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An Experimental Analysis of Equal Punishment Games*

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Abstract

In equal punishment games first the proposer suggests how to split the pie, i.e. a positive monetary reward. Unlike in the ultimatum game, the responder can decide among many (for proposer and responder) equal penalty payments. To exclude negative payoffs, punishment was bounded from above depending on the proposal and the (for proposer and responder) same show up-fee, our only treatment variable. Although inequality aversion (Bolton and Ockenfels, 1999, and Fehr and Schmidt, 1999) predicts zero-punishments, we observe positive punishments which, however, became smaller in the repetition. Initial fairness is often substituted in the repetition by extreme greed. Whereas greed is sticky, fairness is more characteristic for initial inclinations and not a stable behavioral pattern.

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1. Introduction

One of the questions inspired by experimental studies of ultimatum bargaining (see Güth and Tietz, 1990, as well as Roth, 1995, for surveys) is why proposers make fair offers, e.g. by proposing the 50 : 50-split of the pie, or refraining at least from meager offers. The main two interpretations of such results are that proposers are intrinsically fair, e.g. in the sense of being inequality averse (see, for instance, Bolton and Ockenfels, 1999, Fehr and Schmidt, 1999, Rabin, 1993) or that proposers expect meager offers to be rejected. The latter explanation raises, of course, the question why responders turn down meager, but positive offers. One possible explanation would be (asymmetric) inequality aversion in the sense that one is averse only against unequal treatment in one's own disfavor (Bolton, 1991).

There have been obvious ways to settle the dispute empirically. In the so-called impunity games (see Bolton and Zwick, 1995, and Güth and Huck, 1997) the proposer cannot be punished at all by the responder. One well-known impunity game is the dictator game where the "responder" has no veto power at all, but receives on average still a substantial share of the pie. Another impunity game allows the responder to reject what is offered to him, but not to veto the proposer's payoff. Here the responder gets slightly less than in dictator giving what is probably due to some fear of inefficiency (see Güth and Huck, 1997). What one can conclude from such studies is that fear of rejection certainly is an important motive for proposer behavior, but not the only one, and that an intrinsic concern for the well-being of the responder cannot be denied in most cases.

Suleiman (1996) has explored experimentally a modified ultimatum game to settle the debate about ultimatum bargaining behavior empirically. If the responder rejects the proposal, both parties' proposed payoffs are discounted by the same factor δ with $0 \leq \delta \leq 1$. Clearly, $\delta = 0$ corresponds to the ultimatum game and $\delta = 1$ to the dictator game, i.e. the one parameter-class of games allows for a continuous transition from ultimatum bargaining to dictator giving. The main experimental finding is that allocators offer substantial shares of the pie for all

values of the discount parameter $\delta = 0, .2, .5, .8$, and 1 and that the share, which they offer, strongly depends on δ (although the 50 : 50-split was the mode for all δ -treatments, the share of equal splits decreased significantly with δ , see Suleiman, 1996).

What we can conclude therefore is that no simple argument will do. The hypothesis that proposers are only fair since they fear conflict is rejected by the evidence for large values of δ , especially by the extreme impunity case $\delta = 1$ which had already been tested before. The hypothesis that proposers are only guided by their intrinsic incentives (in fairness) is rejected by the strong dependence of their offers on the discount factor. In our view, this clearly indicates that proposers rely on a rich motivational structure involving conflicting interests. Especially, most people are neither pure ‘fairmen’ nor pure ‘gamesmen’ (Binmore, Shaked, and Sutton, 1985).

To investigate the ways how competing motivational forces determine decision behavior one can rely on psychological concepts like the theory of cognitive dissonance (see Festinger, 1957). Another possibility is to rely on more complex preferences and to estimate their functional form empirically (see, for instance, Bolton and Ockenfels, 1999, and Fehr and Schmidt, 1999) what, of course, assumes that the traditional rationality assumption in economics is never questioned.

Here we do not want to argue for one specific approach of decision emergence in case of conflicting motivational forces. What we want to stress, however, is that one needs rich data sets for many different strategic settings to settle the issue empirically. To establish more stylized facts about ultimatum bargaining behavior we became interested in studying another modified ultimatum game supplementing the innovative study of Suleiman (1996). Unlike Suleiman (1996) the responder does not have only a binary choice, namely to accept or to reject the proposal, but can choose among many response modes if the offer is positive¹.

