Inequality Aversion in Ultimatum Games with Asymmetric Conflict Payoffs

– A Theoretical and Experimental Analysis[*]–

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Assuming inequality averse subjects as modeled by Fehr and Schmidt (1999) or in the ERC model by Bolton and Ockenfels (2000) in ultimatum games with asymmetric conflict payoffs allows to make predictions especially concerning responder acceptance thresholds. These predictions are tested in a laboratory experiment eliciting proposer offers and respondent's acceptance thresholds using the strategy vector method. By and large both models make good predictions. However, they are unable to convincingly explain the observed selfishness on behalf of responders in ultimatum games favoring them in conflict. Overall, observed behavior gives rise to a context dependent interpretation of inequality aversion and to Knez and Camerer's 1995 observation that subjects form '*egocentric assessments of fairness*'.

1. Introduction

Many results from laboratory experiments question the assumption of selfish payoff maximizing subjects. This led to a burgeoning literature on "*other regarding behavior*" (Hoffman et al., 1994, 1996). The term 'other regarding behavior' summarizes manifold different kinds of observed deviations from predicted behavior. Most of all, however, it describes behavior like altruistic action (e.g., in the dictator game, see Forsythe et al., 1994) or behavior which to a large degree appears to be motivated by 'fairness' concerns like for example in the ultimatum game (Güth et al., 1982).[1]

First models trying to explain other regarding behavior did not explicitly question that own material payoff is the only driving force behind individual behavior. These models are more or less refinements of classical solution concepts. First refinements, e.g., introduced infinitesimal

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[1]See, also Güth (1976); Güth and Tietz (1990) and, for a survey, Roth (1995).

small errors (Myerson, 1978; Selten, 1975). Others again, like for example Rosenthal (1989) assumed that subjects make larger errors.[2] So far this branch of research has culminated in the random utility model by McKelvey and Palfrey (1995, 1998) - an adoption of quantal response theory to game theory. Another approach which may also be labelled refinements of classical solution concepts are models analyzing a larger subgame subjects may be more familiar with (see e.g., the Folk theorem treated in Fudenberg and Maskin, 1986).

A completely different branch of research, however, tries to explain the observed deviations by introducing additional motives. Two very first approaches in the economic literature can be found in Becker (1974), in Andreoni's, 1989, model of warm glow giving or in Levine's, 1998, model of altruism and spitefulness. More recently two different approaches developed within the branch of social utility models. They differ in how fairness is measured. The first measures fairness as intentions translated into actions which the other party reciprocates. Depending on the feasible action space available to the other party, each party evaluates the observed or expected action of the other party as 'helping' or 'hurting' and reciprocates accordingly. Rabin (1993) formulated this *reciprocal kindness* approach for normal form games, which was translated to sequential games by Dufwenberg and Kirchsteiger (2004).

The second approach models *distributive fairness* which relates to well established findings about social comparison in the neighboring fields of sociology and social psychology.[3] Here, fairness is defined primarily by the outcome of a game. The basic idea behind it is that subjects do not only care about their own payoff, but also about how this payoff compares to that of the other game partners. In the economic literature related discussions of (in)equity can already be found in e.g. Selten (1987) and Bolton (1991). Detailed models of distributive fairness are the ERC model by Bolton and Ockenfels (2000) and the more restrictive utility model by Fehr and Schmidt (1999) (F&S in the following). Both models are able to explain many observations made in laboratory experiments as a result of inequality aversion.[4] Furthermore, other studies are able to show why people may have such motives. Most analyze evolutionary games (see e.g., Ellingsen, 1997; Gale et al., 1995; Huck and Oechssler, 1999; Koçkesen et al., 2000), some of which also include (rudimentary) reciprocal behavior (see e.g., Güth, 1995; Sethi and Somanathan, 2001), combining the two different approaches.

A simple variation of the classical ultimatum game - the ultimatum game with (nonzero) asymmetric conflict payoffs[5] (UGAC) is well suited to test, whether inequality aversion is a good model of fairness considerations: If subjects are inequality averse as outlined by ERC or F&S one can influence the desirability of conflict by systematically changing the combination of the proposer and responder conflict payoffs ($c_p, c_r \geq 0$ with $c_r + c_p = C > 0$). Within an equilibrium framework, this changing of the desirability of rejection has clear implications for responder acceptance thresholds and thus for proposer offers. Using the ERC and F&S

[2]Rosenthal (1989) assumes that the likelihood that a particular strategy is played, and the expected payoff this strategy yields are correlated.

[3]See, e.g., Adams (1965), Goodman (1977) and Bazerman (1993).

[4]Bolton and Ockenfels (2000) use the word *equity* instead of *equality.* For reasons of consistency the term *(in)equality* will be used throughout. Furthermore, in social psychology *equity theory* argues that people prefer outcomes which rewards previous inputs or efforts proportionally. Both models, ERC and F&S, do not explicitly cater for previous inputs. What role previous inputs may play in ultimatum games is illustrated in, e.g., Güth and Tietz (1986) and Hoffman et al. (1994).

[5]Sometimes conflict points in the ultimatum game are also referred to as *outside options* (see e.g. Binmore et al., 1991; Knez and Camerer, 1995; Schmitt, 2004). However, this may lead to confusions with a different game which includes the ultimatum game as a subgame preceded by the responder of the ultimatum game choosing between an outside option and playing the subgame.

models, this survey analyzes predictions from inequality aversion. With the predictions in mind an experiment is conducted eliciting acceptance thresholds from responders and offers from proposers.

Though it would be interesting to compare predictions by inequality aversion with those by reciprocal kindness models, due to scope this is not be done in this survey.[6] The main findings of this survey are that, while both models are quite good in predicting actual behavior, this is to a large degree due to rather large prediction intervals. Furthermore, important patterns of behavior are not observed at all. Especially, responders' thresholds suggest the interpretation that they form egocentric interpretations about what constitutes a fair offer, as already found in Knez and Camerer (1995). There is no evidence that responders entertain inequality aversion for outcomes preferring themselves. Lastly, comparing the two models with each other, F&S performs a bit better than ERC. Similar to results from Charness and Rabin (2002); Engelmann and Strobel (2004) this is, among others, due to the different measurements of inequality.

Section 2 analyzes ERC predictions on ultimatum bargaining with asymmetric conflict payoffs. This is followed by an analysis of predictions according to the F&S model in section 3. The design of the experiment conducted to systematically analyze behavior, and its experimental predictions are presented in sections 4 and 5. Results are reported in section 6 and finally section 7 concludes.

2. Equity, reciprocity and cooperation (ERC)

Bolton and Ockenfels (2000) explain observed behavior in many laboratory experiments as a result of inequality averse subjects. They introduce inequality aversion by defining a subject and task specific motivation function v_i which depends on both the pecuniary payoff x_i a subject i obtains,[7] and the relative share of his payoff compared to the sum of payoffs of all other players $\sigma_i = x_i/\Sigma$ (with $\sigma_i = 1/n$ for $\Sigma = 0$) where Σ is the sum $\sum_{j=1}^{n} x_j$ of all achieved nonnegative payoffs and n is the total number of players. In the ultimatum game for example, in case of an agreement $\Sigma = p$ with p being the total available pie. The assumptions made about $v_i(x_i, \sigma_i)$ are:

Assumption 1 $v_i(x_i, \sigma_i)$ is continuous and twice differentiable on the domain of (x, σ).

Assumption 2 Keeping the relative payoff constant, the motivation function is nondecreasing and concave in the pecuniary payoff, i.e. $\frac{\partial v_i(x_i,\sigma_i)}{\partial x_i} \geq 0$ and $\frac{\partial^2 v_i(x_i,\sigma_i)}{\partial x_i^2} \leq 0$.

Assumption 3 At a share of payoffs of $\sigma_i = 1/n$ the following holds: $\frac{\partial v_i(x_i,\sigma_i)}{\partial \sigma_i} = 0$ and $\frac{\partial^2 v_i(x_i,\sigma_i)}{\partial \sigma_i^2} < 0$.

[6]Dickinson (2000) analyzes a model of reciprocal kindness in the ultimatum game. However, arguing that the responder observes the kindness of the proposer through his actions, Dickinson doesn't take beliefs on behalf of the responder into account. This appears to be incomplete as it ignores one important aspect: Assume that a proposer offers 40% of the pie. Depending on what the responder assumes about what the proposer believed about his acceptance threshold, this can now constitute a kind or unkind action. If this second order belief was a threshold of, say 10%, an offer of 40% would most likely be evaluated to be a kind action. If, however the second order belief was 40%, i.e. if the responder believes that the proposer offered exactly what he believed to be the smallest accepted offer, it is rather unkind and selfish. Including this aspect into the reciprocal kindness model complicates the analysis considerably and makes multiple equilibria, including 'self fulfilling expectations' equilibria, likely.

[7]Please note that the notation used in this paper is different from Bolton and Ockenfels (2000).

This assumption implies, e.g., that the motivation function of a subject who only cares for his relative payoff has a maximum at the equal share of payoff.

With these characteristics of the motivation function, Bolton and Ockenfels define two payoff shares s_i and r_i. Hereby s_i is defined to be that share of the non–zero total group payoff Σ which yields a subject the same valuation as the outside option of no participation or the outcome of a rejection in the ultimatum game.

Definition 1

$$s_i\colon\ v_i(s_i p, s_i) = v_i(0, 1/n)$$

Therefore in the ultimatum game, share s_i translates to the responder's acceptance threshold t_i with $t_i = s_i p$. Clearly, given the functional form of v_i, esp. assumption 3, a subject must have at least a lower but could possibly also have an upper s_i, i.e., responder strategies are not necessarily monotonic.[8] In an ultimatum game with zero conflict payoffs for example, a subject who only cares for equity (i.e. $\frac{\partial v_i}{\partial x_i} = 0$) would exhibit $s_i \equiv {}^1\!/_2$ and neither accept any offered share below nor above ${}^1\!/_2$. Eventually the second threshold r_i is defined as that share of the total payoff, which maximizes a subject's own motivation function; i.e.:

Definition 2

$$r_i = \underset{\sigma_i}{\operatorname{argmax}}\ v_i(\sigma_i p, \sigma_i)$$

Given assumptions 2 and 3, r_i must lie within the interval[9] $r_i \in [1/n, 1]$ and s_i must lie within the interval[10] $s_i \in (0, 1/n]$. Finally Bolton and Ockenfels assume that all possible levels of s_i ($s_i \in (0, 1/n]$) and r_i ($r_i \in [1/n, 1]$) appear with positive probability.

By incorporating v_i into a perfect Bayesian equilibrium framework Bolton and Ockenfels are able to describe major observations made in bargaining experiments as a result of v_i maximization behavior. Concerning responder behavior in the ultimatum game, the following must hold: (i) the probability of a randomly selected responder turning down a share of 1/2 of p is zero and the probability of an offered share of zero being turned down equals 1; (ii) the probability of a randomly selected responder accepting an offered share of σ_r strictly increases in σ_r over the interval $(0, {}^1\!/_2)$ and (iii) the probability of a fixed share being turned down is non-increasing in the size of the total available pie. And for proposers they predict that they keep a share of $\sigma_p \leq r_p$ with $\sigma_p \in ({}^1\!/_2, 1)$ where $r_p \in ({}^1\!/_2, 1)$ equals the share they would keep as dictators.

2.1. ERC in ultimatum bargaining with nonzero conflict payoffs

In bargaining experiments conflict payoffs are usually normalized to zero. After all, assuming that players are selfish payoff maximizers, nonzero conflict payoffs - symmetric or not - shouldn't alter demands by more than a linear shift with only the surplus being divided

[8] If not mentioned otherwise, s_i refers to the lower threshold share also denoted by $\underline{s}_i$ and not to a possible upper threshold share denoted $\overline{s}_i$.

[9] At least in the vicinity of $\sigma_{1/n}$ it must be true that for $\tilde{\sigma}_i > \sigma_{1/n}$, $\frac{\partial v_i}{\partial \sigma_i} < 0$. As $\frac{\partial v_i}{\partial x_i} \geq 0$, v_i must have a maximum at or above $\sigma_{1/n}$.

[10] For $\sigma_i < {}^1\!/_n$, $\frac{\partial v_i}{\partial \sigma_i} > 0$; and, as $\frac{\partial v_i}{\partial x_i} \geq 0$ the (lower) acceptance threshold must be strictly greater 0. Furthermore, for $x_i > 0$ and $\sigma_i = {}^1\!/_n$, v_i must be at least as high as for $x_i = 0$ and $\sigma_i = {}^1\!/_n$, which implies that $s_i \leq {}^1\!/_n$.

among the players. If, however, one assumes that subjects are inequality averse, the resulting nonlinearity in the motivation function may predict behavior which is essentially different.

