^*\right)\right]+$$
$$(1-p(\Pi_L|y))\left[u_Y\left(y-c,(\Pi_S-y)\rho^*\right)-u_Y\left(y,(\Pi_S-y)\rho^*\right)\right]\geq 0.$$

Since $\frac{\partial u_Y(\pi_Y,\pi_X)}{\partial \pi_Y}>0$, the previous equation never holds true and, consequently, SPITE, SEL, ALTR, and EFF types are never willing to invest in information.

Concerning the IA type, different cases need to be worked out according to the possible combinations of optimal destruction decisions. Specifically, let us discuss the following situations:

- $\rho_I^*(\Pi_S)=0$. In this case the responder destroys the offer when he invests in information and he knows that the pie is small. This implies that he destroys the offer also when the pie is large, i.e., $\rho_I^*(\Pi_L)=0$. Assume that $\rho^*(U)=0$. As a consequence $v^*(I)=p(\Pi_L|y)u_Y\left(y-c,0\right)+(1-p(\Pi_L|y))u_Y\left(y-c,0\right)$ is lower than $v^*(U)=p(\Pi_L|y)u_Y\left(y,0\right)+(1-p(\Pi_L|y))u_Y\left(y,0\right)$, which is equal to $v^*(\bar{I})$. Hence, $\underline{p}v^*(\bar{I})+(1-\underline{p})v^*(U)$ is greater than $\bar{p}v^*(I)+(1-\bar{p})v^*(U)$. On the contrary, now assume that $\rho^*(U)=1$. This implies that $v^*(U)=p(\Pi_L|y)u_Y\left(y,\Pi_L-y\right)+(1-p(\Pi_L|y))u_Y\left(y,\Pi_S-y\right)$ is greater than $v^*(\bar{I})=p(\Pi_L|y)u_Y\left(y,0\right)+(1-p(\Pi_L|y))u_Y\left(y,0\right)$, which, in turn, is greater than $v^*(I)=p(\Pi_L|y)u_Y\left(y-c,0\right)+(1-p(\Pi_L|y))u_Y\left(y-c,0\right)$. Also in this case $\underline{p}v^*(\bar{I})+(1-\underline{p})v^*(U)$ is greater than $\bar{p}v^*(I)+(1-\bar{p})v^*(U)$. Thus, the responder does not invest in information when $\rho_I^*(\Pi_S)=0$.

- $\rho_I^*(\Pi_S)=1$ and $\rho_I^*(\Pi_L)=1$. For the moment, assume that $\rho^*(U)=0$. Then, $v^*(U)=p(\Pi_L|y)u_Y\left(y,0\right)+(1-p(\Pi_L|y))u_Y\left(y,0\right)$ is greater than $v^*(\bar{I})=p(\Pi_L|y)u_Y\left(y,\Pi_L-y)\right)+(1-p(\Pi_L|y))u_Y\left(y,\Pi_S-y\right)$, which, in turn, is greater than $v^*(I)=p(\Pi_L|y)u_Y\left(y-c,\Pi_L-y)\right)+(1-p(\Pi_L|y))\ u_Y\left(y-c,\Pi_S-y\right)$. Hence, any combination of $v^*(U)$ and $v^*(\bar{I})$ is preferred to any combination of $v^*(U)$ and $v^*(I)$. Assume, instead, that $\rho^*(U)=1$. Then, it is immediate to see that $v^*(U)=p(\Pi_L|y)u_Y\left(y,\Pi_L-y)\right)+(1-p(\Pi_L|y))u_Y\left(y,\Pi_S-y\right)$ is greater than $p(\Pi_L|y)u_Y\left(y-c,\Pi_L-y)\right)+(1-p(\Pi_L|y))u_Y\left(y-c,\Pi_S-y\right)=v^*(I)$. Hence, also in this case, any combination of $v^*(U)$ and $v^*(\bar{I})$ is preferred to any combination of $v^*(U)$ and $v^*(I)$. Thus, the responder does not invest in information when $\rho_I^*(\Pi_S) = 1$ and $\rho_I^*(\Pi_L) = 1$.