¹Strictly speaking this, of course, means that a proposal is not an ultimatum since it may leave many choices to the responder. When only one most essential aspect is specified in a take it or leave it-way, Güth (1976) speaks of situations with an ultimatum aspect.

More specifically, let $c (> 0)$ be the “pie”, i.e. the monetary amount which the two parties, the proposer X and the responder Y , can allocate among themselves. A proposal by X is a vector (x, y) with $x, y \geq 0$ and $x + y = c$ where x is what X demands for himself and y what he offers to Y . Knowing the proposal (x, y) , responder Y chooses any punishment p satisfying

$$0 \leq p \leq \min \{s + x, s + y\}$$

Here, $s (\geq 0)$ denotes the show up-fee for participating in the experiment which is equal for both parties. Thus a play consists of the proposal (x, y) by X and the response p by Y with payoffs $x - p$ for proposer X and $y - p$ for responder Y in addition to the show up-fee. The upper bound $\min \{s + x, s + y\}$ for the punishment p makes sure that neither party receives a negative payoff. To allow for an easy terminology we refer to this situation as the **equal punishment game**.

How may experimental results for the equal punishment game shed new light on the debate how to explain proposer and responder behavior? Clearly, if $s = 0$ or if s is very small, a proposer fearing conflict can avoid any risk by taking it all, i.e. by setting $x = c$. Only when being generous, i.e. when choosing $y > 0$, proposer X has to consider how responder Y might react. Thus for small s the ‘gamesmen’-hypothesis predicts x close to c whereas the ‘fairmen’-hypothesis still claims $x = c/2$ and the acceptance of the 50 : 50-split. Since “greed” is less dangerous than in usual ultimatum bargaining, one should observe more ambitious demands x , i.e. a behavior closer to the game theoretic solution due to – in view of earlier findings – undeniable self-interest.

If s is rather large, there exists no proposal (x, y) so that proposer X can exclude any risk. The “greedy proposal” (x, y) with y being close to 0 can still lead to a considerable punishment. What we expect is that proposers will try to make sure what they finally receive by being fair. This justifies our main hypothesis that most proposers will rely on (nearly) “equal splits” when s is large. Compared to

small s -values, $s \gg 0$ should lead to less proposals (x, y) with $c/2 \ll x \leq c$ where “ \gg ” stands for essentially larger and should be specified numerically in light of the data.

Regarding responders one should note that punishments in the equal punishment game imply the same costs of conflict for X and Y whereas in ultimatum bargaining rejecting an unfair offer means that the loss of X is much larger than the one of Y . One conjecture is that this will eliminate punishments at all, i.e. induce $p = 0$ regardless of the proposal. Such a hypothesis follows, for instance, from Bolton and Ockenfels (1999). If s is small, a meager offer y should, however, not prevent punishments (in the impunity game, where Y could only reject y , small y -values were typically rejected, see Güth and Huck, 1997). Our hypothesis concerning response behavior is therefore that very low offers y will be rejected when s is small, whereas for $s \gg 0$ unfair offers will be accepted more often than in usual ultimatum bargaining.

2. Experimental design

Although we consider $s = 0$ as an interesting border case, we prefer to compare a rather **low show up-fee** $\underline{s} = \text{DM } 2$ with the **substantial show up-fee** $\bar{s} = \text{DM } 9$. The reason is that $\underline{s} = 0$ would mean not to speak of show up-fees at all. A low value of \underline{s} allows us to use the same verbal instructions both for \underline{s} and \bar{s} except for the different parameter value s .

To obtain more interesting data we, furthermore, use the **strategy method** when eliciting responder behavior. Proposers are only allowed to choose integer demands x and, correspondingly, integer offers y . Thus a responder strategy has to assign a penalty p with $0 \leq p \leq \max\{s + x, s + y\}$ to all integer offers y with $0 \leq y \leq c$. In our experiment participants were either players of the equal punishment game with $\underline{s} = \text{DM } 2$ and the pie $c = \text{DM } 32$ or of the equal punishment game with $\bar{s} = \text{DM } 9$ and $c = \text{DM } 18$ which, for an easy notation, will be simply called the **\underline{s} -game**, respectively the **\bar{s} -game**. Thus in both situations,

the \underline{s} - and the \bar{s} -game, both parties will earn DM 36 in total by reaching an agreement, i.e. without punishment.