In order to analyze the impact of an ERC–type motivation function on the subgame perfect Bayesian equilibrium prediction of the UGAC, assumption 3 must first be specified more precisely:

Assumption 4 $\frac{\partial v_i}{\partial \sigma_i}$ has only one null, which lies at $\sigma_i = 1/2$; and $\frac{\partial^2 v_i}{\partial \sigma_i^2}(\sigma_i = 1/2) < 0$.

When modeling the valuation of conflict one could think of two alternative concepts. The first assumes that conflict payoffs are certain and therefore 'off the agenda', meaning that they are not part of the negotiation. This is similar to the equilibrium play of the classical subgame perfect solution assuming selfish payoff maximizing subjects. While conflict is an integral part of the solution concept, it never occurs in the resulting equilibrium and therefore constitutes a counterfactual assumption.

As both, ERC and F&S rely on a Bayesian equilibrium framework, the probability that play ends in conflict, however, is positive. Furthermore, the game itself allows for outcomes giving more to one party than she would obtain in conflict. Assuming now that conflict behaviorally is 'off the agenda' required some kind of common agreement. It is hard to imagine where this agreement could be based on. If one, nevertheless, applied this principle, it is easy to show that both ERC and F&S predict demands of constant shares of the surplus, independent of the composition of conflict payoffs. As Fischer et al. (2004) show this is not the case, neither in Ultimatum nor in Nash demand games.

Given these experimental observations and the fact that models of distributive fairness explicitly concentrate on the final and total outcome of a game, the following alternative, taking conflict into the motivation function will be used in this survey: In conflict a subject i obtains a pecuniary payoff of c_i and a relative payoff of c_i/C and not of 0 and $1/2$, which is reflected in the following reformulation of definition 1:

Definition 3 In the ultimatum game with non–zero conflict payoffs $c_i, c_j \geq 0$ (with $C = c_i + c_j > 0$ and $C < p$), the lowest share a subject is still willing to accept must satisfy the following condition:

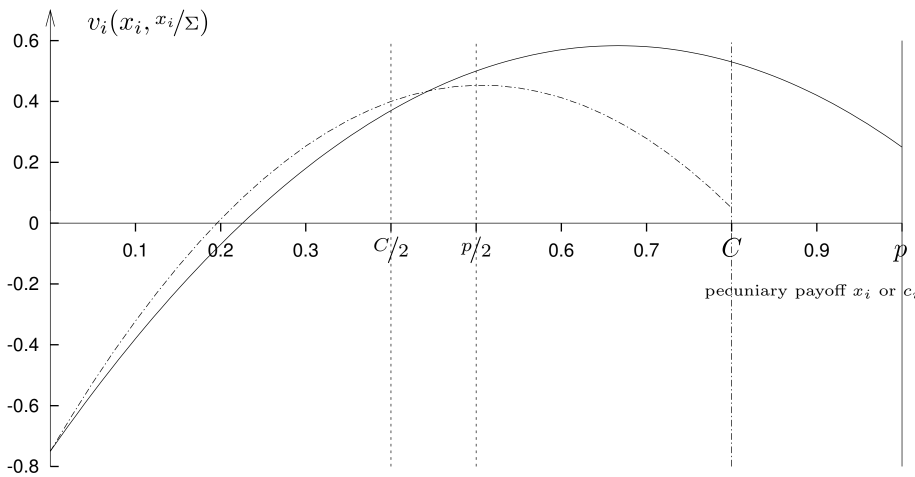
$$\underline{s}_i : v_i(\underline{s}_i p, \underline{s}_i) = v_i(c_i, c_i/C)$$

Furthermore, the same condition must hold for a possibly but not necessarily existent upper threshold share $\overline{s}_i$, depicting that share of the pie above which the subject would reject any higher offer.

2.2. Properties of the lower acceptance threshold

With respect to the UGAC game, the adjusted motivation function now has the following properties:

Property ERC 1 The functional form of the motivation function for a sum of payoffs $\Sigma = C$, i.e. $v_i(x_i, x_i/C)$ and that for a sum of p, i.e., $v_i(x_i, x_i/p)$ intersect[11] at payoff $\hat{x}_i$ with $\hat{x}_i \in (C/2, p/2)$. For payoffs $\dot{x}_i$ with $0 < \dot{x}_i < \hat{x}_i$ the valuation of conflict is higher than that of agreement, i.e., $v_i(\dot{x}_i, \dot{x}_i/C) > v_i(\dot{x}_i, \dot{x}_i/p)$ and for payoffs $\ddot{x}_i$ with $p \geq \ddot{x}_i > \hat{x}_i$ it is the other way around, i.e., $v_i(\ddot{x}_i, \ddot{x}_i/C) < v_i(\ddot{x}_i, \ddot{x}_i/p)$. Furthermore, $v_i(0, 0/C) = v_i(0, 0/p)$.



NOTE: Function used is $v_i(x_i, {}^{x_i}/\Sigma) = x_i - 3\,({}^{x_i}/\Sigma - 0.5)^2$ once in case of an agreement, i.e., for $\Sigma = p = 1$ (solid line) and once in case of conflict, i.e., for $\Sigma = C = 0.8$ (dotted line).

Figure 1: Example of motivation function

The proof of property ERC 1 is described in appendix A.1 and the graphs in figure 1 illustrate property ERC 1 of the motivation function by ways of an example. The functional form satisfies all assumptions mentioned above, but nevertheless is only an example and by no means the only function for which the statements and proofs are valid or based on. In figure 1 the solid line gives a subject's valuation of an agreement as a function of his payoff x_i ($\Sigma = p = 1$) whereas the dotted line gives the same subjects valuation of conflict as a function of his own conflict payoff c_i ($\Sigma = C = 0.8$).

This property already allows to derive two borders for the acceptance threshold $\underline{t}_i = \underline{s}_i p$:

Property ERC 2 For $0 < c_i < {}^C/2$ every responder rejects an offer at or below his conflict payoff c_i and for $c_i \geq {}^p/2$ threshold $\underline{t}_i$ must be smaller than c_i. In detail:

$$\underline{t}_i \begin{cases} > c_i & \text{for } 0 < c_i < {}^C/2 \\ < c_i & \text{for } {}^p/2 < c_i \leq C \end{cases}$$

The proof of this property can directly be drawn from property ERC 1 and follows from the relation of conflict versus agreement valuation described therein. Another property of the motivation function with importance especially for $c_i < {}^p/2$ is the following:

Property ERC 3 The lowest share a responder is still willing to accept (s_i) can not be greater than the share he would obtain in conflict (${}^{c_i}/C$), i.e. $s_i \leq {}^{c_i}/C$ and therefore $\underline{t}_i \leq {}^{pc_i}/C$.

Proof Holding the obtained share σ_i constant at $\overline{\sigma}_i$, we derive v_i with respect to Σ. As

$$\frac{dv_i(\overline{\sigma}_i\Sigma, \overline{\sigma}_i)}{d\Sigma} = \overline{\sigma}_i \frac{\partial v_i}{\partial x_i} \geq 0, \tag{5}$$

[11] Note that the intersection of the functional forms can lie outside the defined intervals of the motivation functions, e.g. for some $C < {}^p/2$.

the same share never yields a lower valuation if the pecuniary payoff is higher.[12] Consequently, as accepting the conflict share ${c_i}/{C}$ of p always yields at least the same valuation as conflict ($v_i({pc_i}/{C}, {c_i}/{C}) \geq v_i(c_i, {c_i}/{C})$), no *lower* acceptance threshold can lie above ${pc_i}/{C}$.

Up to now the analysis allowed for subjects who dislike inequality to their advantage more than inequality to their disadvantage.[13] Given that the feeling of obtaining less than others is supposedly stronger than a possible disliking of being treated preferentially, it is reasonable to limit inequality aversion such that no subject reflects a higher aversion towards advantageous inequality than towards disadvantageous. Therefore it is imposed:

Assumption 5 No subject dislikes inequality towards his advantage more than he dislikes inequality towards his disadvantage; i.e. $\frac{\partial v_i}{\partial \sigma_i}(\tilde{\sigma}_i) \geq -\frac{\partial v_i}{\partial \sigma_i}(1-\tilde{\sigma}_i)$ for all $\tilde{\sigma}_i < 1/2$.

For the UGAC this implies

Lemma 1 For $c_i > C/2$ the relation

$$v_i\left(C - c_i, \frac{(C-c_i)}{p}\right) < v_i\left(C - c_i, \frac{(C-c_i)}{C}\right) \leq v_i\left(c_i, \frac{c_i}{C}\right)$$

always holds.[14]

This in turn implies:

Property ERC 4 For $c_i \geq C/2$ lower acceptance threshold $\underline{t}_i$ satisfies $\underline{t}_i \geq C - c_i$.

By imposing assumption 4, every subject was forced to be at least a bit inequality averse. In order to allow for fully selfish subjects the following assumption is added:

Assumption 6 Contrary to assumption 4 subjects may have a motivation function which is completely independent of payoff share σ_i, implying that ${\partial v_i}/{\partial \sigma_i} = 0$ for all $\sigma_i \in [0,1]$. Furthermore, such subjects have a strictly increasing valuation in the pecuniary payoff, i.e., ${\partial v_i}/{\partial x_i} > 0$.

The implications of this assumption are straight forward. A fully selfish subject gets the same valuation for the same pecuniary payoff independently of the sum off all payoffs.Therefore the motivation functions for $\Sigma = C$ and $\Sigma = p$ lie on each other and are nondecreasing in the pecuniary payoff implying:

Property ERC 5 A fully selfish subject as defined in assumption 6 always accepts an offer equal to or above c_i, i.e., $\underline{t}_i = c_i$.

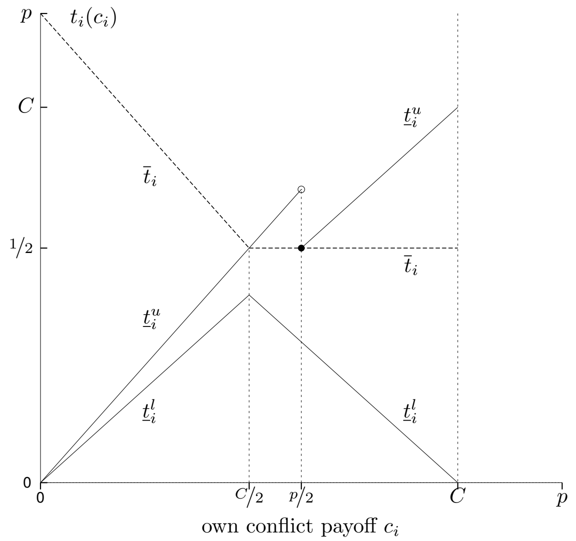
One now can define for every c_i an interval inside which the lower acceptance threshold $\underline{t}_i$ must lie if subjects are inequality averse as formulated by ERC:

Statement 1 Under ERC-type inequality aversion, as adopted to the class of ultimatum games with asymmetric conflict here, the lowest offer $\underline{t}_i$ a responder is still willing to accept

[12] Note that $\frac{\partial \tilde{\sigma}_i}{\partial \Sigma} \equiv 0$ by assumption.

[13] In this context the terms advantageous and disadvantageous do not refer to an inequality averse evaluation of an outcome, but to the traditional selfish notion of 'more for oneself is better'.

[14] The proof of lemma 1 can be found in appendix A.2.



NOTE: $\underline{t}_i^l$ and $\underline{t}_i^u$ stand for the lower and upper border of the predicted interval for the lower acceptance threshold $\underline{t}_i$ (at $c_i = p/2$: $\underline{t}_i^u = p/2$), whereas $\bar{t}_i$ sketches the smallest possible value for an upper threshold.

Figure 2: ERC: Range of t_i as a function of c_i

can not lie - depending on whether the particular interval for c_i is defined[15]- outside the following intervals:

$$\underline{t}_i \in \begin{cases} [c_i, \frac{c_i}{C}p] & \text{for } c_i \leq \frac{C}{2} \\ [C - c_i, \frac{c_i}{C}p] & \text{for } \frac{C}{2} < c_i < \frac{p}{2} \\ [C - c_i, c_i] & \text{for } c_i \geq \frac{p}{2} \end{cases} \tag{7}$$

The intervals of statement 1 are illustrated in figure 2 as a function of the own conflict payoff c_i, given a constant sum $c_i + c_j = C > p/2$. The lowest border of the intervals for $\underline{t}_i$ given in statement 1 is indicated by $\underline{t}_i^l$, the upper one by $\underline{t}_i^u$. Note that the discontinuity in $\underline{t}_i^u$ at $c_r = p/2$ does not imply that actual schedules of $\underline{t}_i$ have such a discontinuity.