- $\rho_I^*(\Pi_S) = 1$ and $\rho_I^*(\Pi_L) = 0$. Further assume that $\rho_{\bar{I}}^*(\Pi_L) = \rho_{\bar{I}}^*(\Pi_S) = \rho^*(U) = 1$. Note that $u_Y(y - c, \Pi_S - y) < u_Y(y, \Pi_S - y)$ and, since $\rho_{\bar{I}}^*(\Pi_L) = 1$, $u_Y(y - c, 0) < u_Y(y, 0) < u_Y(y, \Pi_L - y)$. These conditions imply that $v^*(U) > v^*(I)$ and, hence, any combination of $v^*(U)$ and $v^*(\bar{I})$ is preferred to any combination of $v^*(U)$ and $v^*(I)$. On the contrary, now assume that $\rho_{\bar{I}}^*(\Pi_L) = \rho_{\bar{I}}^*(\Pi_S) = \rho^*(U) = 0$. In this case $u_Y(y - c, 0) < u_Y(y, 0)$ and, since $\rho_{\bar{I}}^*(\Pi_S) = 0$, $u_Y(y - c, \Pi_S - y) < u_Y(y, \Pi_S - y) < u_Y(y, 0)$. These conditions imply that $v^*(U) > v^*(I)$ and, hence, any combination of $v^*(U)$ and $v^*(\bar{I})$ is preferred to any combination of $v^*(U)$ and $v^*(I)$. Thus, the responder does not invest in information when $\rho_I^*(\Pi_S) = 1$ and $\rho_I^*(\Pi_L) = 0$.

- $\rho_I^*(\Pi_S) = 1$ and $\rho_I^*(\Pi_L) = 0$, as in the previous point, but now assume that $\rho_{\bar{I}}^*(\Pi_L) = 0$ and $\rho_{\bar{I}}^*(\Pi_S) = 1$. In this situation, where $v^*(I) = p(\Pi_L|y)u_Y(y - c, 0) + (1 - p(\Pi_L|y))u_Y(y - c, \Pi_S - y)$ and $v^*(\bar{I}) = p(\Pi_L|y)u_Y(y, 0) + (1 - p(\Pi_L|y))u_Y(y, \Pi_S - y)$, we need to consider two different cases: $\rho^*(U) = 0$ and $\rho^*(U) = 1$. In the former case, $v^*(U) = p(\Pi_L|y)u_Y(y, 0) + (1 - p(\Pi_L|y))u_Y(y, 0)$ and we thus cannot exclude that $v^*(U) < v^*(\bar{I})$ as $u_Y(y - c, \Pi_S - y) \lesseqgtr u_Y(y, 0)$. In the latter case, $v^*(U) = p(\Pi_L|y)u_Y(y, \Pi_L - y) + (1 - p(\Pi_L|y))u_Y(y, \Pi_S - y)$ and, again, we cannot exclude that $v^*(U) < v^*(\bar{I})$ as $u_Y(y, \Pi_L - y) \lesseqgtr u_Y(y - c, 0)$. Thus, for both $\rho^*(U) = 0$ and $\rho^*(U) = 1$, the responder might invest in information.

To sum up, a necessary condition for the IA type to invest in information is that $\rho_I^*(\Pi_S) = \rho_{\bar{I}}^*(\Pi_S) = 1$ and $\rho_I^*(\Pi_L) = \rho_{\bar{I}}^*(\Pi_L) = 0$. Moreover, the IA type invests if the disutility of paying the cost, c, is outweighed by the increased utility coming from the higher likelihood to optimize separately the two destruction decisions for the small and the large pie.

B Experimental instructions

This appendix reports the instructions (originally in German) that we used for the new UG. The instructions for the other games—namely PG, IG, and DG—were adapted accordingly and are available upon request.

Welcome! You are about to participate in an experiment funded by the Max Planck Institute of Economics. Please switch off your mobile and remain quiet. It is strictly forbidden to talk to the other participants during the experiment. It is very important that you follow these rules. Otherwise we must exclude you from the experiment and from all payments. Please read the instructions which are identical for all participants carefully. Whenever you have a question or a concern, please raise your hand and one of the experimenters will come to your aid.

You will receive €3 for participating in this experiment. Beyond this you can earn more money, depending partly on the decisions that you take during the experiment, partly on the decisions of other participants, and partly on chance. But there is also a small possibility of ending up with a loss that you can cover by your participation fee. The participation fee and any additional amounts of money you may earn will be paid to you in cash at the end of the experiment. Payments are carried out privately, i.e., with the others unaware of the extent of your earnings. During the experiment we shall speak of ECU (Experimental Currency Units) rather than euros. The conversion rate between them is 5 ECU per euro.

Detailed information on the experiment

In this experiment you will be placed in a group of two people (a pair). You and the other participant will interact just once. Each one of you will be randomly assigned to one of two roles: X or Y. Your role will be told to you at the beginning of the experiment.