To check for experience effects each participant plays the same game twice without switching roles, i.e. one is either the proposer X or the responder Y in both plays. After the first play both players are informed about their own play before they repeat the game with a new partner. To avoid reputation effect and to guarantee statistically independent observations even for the repetition four participants (two X - and two Y -participants) form a matching group: When X_i plays with Y_i first for $i = 1, 2$, the player pairs in the repetition are the combinations X_i and Y_j with $i \neq j$ and $i, j = 1, 2$.

The experiment was performed as a pen and paper-classroom experiment which lasted 90 minutes since it took some time to compute the results of the 1st play and to inform participants about these results. All 134 participants were undergraduate students attending a basic course in macro-economics at the University of Halle.

3. Hypotheses

A higher show up-fee s allows for larger punishments even in case of low offers. We expect that a larger potential will inspire more punishments, i.e.

Hypothesis A: For $\bar{s} = \text{DM } 9$ the penalties for an offer y leading to a total payment of $\bar{s} + y$ are larger than for $\underline{s} = \text{DM } 2$ and an offer $y + \text{DM } 7 = y + \bar{s} - \underline{s}$ leading to the same total payment.

Hypothesis A is, of course, restricted to offers y in the range $0 \leq y \leq 18$ in treatment $\bar{s} = \text{DM } 9$.

As already observed by Güth et al. (1982) and Binmore et al. (1985) we, furthermore, expect lower offers for the second play. Our more encompassing hypothesis claims that this will lead to a lower efficiency in the sense of a lower level $(36 - 2\bar{p})/36$, where \bar{p} is the average punishment actually chosen:

Hypothesis B:

- (i) $\frac{y}{36-2s}$ is smaller for the 2nd than for the 1st play, for both values of s .
- (ii) The efficiency is smaller in the 2nd than in the 1st play.

By the very definition of equal punishments in case of unfair offers the responder cannot improve his share by punishing. Unlike in ultimatum bargaining, unfair offers do not imply efficiency in punishing in the sense that it costs the responder very little to hurt the proposer a lot. This is why inequality aversion as postulated by Bolton and Ockenfels (1999) and Fehr and Schmidt (1999) imply $p = 0$. Anticipating $p = 0$ by the proposer means, of course, that equal punishment games are equivalent to dictator games. Thus inequality aversion as formulated by Fehr and Schmidt (1999) as well as by the “quadratic version” of the motivation function by Bolton and Ockenfels (1999) imply $y = 0$, i.e. the lowest possible offer². Since they are aware of positive offers in dictator giving, Bolton and Ockenfels (1999) try to capture this by a more general formulation of inequality aversion. The hypothesis which we hope to reject is

Hypothesis C:

- (i) Responders do not punish.
- (ii) Proposers offer $y = 0$ or $y = 1$.

²cf. Appendix for the proofs.

Our reason for not believing in Hypothesis C is that low offers in the sense of $y = 0$ or $y = 1$ frustrate responders and that frustrated responders will simply react by punishing, regardless whether or not they hereby improve their share.

Assume a proposer making a fair offer, e.g. $y = 9$ for \bar{s} and $y = 16$ for \underline{s} , in the 1st play and who nevertheless is punished in the sense of $p > 0$. One would not expect this to be a frequent event. If it, however, happens, this certainly should discourage fairness or crowd out an intrinsic motivation for fairness (see Frey, 1997).

Hypothesis D:

- (i) Punishing fair proposers makes them more greedy.
- (ii) Punishing unfair proposers slows down or even stops the erosion of fairness among proposers.

4. Confirmation of hypotheses

Hypothesis A will be analyzed by comparing mean penalties for identical total offers (offer + show up fee) in two treatments and different trials (cf. Figures 1 and 2).