An intuitive explanation for the first interval in statement 1 is that for $c_i \leq C/2$, accepting an offer equal to the conflict payoff c_i yields the same pecuniary payoff but a worse share ($c_i/p < c_i/C$), i.e., the lowest offer which is still accepted can not lie below c_i. At the same time, accepting a share c_i/C of p yields the same share as in conflict but a higher pecuniary payoff, which implies that $\underline{t}_i \leq pc_i/C$. The intuition behind the third interval is similar: In case of $c_i \geq p/2$ a subject who dislikes inequality to his advantage would be willing to accept less than c_i in order to avoid the less equitable outcome $c_i/C > 1/2$ (i.e. $t_i \leq c_i$).

So far, the intervals only allow to make predictions about the distribution of acceptance thresholds. However, at least one prediction can be made about individual patterns of acceptance thresholds. For responder conflict payoffs of $c_i < C/2$ it is easy to show that $dv_i(c_i, c_i/C)/dc_i > 0$ and $dv_i(x_i, x_i/p)/dx_i > 0$. Therefore, valuation of conflict increases in c_i, which must be matched by the increasing valuation of agreements in increasing x_i, which implies the following property:

[15]In case of $C < p/2$, statement 1 is reduced to the first two intervals.

Property ERC 6 For responder conflict payoffs of $c_i < {}^{C}/_2$ every individual's acceptance threshold $\underline{t}_i$ strictly increases in c_i.

2.3. Properties of the upper acceptance threshold

As assumption 3 allows for decreasing valuation of increasing pecuniary payoffs if the share of payoffs is high it is fairly possible that a subject has, in addition to the lower, also an upper acceptance threshold $\bar{t} = \bar{s}p$. By definition of s_i, both $\bar{s}_i$ and $\underline{s}_i$ must yield the same valuation, i.e. $v_i(\bar{s}_i p, \bar{s}_i) = v_i(\underline{s}_i p, \underline{s}_i)$. Furthermore, individually $\bar{s}_i \geq \underline{s}_i$ must always hold.[16] Therefore the following condition must be satisfied:

$$\begin{aligned} v_i(\bar{s}_i\Sigma, \bar{s}_i) - v_i(\underline{s}_i\Sigma, \underline{s}_i) &= \int_{\underline{s}_i}^{\bar{s}_i} \frac{dv_i}{d\sigma_i} d\sigma_i = \Sigma \int_{\underline{s}_i}^{\bar{s}_i} \frac{\partial v_i}{\partial x_i} d\sigma_i + \int_{\underline{s}_i}^{\bar{s}_i} \frac{\partial v_i}{\partial \sigma_i} d\sigma_i \\ &= \Pi_i + \Theta_i = 0 \end{aligned} \tag{8}$$

Given assumption 2, $\Pi \geq 0$. From assumption 4 and 5 it follows that

$$\Theta \begin{cases} > 0 & \text{for } \underline{s}_i < {}^1/_2 \text{ and } \bar{s}_i \leq 1 - \underline{s}_i \\ \gtreqless 0 & \text{for } \underline{s}_i \leq {}^1/_2 \text{ and } \bar{s}_i > 1 - \underline{s}_i \\ \leq 0 & \text{for } \underline{s}_i \geq {}^1/_2 \ . \end{cases} \tag{9}$$

In combination with statement 1 this result implies

Statement 2 If existent, a respondent's upper acceptance threshold $\bar{t}_i$, i.e. the payoff above which he would reject any (higher) offers must satisfy $\bar{t}_i(c_i) \geq \underline{t}_i(c_i)$ and has the following characteristics:

$$\bar{t}_i \begin{cases} \geq \frac{(C-c_i)}{C} p & \text{for } c_i \leq \frac{C}{2} \\ \geq \frac{p}{2} & \text{for } c_i > \frac{C}{2} \end{cases} \tag{10}$$

2.4. Proposer offers

Overall, inequality aversion affects proposer offers via two channels: i) Expected inequality aversion of responders affects the likelihood of acceptance and ii) proposer's own inequality aversion affects their own valuation of pie divisions. In detail a proposer or "first mover" faces the following maximization problem:

$$\underset{\sigma_p}{\operatorname{argmax}} \left((1 - F^s(\sigma_r))\, v_p(\sigma_p p, \sigma_p) + F^s(\sigma_r)\, v_p(c_p, {}^{c_p}/_C) \right) \tag{11}$$

where $F^s(\sigma_r)$ is the expected probability that the share $\sigma_r = 1 - \sigma_p$ offered to the responder lies within her acceptance region $[\underline{s}_r, \bar{s}_r]$.

Property ERC 7 In case of $c_r \leq {}^{C}/_2$, as long as $r_p \leq 1 - {}^{c_r}/_C$ a proposer would always demand the share r_p ($r_p \in [{}^1/_2, 1]$) of p which maximizes his own motivation function and equals what he would give as a dictator.

[16] Lower threshold share $\underline{s}_i$ is only defined for ${}^{dv_i}/_{dx_i} > 0$, whereas upper threshold share $\underline{s}_i$ only exists for payoffs with ${}^{dv_i}/_{dx_i} < 0$. Clearly both conditions can not be satisfied at the same time, and the latter condition can only apply for shares greater ${}^1/_2$ implying the stated relation.

Property ERC 7 (proven in appendix A.3) implies that expected inequality aversion of responders does not affect proposer behavior only for (very) small responder conflict payoffs. It is impossible to make further detailed statements about proposer behavior without imposing further restrictions on the utility functions and on the expected distribution of thresholds $\underline{t}_r$ and $\bar{t}_r$ in the population.[17] One could of course make an assumption similar to that of positive likelihood for all possible levels of s_i and r_i, stating that proposers correctly expect that all possible thresholds occur with positive probability. However, for further predictions on proposer offers, even this restriction is not sufficient. Predictions crucially depend on the exact distribution of expected thresholds and on the exact functional form of proposer utility. Such detailed assumptions are not in the spirit of the general approach of the ERC–model which is why such additional restrictions are not being imposed in this survey.

3. Fehr and Schmidt (1999) inequality aversion in the UGAC

While Bolton and Ockenfels (2000) do not suggest a particular functional form of inequality averse utility and, furthermore, do not explicitly distinguish between advantageous and disadvantageous inequality, Fehr and Schmidt (1999) do so. They assume that inequality averse utility is not only linear in one's own payoff but also in the average distance of one's own payoff to that of other players. Here they distinguish between the average distance of ones own payoff to higher ones on the one hand and to smaller ones on the other. Considering a set of n players and a vector $x = (x_1, x_2, \dots, x_n)$ of monetary payoffs among all subjects, they define inequality averse utility as:

$$U_i(x) = x_i - \alpha_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta_i \frac{1}{n-1} \sum_{j \neq i} \max\{x_i - x_j, 0\} \qquad (12)$$

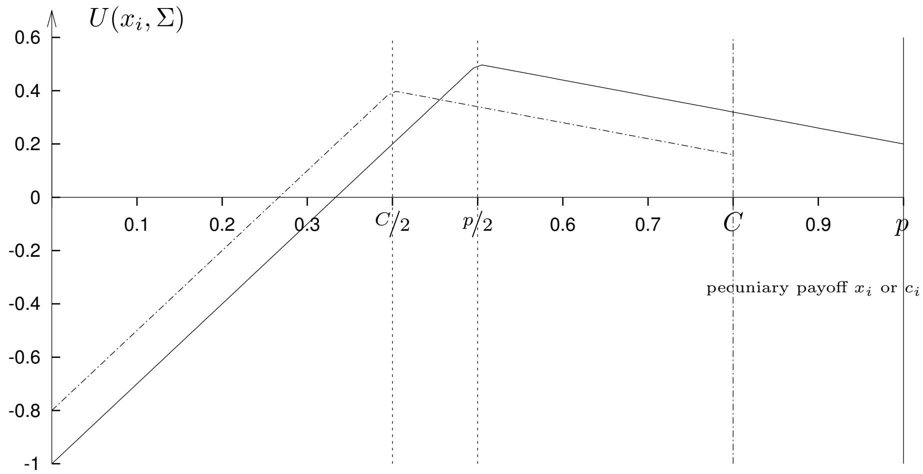
where β_i and α_i are subject specific coefficients indicating inequality aversion towards one's advantage on the one and towards one's disadvantage on the other hand, with $\beta_i \leq \alpha_i$ and $0 \leq \beta_i < 1$. In the two party ultimatum game this function reduces to

$$U_i(x) = \begin{cases} -\alpha_i \Sigma + (1 + 2\alpha_i) x_i & \text{for } x_i < \Sigma/2 \\ \beta_i \Sigma + (1 - 2\beta_i) x_i & \text{for } x_i \geq \Sigma/2 \end{cases} \qquad (13)$$

where $\Sigma = x_i + x_j = p$ in case of an accepted offer and $\Sigma = c_i + c_j = C$ in case of a rejection. An example similiar to the one given for the ERC motivation function is given in figure 3. Again the solid line gives subject i's utility in case he obtains x_i in an agreement, whereas the dotted line gives the utility he obtains in case of a rejection which results in c_i for him and $c_j = C - c_i$ for the other subject. In the example the individual coefficients are set to $\alpha_i = 1$ and $\beta_i = 0.8$. For $\beta_i = 1/2$ the right hand branch of each of the two graphs would be horizontal and for $\beta_i < 1/2$ it is increasing at a rate not above that of the left hand branch. As can be seen in figure 3, the F&S utility function has quite similar properties to the ERC motivation function which is reflected in the following property (for a proof, see appendix B.1).

Property F&S 1 For $\beta_i > 0$ a subject's utilityfunction for a total payoff of C (i.e., $U_i(x, C)$), and that for a total payoff of p (i.e., $U_i(x, p)$), intersect at payoff $\hat{x}_i = \frac{\alpha_i p + \beta_i C}{2(\alpha_i + \beta_i)}$ with $U_i(x, C) \geq U_i(x, p)$ for $x_i \leq \hat{x}_i$ and $U_i(x, C) < U_i(x, p)$ for $x_i > \hat{x}_i$. The point of intersection $\hat{x}_i$ lies within

[17] See Güth and Napel (2002) who rely on (different) functional specifications to obtain unambiguous results.



NOTE: Utility functions for $\alpha_i = 1$ and $\beta_i = 0.8$ once in case of an agreement, i.e. for $\Sigma = p = 1$ (solid line) and once in case of conflict, i.e., for $\Sigma = C = 0.8$ (dotted line).

Figure 3: Example of utility function according to Fehr and Schmidt (1999)

the interval $\hat{x}_i \in \ ({}^{(p+C)}/_4, {}^p/_2)$. Furthermore, for $\beta_i = 0$ and $x_i > {}^p/_2$ both functions lie on each other.

3.1. Properties of the lower acceptance threshold

Similar to the analysis of ERC type valuation in the UGAC, it is now investigated in what range the lowest payoff a subject is still willing to accept $\underline{t}_i$ lies according to the F&S model. The definition of the utility function according to F&S is very detailed and only leaves degrees of freedom to coefficients α_i and β_i. Therefore, while laborious, the derivations and proofs are not very complicated which is why they are relegated to the appendix (see appendix B.2). Similar to the ERC model the following statement concerning $\underline{t}_i$ can be made:

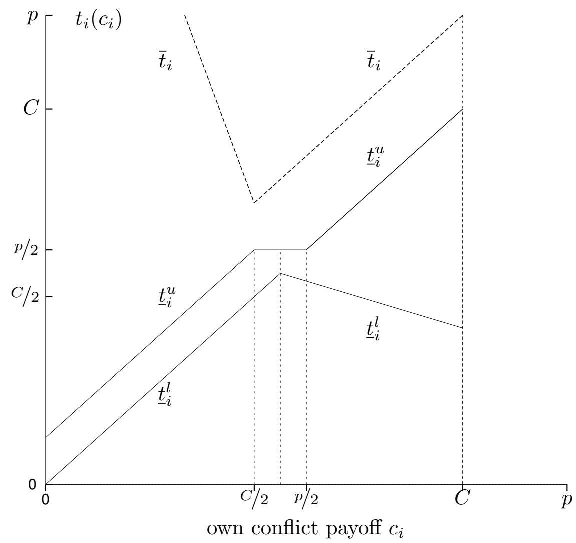
Statement 3 Assuming inequality aversion as outlined by Fehr and Schmidt (1999), a responder i has an acceptance threshold $\underline{t}_i$ which depending on his aversion parameters α_i and β_i and his conflict payoff c_i lies within the following (if defined[18]) intervals:

$$\underline{t}_i \in \begin{cases} [c_i, c_i + {}^{(p-C)}/_2) & \text{for } \ c_i < {}^C/_2 \\ [c_i, {}^p/_2) & \text{for } \ {}^C/_2 \leq c_i < {}^{(C+p)}/_4 \\ ({}^{(C+p-c_i)}/_3, {}^p/_2) & \text{for } \ {}^{(C+p)}/_4 \leq c_i \leq C \\ ({}^{(C+p-c_i)}/_3, c_i] & \text{for } \ c_i \geq {}^p/_2 \end{cases} \tag{14}$$

3.2. Properties of the upper acceptance threshold

For $\beta_i > {}^1/_2$ the right hand branch of the F&S utility function bends downwards, implying a responder would loose utility if he were to accept an higher offer. Consequently, similar to the

[18]Note that for example for $C < {}^p/_2$ interval $c_i > {}^p/_2$, or, that for $C < {}^p/_3$ interval ${}^{(C+p)}/_4 < c_i \leq C$ and $c_i > {}^p/_2$ are not defined, reducing statement 3 to the remaining intervals.