Each pair can share a positive amount of ECU. In the following, we shall refer to the amount that X and Y can share as the "pie". There are

- 5 chances out of 10 (i.e., 50% probability) that the pie is small and equal to 55 ECU, and
- 5 chances out of 10 (i.e., 50% probability) that the pie is large and equal to 95 ECU.

So the pie can be either 55 ECU or 95 ECU, where both values are equally likely.

Role X

X has the right to propose how the pies must be divided between him/herself and Y. X must make two proposals: one about how to divide 55 ECU and another about how to divide 95 ECU. In particular, for each one of the two pies, X proposes a distribution (x, y) meaning that X wants to keep x ECU for him/herself and to give y ECU to Y.

For each pie, X can give Y three amounts: 5, 25, or 45 ECU. This means that X can keep for him/herself: 50, 30, or 10 ECU if the pie is 55 ECU; 90, 70, or 50 ECU if the pie is 95 ECU. More specifically, X will face two tables like the ones shown below. For each pie, X can choose the distribution (s)he prefers by clicking on the corresponding button.

pie = 55 ECU

x	50	30	10
y	5	25	45
	○	○	○

pie = 95 ECU

x	90	70	50
y	5	25	45
	○	○	○

Consider, for instance, the table on the left-hand side which refers to a pie of 55 ECU. X can select any of the three distributions of the 55 ECU reported in this table. Specifically, if X wants to keep 50 ECU for him/herself and to give 5 ECU to Y, (s)he must click on the button below the first column, where $x = 50$ and $y = 5$. Similarly, if X wants to keep 10 ECU for him/herself and to give 45 ECU to Y, (s)he must click on the button below the last column, where $x = 10$ and $y = 45$. The same applies to the table on the right-hand side which refers to a pie of 95 ECU. X can select any of the three distributions of the 95 ECU reported in this table.

Role Y

Y has to perform three tasks, each one of which will be explained next.

I. *Investing in information*

First, Y determines the chances of being informed about the actual pie size.

For each possible amount that X can give him/her (i.e., $y = 5$, $y = 25$, and $y = 45$), Y must decide whether or not (s)he wants to invest in information.

- If Y does NOT INVEST in information: (s)he has 1 chance out of 10 (10% probability) of being informed whether the pie is 55 or 95 ECU, and 9 chances out of 10 (90% probability) of not being informed about the pie size.
- If Y INVESTS in information, the probabilities are exchanged: (s)he has 9 chances out of 10 (90% probability) of being informed whether the pie is 55 or 95 ECU, and 1 chance out of 10 (10% probability) of not being informed about the pie size.

Thus, there is a 10% probability that Y does not know the pie size even when investing, and a 10% probability that Y gets to know the pie size even when NOT investing.

Investing in information is costly only when Y is actually informed about the pie size. In particular, if Y decides to invest and the pie size is revealed to him/her, then (s)he has to pay 3 ECU. Otherwise, (s)he pays nothing as in case of not investing.

II. *Accepting or rejecting y*

The second task of Y is to specify, for each possible amount that X can give him/her (i.e., $y = 5$, $y = 25$, and $y = 45$), if (s)he wants to ACCEPT or REJECT it. Y has to decide between acceptance and rejection of each y when the pie is 55 ECU, when the pie is 95 ECU, and when the pie remains Unknown (U) to him/her. More specifically, for $y = 5$, Y will face a table like the one shown below.

X gives 5 ECU to Y

pie = 55	pie = 95	pie = U
Accept ◦ Reject ◦	Accept ◦ Reject ◦	Accept ◦ Reject ◦

Y must decide between "Accept" and "Reject" 5 ECU when the pie is 55 ECU, 95 ECU, and U(nknown) by clicking on the corresponding button. Consider, for instance, the column "pie = 55". Clicking on "Accept" in this column, Y states that (s)he accepts an offer of 5 ECU when the pie is 55

ECU. Similarly, clicking on "Reject" in the column "pie = U", Y states that (s)he rejects an offer of 5 ECU when the pie is U(nknown) to him/her.

Y will face a table like the one shown above also for $y = 25$, and $y = 45$. So, in total, Y will make 9 acceptance/rejection decisions.

III. *Destroying or not destroying x*

The third task of Y is to indicate, for each possible amount that X can give him/her (i.e., $y = 5$, $y = 25$, and $y = 45$), if (s)he wants to DESTROY or NOT DESTROY the amount that X proposes to keep for him/herself, that is: pie $- y$. Y has to decide between destroying and not destroying X's share of the pie when the pie is 55 ECU, when the pie is 95 ECU, and when the pie remains Unknown (U) to him/her. More specifically, for $y = 5$, Y will face a table like the one shown below.