	$\underline{s} = 2$			$\bar{s} = 9$		
	y offer	\bar{p} 1st play	\bar{p} 2nd play	y offer	\bar{p} 1st play	\bar{p} 2nd play
unfair offer	0	.90	.66			
	1	1.20	.94			
	2	1.57	1.22			
	3	1.83	1.47			
	4	1.80	1.38			
	5	1.97	1.50			
	6	2.23	1.56			
	7	2.53	1.75	0	2.31	1.83
	8	2.37	1.75	1	2.28	1.17
	9	1.83	1.88	2	2.28	1.13
	10	2.23	1.34	3	2.21	1.13
	11	2.37	1.31	4	2.17	1.07
	12	2.30	1.13	5	2.21	1.03
	13	2.23	.69	6	1.97	1.00
	14	1.87	.59	7	1.93	.93
15	1.93	.44	8	2.00	.93	
equal split	16	1.13	.22	9	.17	.37
altruistic offer	17	.73	.34	10	.31	.43
	18	.80	.31	11	.41	.40
	19	.73	.31	12	.52	.40
	20	.67	.38	13	.62	.43
	21	.50	.53	14	.72	.40
	22	.30	.75	15	.79	.33
	23	.23	.59	16	.86	.37
	24	.20	.47	17	.97	.37
	25	.50	.53	18	1.07	.37
	26	.40	.50			
	27	.23	.44			
	28	.20	.38			
	29	.27	.44			
	30	.33	.34			
	31	.30	.38			
	32	.37	.50			

Figure 1: The \bar{p} -values are mean penalties of the strategies of all responders dependent on offer y , show up fee s , and trial.

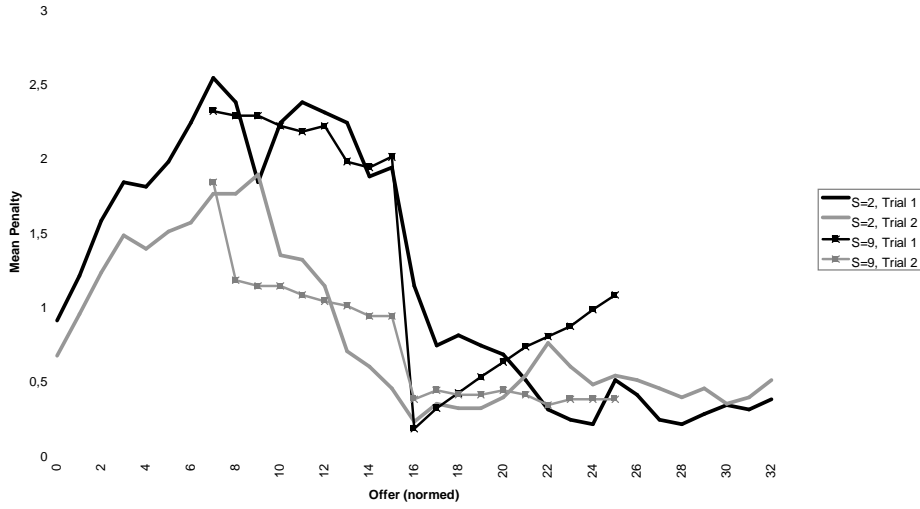


Figure 2: Graphs for mean penalties of Figure 1

The table in Figure 1 and the curves in Figure 2 show that \bar{p} does not change in a unique direction when the show up fee increases. \bar{p} decreases significantly from 1st to 2nd play in both treatments in the range of unfair offers (upper part of the table). There is only one outlier (cf. data for $\underline{s} = 2$, $y = 9$).

Concerning Hypotheses B (i) we have conducted Mann-Whitney-Tests for the normalized variable $\frac{y}{36-2s}$. For both cases, $s = \underline{s} = 2$ and $s = \bar{s} = 9$, the relative offers are significantly smaller in the 2nd than in the 1st trial (two tailed asymptotic significance of .002 for $\underline{s} = 2$, respectively .007 for $\bar{s} = 9$).

To check Hypothesis B (ii) we observe the aggregated realized penalties for each trial and each show up fee separately and compare them to the total pies. We interpret the ratio penalty/pie size as an inefficiency measure, correspondingly the ratio realized pay off/pie size as an efficiency measure:

1st play	$\bar{s} = 9$	$\underline{s} = 2$
pie size	DM 1080	DM 1152
penalty	DM 116 (10.74 %)	DM 92 (7.99 %)
pay off	DM 964 (89.26 %)	DM 1060 (92.01 %)

2nd play	$\bar{s} = 9$	$\underline{s} = 2$
pie size	DM 1080	DM 1152
penalty	DM 42 (3.89 %)	DM 31 (2.69 %)
pay off	DM 1038 (96.11 %)	DM 1121 (97.31 %)

Figure 3: Measuring efficiency

For both plays the lower show up fee leads to more efficient pay offs. Experienced proposers were more demanding and, contrary to Hypothesis B (ii), experienced responders are less willing to punish proposers³.