NOTE: $\underline{t}_i^l$ and $\underline{t}_i^u$ stand for the lower and upper border of the predicted interval for the lower acceptance threshold $\underline{t}_i$ whereas $\bar{t}_i$ sketches the lowest possible value for a possible upper threshold.

Figure 4: Range of t_i as a function of c_i in the F&S model

ERC model reponders may have an upper acceptance threshold $\bar{t}_i$ which is summarized (for a proof, see appendix B.3) in

Statement 4 An inequality averse responder i with a utility function as outlined by Fehr and Schmidt (1999) can have an upper acceptance threshold $\bar{t}_i$ which depends on his coefficients of inequality aversion α_i and β_i, his conflict payoff c_i and parameters C and p. If the threshold exists, it satisfies

$$\bar{t}_i \begin{cases} < C + p - 3c_i & \text{for } c_i \leq C/2 \\ > p - C + c_i & \text{for } c_i > C/2 \; . \end{cases} \tag{15}$$

Similar to figure 2, figure 4 plots the upper ($\underline{t}_i^u$) and lower border ($\underline{t}_i^l$) of lower acceptance threshold $\underline{t}_i$ and the lower border of a possible upper threshold $\bar{t}_i$.

3.3. Proposer behavior

Contrary to the ERC model, F&S predicts that in a dictator game, dictators either give nothing ($\beta_i < 1/2$) or exactly half of the available pie ($\beta_i > 1/2$).[19] Clearly, as his offer would always be accepted (see statement 3 and 4), a proposer offering half the available pie as a dictator should give the same in the UGAC in cases where responder conflict payoff $c_r < p/2$.[20]

[19]Note, however, that for $\beta_i = 1/2$ all offers between zero and half the pie are possible.

[20]Giving half the available pie as a dictator implies that F&S utility has a maximum at $p/2$ in case of an agreement or at $C/2$ in case of conflict. This corresponds to $\beta_i \geq 1/2$. However, given property F&S 1, the former must be greater than the latter for all $C < p$.

Property F&S 2 A proposer giving half of the available pie in a dictator game, also gives half the available pie to the responder in cases where responder conflict payoff is smaller than $p/2$.[21]

Similar to property ERC 7, one may state that for very small responder conflict payoffs, expected responder inequality may not affect proposer behavior. However, contrary to ERC, F&S predict positive acceptance thresholds even for responder conflict payoffs of zero.

4. Experimental design

In order to systematically test the effects of nonzero and asymmetric conflict payoffs in the ultimatum game, an experiment consisting of three parts and employing the strategy vector method (Selten, 1967) was implemented in the laboratory. To be able to correlate proposer giving in the ultimatum game to dictator giving, subjects in a first stage encountered the dictator game. In a second stage several ultimatum games, differing only in conflict payoffs, were played. This stage was followed by a third stage which, however, is not of interest for this study and will be analyzed in an other survey. No feedback was given between stages and instructions for later parts of the experiment were not distributed at earlier stages.

In detail the experiment proceeded as follows. First subjects were handed general instructions, informing them about the general procedure of the experiment and about the exchange rate of €2.20 per 15 ECU (*Experimental Currency Unit*). Furthermore these instructions informed subjects that they have one of two different roles, but that they will not be informed about their role until the end of the session. Following the distribution of the instructions for the first part, not knowing their role, subjects played a dictator game, i.e. all subjects submitted how much of a total pie of 15 they give in case they were the dictator. In the second part subjects played 15 different UGAC, which differed in the conflict payoffs. In detail seven conflict payoff vectors had a sum of payoffs of $C = 12$, five a sum of $C = 8$ and two a sum of $C = 2$ and were defined by $(c_r, c_p) = (2i, C - 2i)$ for $i = 0, 1, \ldots, C/2$. The 15th vector was the usual null vector (0, 0). Subjects decided in both roles. As proposers they submitted how they want to divide the total available pie $p = 15$. As responders they stated for each of the 16 possible integer offers whether they accept or reject. The order of the 30 confronted screens which differed in role and conflict vector was randomized independently for every subject. Only after the end of the second part subjects obtained the instructions for the third part (not analyzed in this study) which was similar in length to the second part.[22]

Only after the end of the last game of the third part subjects were informed about their role and about the result of each part. In order to obtain both, a (in terms of real money) reasonable sized pie and a somewhat balanced relation in the payoff relevance of experimental parts, in stage 2 only four randomly selected games were paid.[23] Matching in the payoff relevant decisions proceeded in a stranger design which was also common knowledge.

While the reasons to use the strategy vector method are grounded in the need for complete responder strategy vectors and are rather obvious, the use of this method, nevertheless, needs

[21] Note that for payoffs $x_i = \Sigma/2$, utility $U_i(x_i) = \Sigma/2$. Therefore, for $\beta > 1/2$ (and as $p > C$), a payoff of half the available pie constitutes not only the point of maximal utility for an agreement, but, furthermore is higher than any conflict utility.

[22] For a translation of instructions, see appendix C.

[23] An argumentation for sufficiently large rewards can, e.g. be found in Smith (1982). Cubitt et al. (1998) discuss the pro and contra of a pure random lottery design. In three experiments, however, they do not find significant differences between random lottery payoff rules and single choice baseline treatments.

some more scrutiny. Previous research on experimental methods or protocol has shown that in many situations it makes a difference which method is being used.[24] Oxoby and McLeish (2004), however, show that behavior in ultimatum games is rather stable and invariant to (strategically equivalent) experimental protocol. They conclude "*...that the use of the strategy vector method for eliciting participants' behavior in sequential bargaining experiments may not significantly bias individuals' behavior*" (Oxoby and McLeish, 2004, p. 403).

Due to the strategy vector method and that no information between stages is given, subjects have no opportunity to learn about the behavior of others. While in many experiments this could be seen as a downfall, in this case it is an advantage as it reduces the risk of learning effects changing behavior over the course of the experiment.

5. Experimental predictions

Concerning predictions of behavior there are several problems arising from discreteness in strategy and payoff space. The first is of mainly technical nature. Predictions may include digits. Remember that in both models, a responder's utility is always nondecreasing in agreement payoff y for all $y < p/2$. A responder having a threshold $\underline{t} \notin \mathbb{N}$ therefore would always round his threshold to ceiling if the resulting threshold $\tilde{\underline{t}} \leq p/2$ (with $\tilde{\underline{t}} \in \mathbb{N}$ and $0 < \tilde{\underline{t}} - \underline{t} < 1$). In the F&S model the argument can, furthermore, be adopted for thresholds $\underline{t} > p/2$. Due to linearity, a *lower* acceptance threshold $\underline{t} > p/2$ implies that the responder's utility function is nondecreasing in y also for agreement payoffs $y > p/2$, i.e. again one can round to ceiling if $\underline{t} \notin \mathbb{N}$ and $\underline{t} > p/2$. In all other cases non-monotonicity may result in opposite behavior, requiring to round non integer predictions such that intervals are widened, giving theory the best chance.

The other problem is due to the nature of the ultimatum game. Assume the proposer offers exactly c_r to the responder. A completely selfish responder now is indifferent between accepting and rejecting the offer. To resolve the responder's indifference, the proposer must offer him $c_r + \varepsilon$ with $\varepsilon > 0$. Whereas in continuous space $\varepsilon \mapsto 0$, in discrete it must equal the smallest possible unit ($u = 1$ECU). Alternatively one may assume that indifferent responders always accept. However, responders having the reputation to accept if indifferent will earn less than those being known to reject. Although the experiment does not allow for reputation building, some prediction intervals must be adjusted according to this indifference problem. On the other hand, one may argue that every subject is at least to some infinitesimally small degree inequality averse. Then, depending on whether conflict payoffs are unequal towards the responder's advantage or disadvantage this 'almost' selfish type either accepts or rejects an offer identical to his conflict payoff. In detail, in the ERC model the strict relations in property ERC 2 are restored. In the F&S model, the exclusion of fully selfish types is reached for setting $\beta_i > 0$ which culminates in the following different predictions: $\underline{t}_i^l > c_i$ for $c_i < \frac{(p+C)}{4}$ and $\underline{t}_i^u < c_i$ for $c_i > \frac{p}{2}$.

In the following two different prediction intervals will be analyzed for each model. Interval $I^{\min}$ applies the minimal inequality aversion principle and interval I^u allows for selfish types and applies the "reject if indifferent" principle. All intervals are listed in table 1. Here, interval I^{strict} is the interval resulting from applying the formulas and assuming continuous strategy

[24] This considers mainly effects of order of play, see e.g., Rapoport (1997) and Brosig et al. (2003).

Table 1: Experimental predictions: Intervals of lower acceptance thresholds

		ERC			F&S		
C	$(c_p\,, c_r)$	I^{strict}_{ERC}	$I^{\min}_{ERC}$	I^{u}_{ERC}	$I^{\text{strict}}_{F\&S}$	$I^{\min}_{F\&S}$	$I^{u}_{F\&S}$
12	(12, 0)	[0, 0]	[0, 0]	[0, 1]	[0 ,1.5]	[0, 2]	[0, 2]
	(10, 2)	[2, 2.5]	[2, 3]	[2, 3]	[2 ,3.5]	[2, 4]	[2, 4]
	(8 , 4)	[4, 5]	[4, 5]	[4, 5]	[4 ,5.5]	[4, 6]	[4, 6]
	(6 , 6)	[6, 7.5]	[6, 8]	[6, 8]	[6 ,7.5]	[6, 8]	[6, 8]
	(4 , 8)	[4, 8]	[4, 8]	[4, 9]	[6.33, 8]	[7, 8]	[7, 9]
	(2 ,10)	[2, 10]	[2, 10]	[2,11]	[5.66, 10]	[6,10]	[6, 11]
	(0 ,12)	[0, 12]	[0, 12]	[0,13]	[5 , 12]	[5,12]	[5, 13]
8	(8 , 0)	[0, 0]	[0, 0]	[0, 1]	[0 ,3.5]	[0, 4]	[0, 4]
	(6 , 2)	[2, 3.75]	[2, 4]	[2, 4]	[2 ,5.5]	[2, 6]	[2, 6]
	(4 , 4)	[4, 7.5]	[4, 8]	[4, 8]	[4 ,7.5]	[4, 8]	[4, 8]
	(2 , 6)	[2,11.25]	[2, 12]	[2,12]	[5.66,7.5]	[6, 8]	[6, 8]
	(0 , 8)	[0, 8]	[0, 8]	[0, 9]	[5 , 8]	[5, 8]	[5, 9]
2	(2 , 0)	[0, 0]	[0, 0]	[0, 1]	[0 ,6.5]	[0, 7]	[0, 7]
	(0 , 2)	[0, 15]	[0, 15]	[0,15]	[2 ,7.5]	[2, 8]	[2, 8]
0	(0 , 0)	[0, 7.5]	[0, 8]	[0, 8]	[0 ,7.5]	[0, 8]	[0, 8]

space. Note that both $I^{\min}$ and I^u are rounded,[25] that the former coincides with the rounded intervals of I^{strict}, and, that the lower border in I^u never differs from $I^{\min}$.

The models only allow some minor predictions concerning proposer behavior. However, as in both models dictator giving is a good measure of inequality aversion it is possible to state a broader prediction. Assuming that beliefs about responder acceptance behavior is independent of one's own inequality aversion[26] at least for unequal conflict payoffs dictator giving and ultimatum giving can be correlated. Lets assume that there are only two types of proposers: (highly) inequality averse and selfish, and, furthermore assume that both have the same (correct) beliefs concerning acceptance behavior. Denote by $y^\star$ the resulting proposer's offer prescribed by payoff maximization. If both, conflict and $y^\star$ favours the proposer, the inequality averse proposer can not offer less than $y^\star$. If, however, conflict and $y^\star$ favors the responder, it is exactly the other way around. I.e. there is either no, or a positive correlation between dictator and ultimatum giving in the former and a negative one in the latter case.