X gives 5 ECU to Y

pie = 55	pie = 95	pie = U
Destroy ○ Not destroy ○	Destroy ○ Not destroy ○	Destroy ○ Not destroy ○

Y must decide between "Destroy" and "Not destroy" the amount kept by X, (i.e., pie $-$ 5 ECU) when the pie is 55 ECU, 95 ECU, and U(nknown) by clicking on the corresponding button. Consider, for instance, the column "pie = 55". Clicking on "Destroy" in this column, Y states that (s)he wants to destroy X's share when the pie is 55 ECU, i.e., (s)he wants to destroy $55 - 5 = 50$ ECU. Similarly, clicking on "Not destroy" in the column "pie = U", Y states that (s)he does not want to destroy X's share when the pie is U(nknown) to him/her.

Y will face a table like the one shown above also for $y = 25$, and $y = 45$. So, in total, Y will make 9 destroying/not destroying decisions.

Experimental payoffs

After X and Y have made their choices, their payoff is determined as follows:

- First, the program randomly selects the pie size (55 or 95 ECU) and checks if—for the actual offer y proposed by X for the randomly selected pie—Y has invested in information or not.

- Then the program determines whether or not Y gets informed about the pie size according to the probabilities specified above.
  If Y has invested in information and it has been randomly determined that the pie should be revealed to him/her, Y must pay 3 ECU.
- Finally, for the actual pie and the actual offer y proposed by X, the program checks whether Y has accepted or rejected y, and whether or not Y has destroyed what X wants to keep.
  - If Y has accepted y, then (s)he collects y ECU. If Y has rejected y, then (s)he gets nothing.
  - If Y has not destroyed what X wants to keep for him/herself, then X earns this amount of ECU. If Y has destroyed what X wants to keep for him/herself, then X gets nothing.

To sum up:
X's payoff depends on his/her proposal in correspondence of the randomly selected pie, and on the decision of Y about whether or not to destroy the amount that X wants to keep for him/herself. In particular,

- if Y has NOT DESTROYED the share of the randomly selected pie that X has actually proposed to keep for him/herself, X earns this amount of ECU, i.e., X earns x ECU;
- if Y has DESTROYED the share of the randomly selected pie that X has actually proposed to keep for him/herself, X earns 0 ECU.

Y's payoff depends on X's actual proposal in correspondence of the randomly selected pie, on his/her own decision about investing in information, and on whether (s)he has accepted or rejected the amount y that X has actually given to him. In particular,

- if Y has ACCEPTED the share of the randomly selected pie that X has actually given to him/her, Y earns:
  - ◇ y ECU if (s)he has NOT INVESTED in information or, even if (s)he has invested, (s)he has NOT got to know the pie size, and
  - ◇ $(y-3)$ ECU if (s)he has INVESTED in information and has got to know the pie size;
- if Y has REJECTED the share of the randomly selected pie that X has actually given to him/her, Y earns
  - ◇ 0 ECU if (s)he has NOT INVESTED in information or, even if (s)he has invested, (s)he has NOT got to know the pie size, and

◇ $(0-3)$ ECU if (s)he has INVESTED in information and has got to know the pie size.

The information you receive

At the end of the experiment, X will be informed of Y's choices as well as of his/her own and Y's experimental payoff. Thus, X will learn (i) whether Y has invested in information or not, (ii) whether the pie size has been revealed to Y or not, (iii) whether Y has accepted or rejected the amount actually given by X, and (iv) whether Y has destroyed or not the amount that X actually proposed to keep for him/herself.
Y will be informed of his/her own experimental payoff. If it is randomly determined that the pie size must be revealed to him/her, Y will also learn whether the pie is 55 or 95 ECU, and X's experimental payoff.

Your final payoff

At the end of the experiment, your experimental payoff will be converted into euros and paid to you in cash, together with the participation fee of €3.00. If Y ends up with a 3 ECU loss, (s)he will compensate it by using the participation fee and will thus collect €2.40.

Before the experiment starts, you will have to answer some control questions to ensure your understanding of the rules of the experiment. Once everybody has answered all questions correctly, the experiment will start. Two practice periods will be held so that you may familiarize yourself with the experimental setup. Your choice in these periods will NOT be relevant for your final payoff.

Please remain quietly seated during the whole experiment. If you have any questions, please raise your hand now. When you have finished reading the instructions and if there are no questions, please click "OK" on your computer screen.

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