In order to illustrate the changes in the proposers' behavior we compare the distributions of the total claims $s + x$ for 1st and 2nd play. Figure 4 reveals the dramatic shift to maximal demands $s + x$ for the 2nd play (see also Figure 2 showing that mean penalties of "Trial 2" are usually below those of "Trial 1"):

treatment	$\underline{s} = 2$ (max. demand = 34.00)				
measures	number of observations	mean	median	mode	standard deviation
1st play	32	24.84	22.00	18	6.87
2nd play	32	30.16	34.00	34	7.20

treatment	$\bar{s} = 9$ (max. demand = 27.00)				
measures	number of observations	mean	median	mode	standard deviation
1st play	30	21.77	20.50	18	3.73
2nd play	30	24.57	26.00	27	2.98

Figure 4: Total claims

Analyzing the types of punishment strategies of the responders reveals that from 1st to 2nd play nearly all responders rely on smaller penalties. As an indicator, the frequency of responders with penalty vector $p \equiv 0$ are compared:

³Since the 2nd play was the last game for the subjects in the session, the motivation to use the last chance to increase one's own pay off may have played a crucial role.

	$\underline{s} = 2$	$\bar{s} = 9$
1st play	10 (of 32)	15 (of 30)
2nd play	14 (of 32)	21 (of 30)

Figure 5: Frequency of penalty vector $p \equiv 0$

We see that the percentage of responders that do not punish at all increases from 1st to 2nd play and is relatively higher for the larger show up fee.

Figures 6 and 7 graphically display the total claim $s + x$ of proposers for \underline{s} and \bar{s} , respectively. Whereas for the 1st trial the distributions are essentially bimodal, they have essentially only one peak at the maximal claim of 34, respectively 27 in the 2nd trial. Thus the increase of no punishment at all, as shown in Figure 5, cannot be justified by more fairness in the 2nd trial. Just the contrary: It seems that proposers rationally anticipated a low willingness to punish.

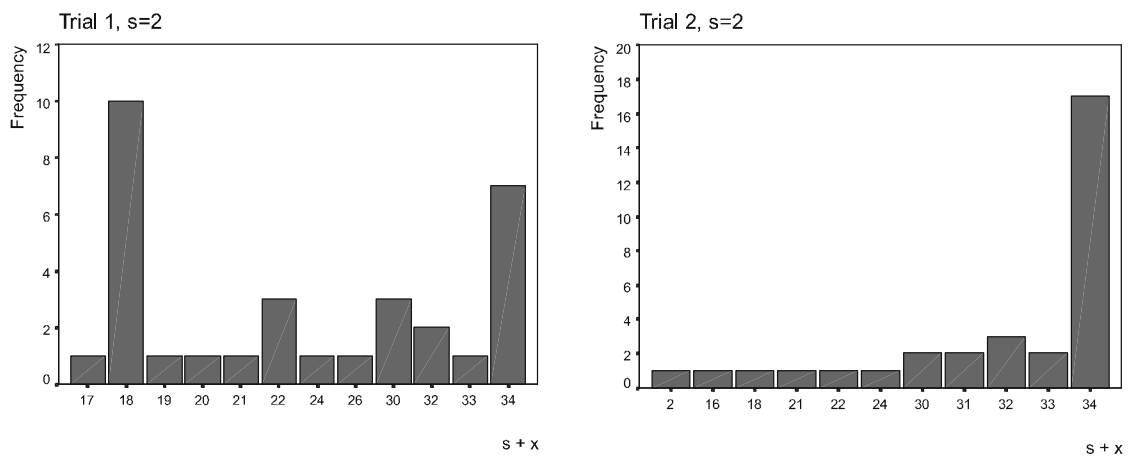


Figure 6: Distribution of total claims $s + x$ for 1st and 2nd play ($\underline{s} = 2$)