6. Experimental results

Altogether three sessions with 24 subjects each were conducted in the computer laboratory of the Max Planck Institute in Jena, which features a network of computers installed in separated booths. The experiment relied on the Z-tree ("*Zürich Toolbox for Readymade Economic Experiments*"; see Fischbacher, 1999) software. Subjects were mostly students from various fields of

[25] Also note that integer predictions resulting from strict relations (e.g. $\underline{t} < c_i$) are presented by their respective bound (e.g. $\underline{t} \mapsto c_i$) and not rounded to the next integer.

[26] Although both models, ERC and F&S rely on a perfect Bayesian equilibrium framework, both are rather evasive as to how beliefs are formed. Implicitly they assume perfect expectations. Clearly, perfect expectations implies independence between own inequality aversion and beliefs.

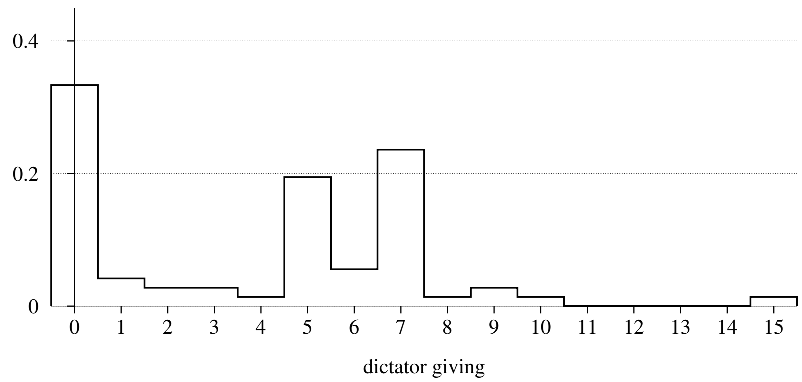


Figure 5: Dictator Giving

studies recruited at the Friedrich Schiller Universität Jena using the ORSEE (Greiner, 2004) recruiting tool software, which guaranteed that the same subjects did not participate twice and allowed to exclude subjects who participated recently in similar bargaining experiments at the Max Planck Institute.

Sessions lasted for about 55 Minutes, starting from admission and ending with the payments. On average subjects earned €11.54 (standard deviation 2.542). Due to the independent randomization of decision screens order effects within one stage are rather unlikely.

6.1. Dictator giving

A Histogram of dictator giving is plotted in figure 5. Average giving is 3.90 (standard deviation=3.41), median giving equals one third (5ECU) and giving nothing is modal. Note that, despite using the strategy vector method, this distribution strikingly resembles the one observed in a dictator experiment by Forsythe et al. (1994) who implemented the play method. Specifically, a Kolmogorov-Smirnov test can not reject the null hypothesis of no differences in distribution ($p = 0.07307$). Furthermore, a Wilcoxon rank sum test finds no differences in location ($p=0.2686$).[27]

6.2. Acceptance thresholds

In the second stage subjects played several ultimatum games. In the role of the responder subjects submitted complete strategy profiles. In altogether 1062 of the total 1080 cases a lower acceptance threshold was identifiable. Here, identifiable means that the player's acceptance profile either only exhibits a lower or both a lower and one upper threshold, but not more. A lower (upper) threshold is the smallest (largest) value a subject (still) accepts. The 18 cases with non-identifiable thresholds exhibit erratic behavior and are excluded from the following analysis.[28] Figures 6, 7, and, 8 plot histograms of thresholds $\underline{t}$ for all 15 possible conflict points. The figures are arranged such, that they can easily be compared to the theoretical

[27] Forsythe et al. (1994) ran two different dictator games. One with, and one without pay. For the comparison only data from the experiments with pay was taken. Furthermore, as Forsythe et al. (1994) used a different pie size, data was normalized to 1.

[28] The 18 cases with non-identifiable lower acceptance thresholds are observed in 5 subjects.

predictions plotted in figures 2 and 4. From the left to the right column responder conflict payoff increases, and histograms are turned on their right side. Solid horizontal lines show the median, dotted the average threshold. Strict ERC intervals I_{ERC}^{strict} are highlighted by small thick bars. The tables arranged below the histograms report the total number of identifiable thresholds (N), and, for each of the rounded predicted intervals,[29] listed in table 1 the interval itself, the number of observations within that interval (n in I) and the result of a binomial test testing wether actual behavior is more likely to be within the predicted intervals than N i.i.d. random draws from a uniform distribution size [0, 15].[30] Significant test results with $p < 0.01$, emphasized by a star (*), imply that the actually observed frequency of correct predictions can not result from naive behavior.

When assuming fully selfish types, both models are very accurate in the sense that the numbers of observations within intervals I^u are significant throughout. The picture, however, changes if one assumes that no subject can be fully selfish. Remember that this assumption in intervals $I^{\min}$ was only introduced in order to resolve the problem of indifference in discrete space. In both models, without selfish types, predictions for very high responder conflict payoffs in the $C = 12$ and, additionally in the ERC model for vector (0, 8) underestimate actual thresholds. Observe that, whereas for small responder conflict payoffs punishment of low offers can be observed to a substantial degree, there is hardly any indication for inequality averse responder behavior for high responder conflict payoffs of $c_r \geq 6$.

Another interesting aspect can be observed when comparing distributions for situations with zero conflict payoff for the responder. Except for conflict point (12, 0), distributions of thresholds for all conflict points with $c_r = 0$ are strikingly similar. Nonparametric tests prove that distributions of thresholds for (0, 0), (2, 0) and (8, 0) do neither differ in distribution, nor in location.[31] Only thresholds for (12, 0) are significantly smaller[32] than those for (0, 0), (2, 0) and (8, 0).

In line with property ERC 6 for a significant number of subjects thresholds are nondecreasing[33] in c_r for $c_r \leq C/2$. For $C = 12$ the number is 57 and for $C = 8$ it is 52 of the 67 subjects with identifiable thresholds for all conflict vectors. Given the high thresholds for high own conflict payoffs, this number only slightly decreases over the entire range of c_r, with 54 nondecreasing schedules for $C = 12$, 49 for $C = 8$ and 59 for $C = 2$.

In altogether 54 cases an upper acceptance threshold $\bar{t}$ can be identified. While for every combination of conflict payoffs at least two $\bar{t}$ are observed, there are six for (6, 6) and (4, 4). As the ERC prediction concerning $\bar{t}$ gives wider intervals than F&S, altogether 36 comply with ERC compared to only 19 for F&S. As the number of observations is too small, no meaningful statistics can be employed for individual conflict points. However, comparing to a success probability of 0.5 of an i.i.d. random draw, the ERC prediction is significantly more accurate (p=0.009917). The F&S prediction, however, is only significantly better when comparing to

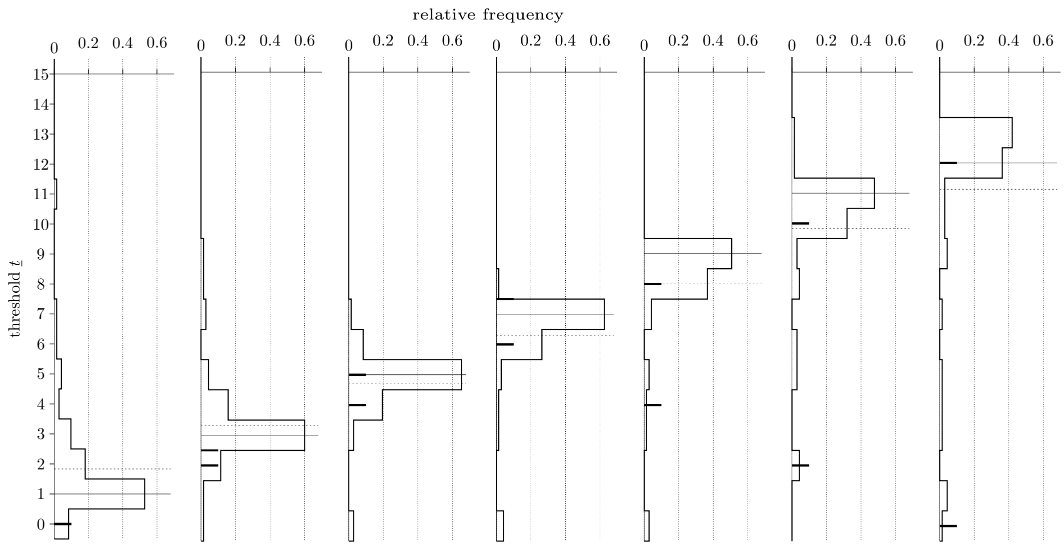
[29]Note that for $C = 2$ and 0, the two F&S intervals $I_{F\&S}^{u}$ and $I_{F\&S}^{\min}$ coincide.

[30]In detail, defining by n_I the actual, and by $n_I^e = \frac{\underline{t}^u - \underline{t}^l + 1}{16} N$ the expected number (assuming N uniform i.i.d. draws from [0, 15]) of observations within the predicted interval $\underline{t} \in [\underline{t}^l, \underline{t}^u]$ occurring by chance, the binomial test compares H_0: $n_I = n_I^e$ against alternative H_1: $n_I > n_I^e$. For $(c_p, c_r) = (0, 2)$ ERC prediction puts no restriction on the action space. Therefore this case is excluded from the analysis.

[31]Hollander test for bivariate symmetry (see Hilton and Gee (1997) and Hollander and Wolfe (1999)) and Mann Whitney test (two sided and paired) for differences in location. Significance level 1%.

[32]Pairwise comparisons by Mann Whitney test. One sided depending on relation of medians.

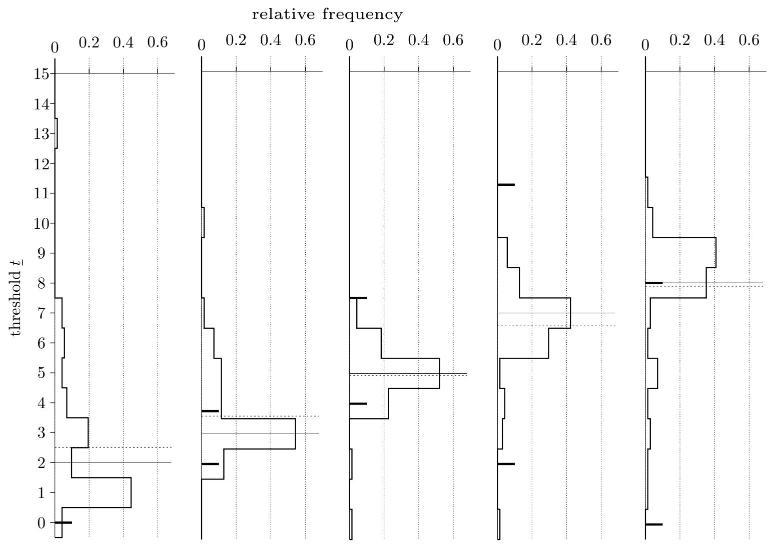
[33]Note that due to discreteness, property ERC 6 must be reformulated from 'strictly increasing' to 'nondecreasing'.



$(c_p,\, c_r)$	(12, 0)	(10, 2)	(8, 4)	(6, 6)	(4, 8)	(2, 10)	(0, 12)
N	72	70	72	72	71	69	69
$I^{\min}_{ERC}$	[0, 0]	[2, 3]	[4, 5]	[6, 8]	[4, 8]	[2, 10]	[0, 12]
n in I	6	50*	61*	65*	32*	34	40
(p-value)	(.294)	(<.001)	(<.001)	(<.001)	(.010)	(.901)	(.999)
I^{u}_{ERC}	[0, 1]	[2, 3]	[4, 5]	[6, 8]	[4, 9]	[2, 11]	[0, 13]
n in I	44*	50*	61*	65*	68*	67*	69*
(p-value)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
$I^{min}_{F\&S}$	[0, 2]	[2, 4]	[4, 6]	[6, 8]	[7, 8]	[6, 10]	[5, 12]
n in I	57*	61*	67*	65*	29*	29	34
(p-value)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(.038)	(.595)
$I^{u}_{F\&S}$	[0, 2]	[2, 4]	[4, 6]	[6, 8]	[7, 9]	[6, 11]	[5, 13]
n in I	57*	61*	67*	65*	65*	62*	63*
(p-value)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)

NOTE: *: significant at 1%; p-values (in parentheses) give results from binomial tests with H_0: Number of successes (n) equals number of successes of N uniform and i.i.d random draws from $[0, 15]$, versus H_1: Number of successes is greater. Solid lines highlight the median and dashed lines the mean. Small thick bars represent bounds of the strict ERC intervals.

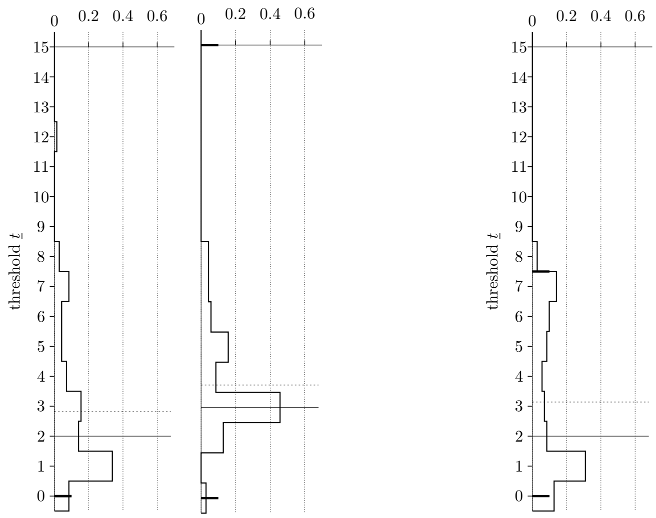
Figure 6: Distributions of lower acceptance thresholds for $C = 12$



$(c_p,\, c_r)$	(8, 0)	(6, 2)	(4, 4)	(2, 6)	(0, 8)
N	72	70	71	71	71
$I_{ERC}^{\min}$	[0, 0]	[2, 4]	[4, 8]	[2, 12]	[0, 8]
n in I	3	55*	69*	70*	38
(p-value)	(.8354)	(<.001)	(<.001)	(<.001)	(.7211)
I_{ERC}^{u}	[0, 1]	[2, 4]	[4, 8]	[2, 12]	[0, 9]
n in I	35*	55*	69*	70*	67*
(p-value)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
$I_{F\&S}^{min}$	[0, 4]	[2, 6]	[4, 8]	[6, 8]	[5, 8]
n in I	61*	68*	69*	60*	33*
(p-value)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)
$I_{F\&S}^{u}$	[0, 4]	[2, 6]	[4, 8]	[6, 8]	[5, 9]
n in I	61*	68*	69*	60*	62*
(p-value)	(<.001)	(<.001)	(<.001)	(<.001)	(<.001)

NOTE: *: significant at 1%; p-values (in parentheses) give results from binomial tests with H_0: Number of successes (n) equals number of successes of N uniform and i.i.d random draws from $[0, 15]$, versus H_1: Number of successes is greater. Solid lines highlight the median and dashed lines the mean. Small thick bars represent bounds of the strict ERC intervals.

Figure 7: Distributions of lower acceptance thresholds for $C = 8$



$(c_p,\, c_r)$	(2, 0)	(0, 2)	(0, 0)
N	71	70	71
$I^{\min}_{ERC}$	[0, 0]	[0, 15]	[0, 8]
n in I	6	–	71*
(p-value)	(.2832)	–	(<.001)
I^{u}_{ERC}	[0, 1]	[0, 15]	[0, 8]
n in I	30*	–	71*
(p-value)	(<.001)	–	(<.001)
$I_{F\&S}$	[0, 7]	[2, 8]	[0, 8]
n in I	68*	68*	71*
(p-value)	(<.001)	(<.001)	(<.001)

NOTE: *: significant at 1%; p-values (in parentheses) give results from binomial tests with H_0: Number of successes (n) equals number of successes of N uniform and i.i.d random draws from $[0, 15]$, versus H_1: Number of successes is greater. Solid lines highlight the median and dashed lines the mean. Small thick bars represent bounds of the strict ERC intervals.

Figure 8: Distributions of lower acceptance thresholds for $C = 2$ and $C = 0$

a 0.2268 random draw probability of success which, nevertheless, is higher than the average relative size of the predicted interval of 0.1292.

6.3. Predictive success

The binomial tests conducted in the preceding chapter tested whether prediction intervals significantly capture actual behavior. Another question is how good the models compare to others as well as to each other.[34] To do so a measure evaluating both accuracy and precision of prediction must be used. An appropriate measure of predictive success is the difference $\theta = h - a$ between *hit rate* h and relative prediction *area* a as introduced by Selten and Krischker (1983). The hit rate is the share of observations according to the prediction and the relative area is the relative size of the prediction interval. Selten (1991) shows that a prediction theory maximizing θ is unimprovable in the sense that any outcome outside the prediction interval occurs at most with average probability and any outcome inside the prediction interval occurs at least with average probability. Table 2 lists the measures θ for the models already introduced and in addition for the the 'split the difference' model I_{split} and the traditional assumption of 'selfish' behavior. The split the difference model assumes that the conflict payoffs are kept and the surplus $p - C$ is divided equally. The assumption of selfishness is again differentiated according to the indifference problem. I^u_{self} assumes that there are selfish responders who reject when indifferent and I_{self} makes the traditional subgame perfect point prediction that the acceptance threshold equals the conflict payoff, i.e. $\underline{t}_r = c_r$. The relative area is $a = 2/16$ for I^u_{self} and $a = 1/16$ for I_{self}. Due to rounding I_{split} also has a relative area of $a = 2/16$. Again, all significant predictions are marked with a star. Furthermore, two sided 98% confidence intervals are given which allow to compare the θ's between models at an approximate 1% significance level.

First, comparing I^{min}_{ERC} with $I^{min}_{F\&S}$ on the one hand and I^u_{ERC} with $I^u_{F\&S}$ on the other, observe that F&S is at least as good as ERC throughout. Ignoring cases in which both models make insignificant predictions, F&S is significantly better than ERC in 4 cases under the *min* – and in 6 cases under the u–assumption. Whereas under *min*, with conflict vectors (2, 6), (8, 0), (2, 0) and (0, 2) these are very different cases, under the u–assumption, due to its better precision F&S is better than ERC in cases favoring the responder: (0, 12), (2, 10), (4, 8), (0, 8) and (2, 6).

Comparing I^{min}_{ERC} and $I^{min}_{F\&S}$ with I_{self} our previous observations are qualified, as I_{self} is better in cases favoring the responder. Significantly so, however, only for (12, 0), (10, 2) and (8, 0) if compared to I^{min}_{ERC} and only for (12, 0) if compared to $I^{min}_{F\&S}$. Of the remaining cases I^{min}_{ERC} is significantly better than I_{self} for 6 (of 12 remaining) conflict payoff vectors. For F&S the picture is again better, as $I^{min}_{F\&S}$ is significantly better than I_{self} in 11 (of 13 remaining) conflict points. Making the same comparison under the u–assumption the selfish solution I^u_{self} turns out to be significantly better than I^u_{ERC} in all situations favoring the responder in conflict. On the other hand I^u_{ERC} is never significantly better than I^u_{self}. Turning to F&S, $I^u_{F\&S}$ and I^u_{self} do not differ significantly except for (0, 12), where I^u_{self} performs significantly better. In line with our previous observations theses results, while to some degree due to the discreteness of the strategy space, question the applicability of inequality aversion to situations favoring the responder.

[34] The binomial tests conducted in chapter 6.2 tested whether the observed rate of correct predictions could also result from naive behavior. This is different from comparing the models to the '*model*' of naive behavior which, having a prediction interval equal to the whole strategy space, is always correct.

Table 2: Measures of Predictive Success θ

(c_p, c_r)	I^{min}_{ERC}	$I^{min}_{F\&S}$	I_{self}	I_{split}	I^u_{self}	$I^u_{F\&S}$	I^u_{ERC}
(12,0)	.021	.604*	.021	.583*	.486*	.604*	.486*
	$[-.04, .128]$	$[.471, .704]$	$[-.04, .128]$	$[.443, .700]$	$[.342, .617]$	$[.471, .704]$	$[.342, .617]$
(10,2)	.589*	.684*	.052	.632*	.589*	.684*	.589*
	$[.447, .707]$	$[.563, .761]$	$[-.02, .170]$	$[.493, .741]$	$[.447, .707]$	$[.563, .761]$	$[.447, .707]$
(8, 4)	.722*	.743*	.132*	.611*	.722*	.743*	.722*
	$[.598, .806]$	$[.640, .794]$	$[.036, .263]$	$[.472, .723]$	$[.598, .806]$	$[.640, .794]$	$[.598, .806]$
(6, 6)	.715*	.715*	.201*	.514*	.764*	.715*	.715*
	$[.604, .779]$	$[.604, .779]$	$[.090, .340]$	$[.370, .641]$	$[.649, .833]$	$[.604, .779]$	$[.604, .779]$
(4, 8)	.138*	.283*	.304*	.382*	.748*	.728*	.583*
	$[.000, .282]$	$[.149, .428]$	$[.175, .448]$	$[.240, .523]$	$[.628, .824]$	$[.619, .787]$	$[.490, .619]$
(2,10)	-.070	.108	.256*	.368*	.672*	.524*	.346*
	$[-.21, .074]$	$[-.03, .254]$	$[.133, .402]$	$[.225, .512]$	$[.537, .772]$	$[.408, .590]$	$[.259, .373]$
(0,12)	-.233	-.007	.230*	.295*	.658*	.351*	.125*
	$[-.38, -.10]$	$[-.15, .137]$	$[.169, .447]$	$[.158, .442]$	$[.520, .761]$	$[.239, .411]$	$[.060, .125]$
(8, 0)	-.021	.535*	-.021	.139*	.361*	.535*	.361*
	$[-.06, .070]$	$[.411, .619]$	$[-.06, .070]$	$[.027, .278]$	$[.221, .503]$	$[.411, .619]$	$[.221, .503]$
(6, 2)	.598*	.659*	.066	.061	.546*	.659*	.598*
	$[.462, .700]$	$[.573, .685]$	$[-.01, .187]$	$[-.03, .193]$	$[.402, .671]$	$[.573, .685]$	$[.462, .700]$
(4, 4)	.659*	.659*	.163*	-.083	.621*	.659*	.659*
	$[.574, .685]$	$[.574, .685]$	$[.059, .299]$	$[-.12, .010]$	$[.483, .732]$	$[.574, .685]$	$[.574, .685]$
(2, 6)	.298*	.658*	.233*	-.069	.593*	.658*	.298*
	$[.222, .312]$	$[.532, .742]$	$[.115, .375]$	$[-.11, .030]$	$[.452, .709]$	$[.532, .743]$	$[.223, .312]$
(0, 8)	-.027	.215*	.290*	-.111	.636*	.561*	.319*
	$[-.17, .112]$	$[.076, .358]$	$[.162, .434]$	$[-.12, -.03]$	$[.498, .743]$	$[.441, .636]$	$[.220, .363]$
(2, 0)	.022	.458*	.022	.002	.298*	.458*	.298*
	$[-.04, .131]$	$[.365, .494]$	$[-.04, .131]$	$[-.07, .122]$	$[.162, .442]$	$[.365, .494]$	$[.162, .442]$
(0, 2)	–	.534*	.066	-.082	.461*	.534*	–
		$[.448, .560]$	$[-.01, .187]$	$[-.12, .011]$	$[.315, .596]$	$[.448, .560]$	
(0, 0)	.438*	.438*	.064	.044	.312*	.438*	.438*
	$[.375, .438]$	$[.375, .438]$	$[-.01, .184]$	$[-.05, .172]$	$[.175, .456]$	$[.375, .438]$	$[.375, .438]$

NOTE: * significant at 1%. Confidence intervals two sided at 98% level.

The split the difference principle only predicts observed behavior significantly for $C = 12$ and conflict combination (8, 0). For some conflict points favoring the responder, it makes better predictions than ERC or F&S. Under the u-assumption, however, F&S always performs better.

In addition to the models above, predictions by the principle of equal pie sharing were tested which, however, turned out to make mostly insignificant predictions, with the only exceptions in some cases with (almost) equal conflict payoffs.

6.4. Proposer offers

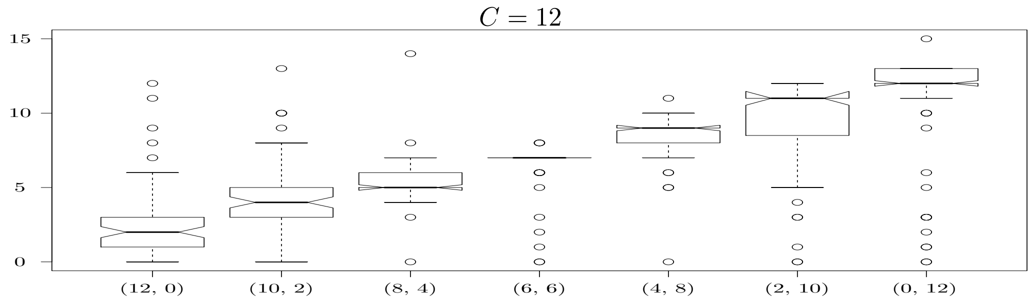
The distributions of proposer offers in the ultimatum game are plotted in the boxplots in figure 9. Notches cutting into the boxes give (roughly measured) 95% confidence intervals for the median (see Chambers et al., 1983). Again plots are arranged similarly to figures 6, 7 and 8. In the lowest panel, a boxplot of dictator giving was added in the very right plot. The correlations listed underneath the plots give the Spearman rank correlation between the respective ultimatum offers and dictator giving. Also the relevant one sided p-value of ρ according to a Spearman test of association is reported.