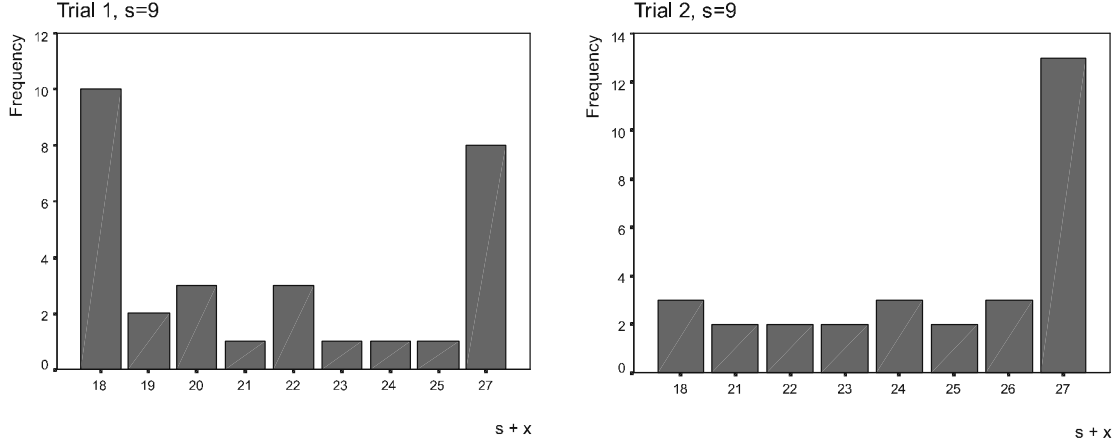


Figure 7: Distribution of total claims $s + x$ for 1st and 2nd play ($\bar{s} = 9$)

5. Further results

In order to explain the punishments p , chosen by responders, we have run linear regressions

$$p = \alpha - \beta \frac{y}{36 - 2s} + \gamma s$$

for which γ turned out to be positive, as expected, but not significantly ($T = 1.222$, $p = 0.222$). For the reduced function $p = \alpha - \beta \frac{y}{36 - 2s}$ the results for the 1st play are, for instance

$$p = 2.286 - 2.082 \frac{y}{36 - 2s}, \quad R^2 = 0.051$$

$$(T = 17.055, p < 0.001) \quad (T = -9.059, p < 0.001)$$

revealing a significantly positive constant and a significantly negative influence of fairness (larger y) on punishments p , but a frustratingly low coefficient R^2 of determination. The influence of the relative offered share $y / (36 - 2s)$ remains

significant when splitting the sample into the \underline{s} - and \bar{s} -observations ($\beta = 2.142$ ($T = 8.453$, $p < 0.001$) for $\underline{s} = 2$ and $\beta = 1.980$ ($T = 4.387$, $p < 0.001$) for $\bar{s} = 9$).

Although fair treatment, e.g. in the sense of $y = 9$ for $\bar{s} = 9$ and $y = 16$ for $\underline{s} = 2$, should induce $p = 0$, there are rare exceptions (see participants 7, 9, 15 for $\bar{s} = 9$ and 31, 38, 44 for $\underline{s} = 2$ of our data file in the Appendix. who all experience $p > 0$ in spite of their fair offer). One should expect that an intrinsically fair proposer is extremely annoyed by such an unreasonable response what could crowd out intrinsic fairness. As a matter of fact 4 of the 6 mentioned participants (except for 9 and 38) reacted to this experience by offering $y = 0$ in the 2nd play, supporting the view that intrinsic motivation will be crowded out by not acknowledging it (Frey, 1997).

Another extreme experience is an offer $y = 0$ in the 1st play what usually induces a considerable punishment $p(y = 0)$ as revealed by the positive regression constant above. 15 of the altogether 62 proposers were greedy in this sense during the 1st play where the number of fair proposers in 1st play ($y = 9$ for $\bar{s} = 9$ and $y = 16$ for $\underline{s} = 2$) was slightly higher at 20. In the 2nd play, 14 of the 15 $y = 0$ -proposers repeated this offer (the only minor exception is an increase to $y = 1$ by participant no. 45), but of the 20 fair proposers in 1st play only 3 repeated this during 2nd play. Quite interestingly of the remaining 17 initially fair proposers 13 switched to extreme unfairness in the sense of $y = 0$ or $y = 1$ during 2nd play. Thus greed seems to be very sticky whereas complete fairness is very fragile and more an aspect of initial inclinations rather than a stable behavioral pattern.