Observe first that distributions in the upmost panel vary considerably in width and median for each of the seven combinations of conflict payoffs. In the symmetric case (6, 6) for example, more than 80% of all offers equal 7. For $C = 12$ offers widen with asymmetry of conflict. For $C = 8$, this however is only true for conflict points favoring the proposer. At the point where responder conflict is close to half of the pie ($c_r = 6$ and $c_r = 8$), despite asymmetry of conflict, distributions of offers do not widen again and get even narrower than under the symmetric vector (4, 4).

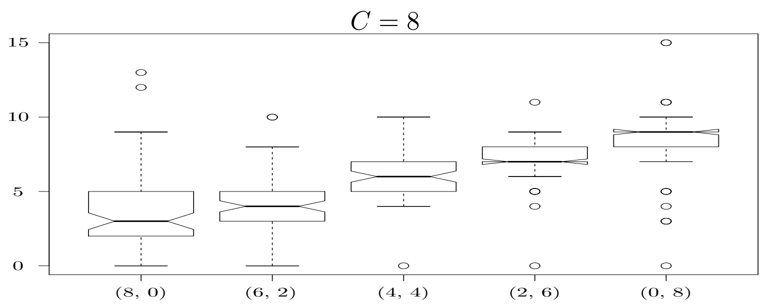
Again, excluding (12, 0), distributions for situations with zero responder conflict payoff look very similar. Mann Whitney tests prove that offers do not differ significantly between cases (8, 0), (2, 0) and (0, 0). From property ERC 7 and 3 it is known that for $c_p > 0$ and $c_r = 0$ proposer offers should equal $(1 - r_i)p$ which also equals dictator giving. Observe, however, that not only offers for (12, 0) are significantly smaller than those for (2,0) but that, furthermore, offers for (12, 0) and (8, 0) differ significantly from dictator giving.

Looking at Spearman correlations ρ of proposer offers with dictator giving for $C = 12$ and 8, signs of ρ are as stated in the experimental predictions. Specifically, for asymmetric conflict favoring the responder they are positive and negative for those favoring the proposer. However, for $C = 8$ all are insignificant and for $C = 12$ only those at the most asymmetric combinations are weakly significant (p<5%). The only highly significant positive association with dictator giving is observed for (0, 2), i.e. at a conflict point, favoring the responder. As a selfish proposer offer of (13, 2) would favor the proposer, this observation in itself does not question the experimental prediction.

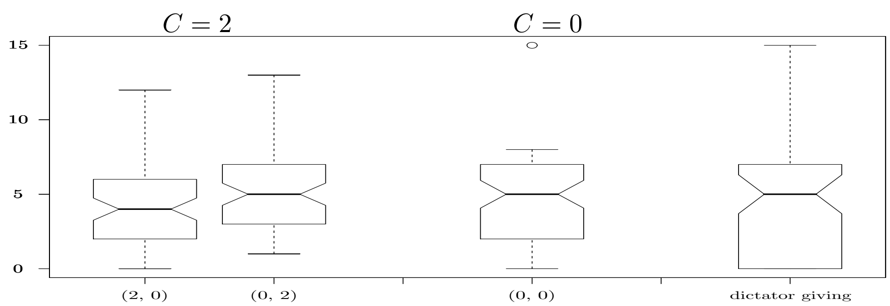
Property F&S 2 predicts that proposers giving half of the pie as dictators should give the same in situations with responder conflict $c_r < p/2$. Figure 10 plots boxplots of proposer offers from those subjects only, who as dictators gave 7 or 8. Obviously, depending on the particular conflict point, offers are significantly different from a 50:50 split. This can be deduced from the notches, which again show 95% confidence intervals of the medians. Wilcoxon signed rank tests confirm this observation for all but the following conflict points: (6, 6), (4, 4), (2, 6) and (0, 2).



	(12, 0)	(10, 2)	(8, 4)	(6, 6)	(4, 8)	(2, 10)	(0, 12)
correlation ρ	0.2010*	0.2098*	0.0250	-0.1921	-0.1144	-0.2012*	-0.2001*
(p-value)	(0.0451)	(0.0384)	(0.4171)	(0.0529)	(0.1690)	(0.0450)	(0.0459)



	(8, 0)	(6, 2)	(4, 4)	(2, 6)	(0, 8)
correlation ρ	0.1122	0.1598	0.1431	-0.1482	-0.1507
(p-value)	(0.1735)	(0.0898)	(0.1149)	(0.1067)	(0.1030)



	(2, 0)	(0, 2)	(0, 0)
correlation ρ	0.0958	0.2758**	0.2149*
(p-value)	(0.2111)	(0.0097)	(0.0350)

NOTE: (c_p, c_r) gives the proposer (c_p) and responder (c_r) conflict payoff. Correlation coefficients ρ are Spearman rank correlations between the respective distribution of ultimatum offers and dictator giving (see lower right panel). *: at 5%, **: at 1% significant (one sided Spearman test of independence.)

Figure 9: Boxplots of proposer offers in the UGAC and correlation with dictator giving

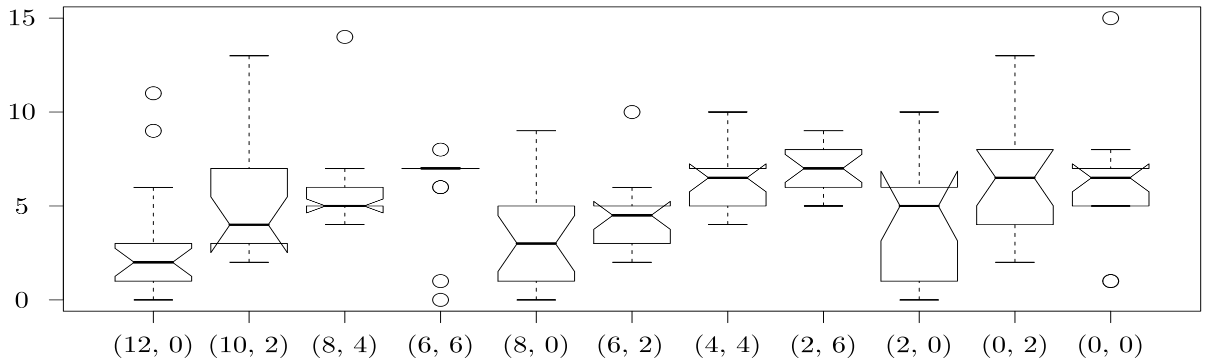
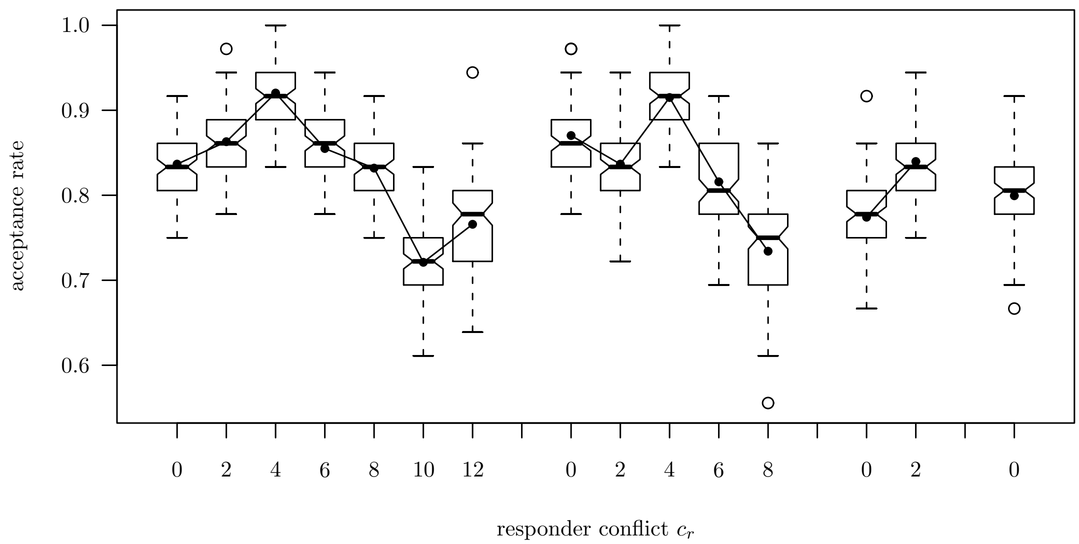


Figure 10: Boxplots of proposer offers in the UGAC from subjects giving 7 or 8 as dictator



NOTE: Rates are results from 200 random matchings of decision vectors. Bullets, connected by lines are the averages. From left to right: $C = 12$, $C = 8$, $C = 2$ and $C = 0$.

Figure 11: Boxplots of acceptance rates

6.5. Acceptance rates and resulting payoffs

How does behavior translate into payoffs? For an analysis of payoffs a transformation of data becomes necessary. Due to the strategy method, there are manifold possibilities of matching participants decisions. For a comparison of acceptance rates and payoffs, decision vectors were matched in 200 randomized matchings. The resulting distribution of payoffs was then analyzed by forming subject wise averages per role and conflict point.

Figure 11 gives boxplots of acceptance rates for each conflict point resulting from 200 random matchings. The points connected by lines mark average acceptance rates. Notches again give an approximate 95% confidence interval for the median. For all $C > 0$, acceptance rates first increase with responder conflict payoff and reach their peak for symmetric conflict, before significantly plummeting for asymmetric conflict favouring the responder.

Combining data for all (c_p, c_r) combinations, proposers' median earnings equal 7.638 which are significantly higher[35] than median responder payoffs of 5.76. Analyzing earnings above own conflict payoffs individually for all cases gives a somewhat different picture. Whereas for most conflict points, payoffs above conflict are (significantly) higher for proposers than for responders, for conflict points considerably favoring the proposer like (12, 0), (10,2) and (8, 0), it is the other way around.

7. Conclusions

Assuming that players are inequality averse as outlined by Bolton and Ockenfels (2000) and Fehr and Schmidt (1999) in ultimatum games with asymmetric conflict payoffs results in rather detailed predictions concerning, especially, responder behavior. Among others, predictions state that for high responder conflict payoffs with $c_r > p/2$, no responder rejects any offer at or above his own c_r and, that responders possibly also have an upper acceptance threshold, refusing all higher offers.

Testing those predictions in a laboratory experiment yields a mixed picture of model accuracy. Catering for a problem arising from possible indifference from selfish responders yields statistically significant fits of the data for all tested conflict payoff combinations. In detail, if one assumes that there are completely selfish types who, furthermore, refuse offers if indifferent – in consequence hurting the proposer without gaining from it – both models' accuracy can not result from chance moves for all combinations of conflict payoffs. However, especially for high responder conflict payoffs these predictions are either significantly worse (ERC) or not significantly better (F&S) than the traditional assumption of selfish payoff maximizing subjects. Furthermore, without imposing the assumption concerning indifference, models are unable to cater for the extraordinarily high frequency of selfish behavior in treatments favoring the responder. Prediction intervals for such cases are unnecessarily large as there are hardly any observations below responders' own conflict payoffs. In the light of the experimental results it is questionable as to whether there is any need for a model which caters for inequality aversion in situations favoring the responder.

Only to some degree this effect is also mirrored in proposer offers. Variance of offers is highest for asymmetric conflict points favoring the proposer, narrows considerably for symmetric conflict and does only mildly widen again for asymmetric conflict favoring the responder. Nevertheless, conflict rates are highest for asymmetric conflict treatments and here, highest at conflict points favoring the responder.

This observation is related to results by Knez and Camerer (1995) in three person ultimatum games, who interpret this as an "*egocentric assessment of fairness*" (Knez and Camerer, 1995, p. 87). Despite this evidence against – and qualification of inequality aversion there are other indications in favor of it. One is the observation of weakly significant correlations between dictator giving and proposer offers.

The fact that on the one hand, responders appear to ignore proposer conflict payoffs up to a considerably high degree, whereas the slightest increase in responder conflict has huge impacts on behavior hints to another explanation of behavior, relating to procedural fairness or justice (see e.g., Bolton et al., 2004; Konow, 2003). High acceptance thresholds in situations favoring the proposer may, in addition to inequality aversion, be motivated by a disutility resulting from being put in a strategically unfavorable position due to the ultimatum. This

[35]Wilcoxon signed rank test, p=0.0082.

effect may be canceled, if the responder, despite the procedurally unfair position finds himself in a situation where conflict favors him.

Overall, experimental results indicate that interpreting equity exclusively as a norm of distributive justice may be short sighted, a thought already put forward by Selten (1987). Furthermore, if applicable at all, inequality aversion appears not to be a constant characteristic but rather context depended.