6. Final remarks

The idea of equal punishment is rooted in explanations of ultimatum bargaining behavior which depend crucially on the punishment efficiency of a responder confronting a meager offer like evolutionary stability arguments (e.g. Gale, Binmore and Samuelson, 1995, Huck and Oechssler, 1999) or inequality aversion (Bolton and Ockenfels, 1999, Fehr and Schmidt, 1999). Since in the equal punishment

game a positive penalty results in an even worse payoff relation than the one implied by that meager offer, such theories predict 0-punishments.

Although we reject the extreme prediction of 0-punishments (even in the repetition only 56.4 % of the responders rely on the extreme $p \equiv 0$ -behavior), the **initially strong inclinations**

- of proposers to be fair and
- of responders to punish unfairness

appear rather fragile. Many such proposers switch to extreme greed and the responders' willingness to punish decreases considerably from 1st to 2nd play.

Thus the final conclusion seems to be that initially people are deciding more emotionally, but that they consider the allocative consequences of punishment more carefully when becoming more experienced. This somewhat specifies the interpretation of inequality aversion which should be more typically for inexperienced decision makers (e.g. Bolton and Ockenfels, 1999).

An alternative hypothesis is that punishment behavior is triggered by emotional arousal due to a meager offer and less by carefully considering what it causes for oneself and the other. Thus punishments occur in equal punishment games simply since responders want to reveal how upset they are about the proposer's greed. According to this interpretation the experience effect simply reflects that in 2nd play responders are more used to unfair treatment and not as upset about it as in 1st play.

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Appendix

A₁ : Calculation of the optimal punishment according to Fehr and Schmidt (1999):

Let X be the proposer and Y the responder. x denotes the claim and y the offer, such that $x + y = c$, where c is the size of the pie. s is the show up-fee. The theory of Fehr and Schmidt then implies the following utility function for the responder Y :

$$\begin{aligned} U_Y(y, p) &= s + y - p - \alpha_Y [(s + x - p) - (s + y - p)] \\ &= s + y - p - \alpha_Y (x - y). \end{aligned}$$

The utility loss from inequality is independent of the size of the punishment. Therefore, $p^* = 0$ maximizes Y 's utility for every given offer y .

A₂ : Calculation of the optimal punishment according to Bolton and Ockenfels (1999):

Let X be the proposer and Y the responder. x denotes the claim, y the offer, and s the show up-fee. Then the size of the pie is $c = x + y$ and we define $\bar{c} = c + 2s$ as the total pie to be distributed. The “quadratic version” of the motivation function for the responder Y has the following form:

$$\begin{aligned} &v_Y \left(s + y - p, \frac{s + y - p}{\bar{c} - 2p} \right) \\ &= \alpha_Y (s + y - p) - \frac{b_Y}{2} \left(\frac{s + y - p}{\bar{c} - 2p} - \frac{1}{2} \right)^2 \\ &= \alpha_Y (s + y - p) - \frac{b_Y (2y - c)^2}{8 (\bar{c} - 2p)^2}. \end{aligned}$$

It follows that

$$\frac{\partial v_Y}{\partial p} = -\alpha_Y - \frac{b_Y (2y - c)^2}{2 (\bar{c} - 2p)^3} < 0$$

holds and therefore $p^* = 0$ maximizes v_Y for every given offer y .

A₃ : Calculation of the optimal total offer $y + s$ of the proposer X according to Bolton and Ockenfels (1999):

The “quadratic version” of the motivation function of the proposer X is

$$v_X = a_X (s + c - y - p) - b_X \frac{1}{2} \left(\frac{s + c - y - p}{\bar{c} - 2p} - \frac{1}{2} \right)^2.$$

For $p = \text{constant}$ this implies

$$\frac{\partial v_X}{\partial y} = -a_X + b_X \cdot \frac{\frac{\bar{c}}{2} - y}{(\bar{c} - 2p)^2}.$$

The optimal offer is

$$y^* = \frac{\bar{c}}{2} - s - \frac{a_X}{b_X} (\bar{c} - 2p)^2.$$

Therefore, the optimal total offer is

$$y^* + s = \frac{\bar{c}}{2} - \frac{a_X}{b_X} (\bar{c} - 2p)^2.$$

This term is independent of s . For $p \equiv 0$ one, furthermore, obtains

$$y^* + s = \bar{c} \frac{b_X - 2a_X \bar{c}}{2b_X}.$$