The two models of inequality aversion, analyzed in this survey are very different especially with respect to the number of restrictions imposed. Among others, the more specific assumptions imposed by F&S result in narrower prediction intervals and in higher predictive success. Another reason why ERC overall does worse than F&S lies in the way inequality is measured. ERC's modeling of inequality as the share of payoffs results in rather awkward predictions in situations with small or no responder conflict.[36] On the other hand some predictions particular to the F&S model could not be observed in the data.

Finally, similar to observations made by, e.g. Bornstein and Yaniv (1998); Roth et al. (1991) and Güth et al. (2003) (for a survey, see Henning-Schmidt et al., 2004) non-monotonous responder strategies are observed.

A. Proofs of ERC predictions

A.1. Proof of property ERC 1

The latter part of property ERC 1 is trivial. For the other part the difference $\Delta_i = v_i(\bar{x}_i, {}^{\bar{x}_i}/_p) - v_i(\bar{x}_i, {}^{\bar{x}_i}/_C)$ is analyzed, where $\bar{x}_i$ indicates that i's payoff is fixed to a level $0 < \bar{x}_i \leq C$. Difference Δ can be rearranged to the integral

$$\Delta_i = \int_C^p \frac{dv_i(\bar{x}_i, {}^{\bar{x}_i}/_\Sigma)}{d\Sigma} d\Sigma = -\bar{x}_i \int_C^p \frac{1}{\Sigma^2} \frac{\partial v_i(\bar{x}_i, {}^{\bar{x}_i}/_\Sigma)}{\partial \sigma_i} d\Sigma \, . \tag{16}$$

From assumptions 1 and 4 it follows that the partial derivative ${}^{\partial v_i}/_{\partial \sigma_i}$ on the right hand side of equation (16) is negative (positive) over the entire domain of the integral for $\bar{x}_i > {}^p/_2$ ($\bar{x}_i < {}^C/_2$). At each level of $\bar{x}_i$ the partial derivative has only one null which is reached in the integral at $\Sigma = 2\bar{x}_i$. Therefore, Δ_i can only have one null for a payoff $\hat{x}$ with ${}^C/_2 < \hat{x} < {}^p/_2$ and with $\Delta_i > 0$ ($\Delta_i < 0$) for $\bar{x}_i > \hat{x}_i$ ($\bar{x}_i > \hat{x}_i$), which proves property ERC 1.

A.2. Proof of lemma 1

The first part of the relation in lemma 1 is trivial and follows directly from property ERC 1 and that for $c_i > {}^C/_2$ by definition ${}^1/_2 > {}^{(C-c_i)}/_C > {}^{(C-c_i)}/_p$. To prove the latter part one must analyze the difference

$$\begin{aligned} v_i\left(c_i, \frac{c_i}{C}\right) - v_i\left(C - c_i, \frac{(C-c_i)}{C}\right) &= \int_{(C-c_i)}^{c_i} \frac{dv_i}{dx_i} dx_i \\ &= \int_{(C-c_i)}^{c_i} \frac{\partial v_i}{\partial x_i} dx_i + \frac{1}{C} \int_{(C-c_i)}^{c_i} \frac{\partial v_i}{\partial \sigma_i} dx_i \; = \; \Omega_i + \Phi_i \end{aligned} \tag{17}$$

[36] Problems related to the measurement of inequality in ERC are also reported by, e.g., Charness and Rabin (2002) and Engelmann and Strobel (2004).

for $c_i \geq C/2$. From assumption 2 follows directly that $\Omega \geq 0$. Similarly, for $c_i \geq C/2$ assumptions 3 and 5 imply that $\Phi \geq 0$. Therefore $\Omega + \Phi \geq 0$ proving the Lemma.

A.3. Proof of property ERC 7

The first order condition for the maximization problem in equation (11) is:

$$\frac{dF^s}{d\sigma_p}(v_p(\sigma_p p, \sigma_p) - v_p(c_p, c_p/C)) + (1 - F^s)\frac{dv_p(\sigma_p p, \sigma_p)}{d\sigma_p} = 0 \tag{18}$$

By definition $\frac{dv_p(r_p p, r_p)}{d\sigma_p}(r_p) = 0$. Furthermore from statement 1 it is known that for $c_i \leq C/2$ no subject can have an upper acceptance threshold share below $(C-c_i)/C \geq 1/2$ and as all $r_p \in [1/2, 1]$, the probability that an offer of $\sigma_r = 1 - r_p$ is being accepted is equal to 1 for $r_p \leq 1 - \underline{s}_r^u$.

B. Proofs of F&S predictions

B.1. Proof of property F&S 1

The proof of the latter part of this property is trivial and follows directly from (13). The difference between the utility given an individual payoff of x_i in an agreement on the one, and in conflict on the other hand is given by:

$$U_i(x_i, p) - U_i(x_i, C) = \begin{cases} -\alpha_i(p - C) & \text{for } x_i < C/2 \\ 2[\beta_i(x_i - C/2) - \alpha_i(p/2 - x_i)] & \text{for } C/2 \leq x_i < p/2 \\ \beta_i(p - C) & \text{for } x_i \geq p/2 \end{cases} \tag{19}$$

which implies that the two functions intersect for $(x_i - C/2)\beta_i = (p/2 - x_i)\alpha_i$ and therefore at $\hat{x}_i$, with the one being greater than the other as outlined in property F&S 1.

Redefining $\alpha_i = \beta_i + \varepsilon_i$ where $\varepsilon_i \geq 0$, one gets $\frac{\partial \hat{x}_i}{\partial \beta_i} < 0$ and $\frac{\partial \hat{x}_i}{\partial \varepsilon_i} > 0$, which implies that

$$\begin{aligned} \sup_{\beta_i, \varepsilon_i}(\hat{x}_i) &= \lim_{\varepsilon_i \to \infty} \hat{x}_i(\beta_i = 0) = \frac{p}{2} \\ \inf_{\beta_i, \varepsilon_i}(\hat{x}_i) &= \lim_{\beta_i \to 1} \hat{x}_i(\varepsilon_i = 0) = \frac{(p + C)}{4} \end{aligned}$$

and proves the rest of property F&S 1.

B.2. Proof of statement 3

The proof is divided into three properties, which combined yield statement 3.

Property F&S 3 Given the assumptions of F&S and $c_i < C/2$, the smallest payoff $\underline{t}_i$ a responder is still willing to accept can not lie outside the interval $\underline{t}_i \in [c_i, c_i + 1/2(p - C))$.

Proof Given $c_i < C/2$ and $\underline{t}_i < p/2$, for the responder to accept an offer $\underline{t}_i$ of p, i.e., for $U_i(c_i, C) = U_i(\underline{t}_i, p)$ to hold, the following condition must be satisfied:

$$-\alpha_i C + (1 + 2\alpha_i)c_i = -\alpha_i p + (1 + 2\alpha_i)\underline{t}_i \ , \tag{20}$$

which yields the acceptance threshold

$$\underline{t}_i = c_i + \frac{\alpha_i(p - C)}{(1 + 2\alpha_i)} \ . \tag{21}$$

As $\frac{\partial \underline{t}_i}{\partial \alpha_i} > 0$, one obtains

$$\begin{aligned} \sup(\underline{t}_i) &= \lim_{\alpha_i \to \infty} \underline{s}_i = c_i + {}^1\!/_2(p - C) \\ \min(\underline{t}_i) &= \underline{t}_i(\alpha_i = 0) = c_i \ . \end{aligned}$$

Consequently the supremum for $\underline{t}_i$ in this parameter constellation is reached for $c_i = {}^C\!/_2$ with $\underline{t}_i < {}^p\!/_2$ implying that the restriction $\underline{t} < {}^p\!/_2$ for condition (20) to apply holds and proves the interval in property F&S 3.

Property F&S 4 For ${}^C\!/_2 \leq c_i \leq C$ and $\underline{t}_i < {}^p\!/_2$ the following intervals for the lowest share a subject is still willing to accept must hold:

$$\underline{t}_i \in \begin{cases} [c_i, {}^p\!/_2) & \text{for } {}^C\!/_2 \leq c_i \leq {}^{(C+p)}\!/_4 \\ ({}^{(C+p-c_i)}\!/_3, {}^p\!/_2) & \text{for } {}^{(C+p)}\!/_4 < c_i \leq C. \end{cases} \tag{22}$$

Proof To prove property F&S 4 conflict utility for conflict payoffs of $c_i \geq {}^C\!/_2$ are compared with agreement utility for payoffs $\underline{t}_i < {}^p\!/_2$, i.e.,

$$\beta_i C + (1 - 2\beta_i)c_i = (1 + 2\alpha_i)\underline{t}_i - ap \tag{23}$$

which defines threshold

$$\underline{t}_i = \frac{\beta_i(p + C) + (1 - 2\beta_i)c_i + \varepsilon_i p}{1 + 2\beta_i + 2\varepsilon_i}. \tag{24}$$

With respect to β_i threshold $\underline{t}_i$ has the following characteristics:

$$\frac{\partial \underline{t}_i}{\partial \beta_i} \begin{cases} \geq 0 & \text{for } {}^C\!/_2 \leq c_i \leq \gamma_i \\ < 0 & \text{for } \gamma_i < c_i \leq C \end{cases} \tag{25}$$

where $\gamma_i = \frac{p+(1+2\varepsilon_i)C}{4(1+\varepsilon_i)}$ implying $\gamma_i \in [{}^C\!/_2, {}^{(p+C)}\!/_4]$. Furthermore the threshold is nondecreasing in ε_i. Therefore the infinum of threshold $\underline{t}_i$ resulting from (24) is given by

$$\inf_{\beta_i, \varepsilon_i} (\underline{t}_i) = \begin{cases} \min(\underline{t}_i) = \underline{t}_i(\beta_i = 0, \varepsilon_i = 0) = c_i & \text{for } {}^C\!/_2 \leq c_i \leq {}^{(p+C)}\!/_4 \\ \lim_{\beta_i \to 1} \underline{t}_i(\varepsilon_i = 0) = {}^{(p+C-c_i)}\!/_3 & \text{for } {}^{(p+C)}\!/_4 < c_i \leq C \end{cases} \tag{26}$$

and the supremum equals

$$\sup_{\beta_i, \varepsilon_i}(\underline{t}_i) = \lim_{\varepsilon_i \to \infty} \underline{t}_i = {}^p\!/_2 \qquad \text{for } {}^C\!/_2 \leq c_i \leq C. \tag{27}$$

Note that for $c_i > {}^{(p+C)}\!/_4$ also ${}^{(p+C-c_i)}\!/_3 < {}^{(p+C)}\!/_4$, which together with the characteristics of γ_i explains the intervals within which the respective infimum is defined. Furthermore $\underline{t}_i < {}^p\!/_2$ implying that condition (23) applies and proving the property.

Other possible thresholds may arise for $c_i \geq {}^{C}\!/\!_{2}$, $\underline{t}_i \geq {}^{p}\!/\!_{2}$ and $\beta_i < {}^{1}\!/\!_{2}$. The latter restriction is necessary as otherwise (for $\beta_i > {}^{1}\!/\!_{2}$) utility for an accepted offer would decrease with increasing payoff, yielding an upper instead of a lower threshold.

Property F&S 5 For ${}^{C}\!/\!_{2} \leq c_i \leq C$ and $\underline{t}_i \geq {}^{p}\!/\!_{2}$ the smallest offer a subject is still willing to accept is $\underline{t}_i \in [{}^{p}\!/\!_{2}, c_i]$.

Proof Setting

$$\beta_i C + (1 - 2\beta_i)c_i = \beta_i p + (1 - 2\beta_i)\underline{t}_i \tag{28}$$

yields threshold

$$\underline{t}_i = \frac{\beta_i(C - p)}{(1 - 2\beta_i)} + c_i. \tag{29}$$

As ${}^{\partial \underline{t}_i}\!/\!_{\partial \beta_i} < 0$ the functional form of threshold $\underline{t}_i$ has the following extremes:

$$\max_{\beta_i}(\underline{t}_i) = \underline{t}_i(\beta_i = 0) = c_i \tag{30}$$

$$\min_{\beta_i}(\underline{t}_i) = \max\{{}^{p}\!/\!_{2}, \lim_{\substack{\beta_i \to {}^{1}\!/\!_{2} \\ \beta_i < {}^{1}\!/\!_{2}}} \underline{t}_i\} = \max\{{}^{p}\!/\!_{2}, -\infty\} = {}^{p}\!/\!_{2} \tag{31}$$

For $c_i < {}^{p}\!/\!_{2}$ the maximum of the functional form of $\underline{t}_i$ is smaller ${}^{p}\!/\!_{2}$ implying that condition (28) is not defined. Therefore (30) only describes the maximum of $\underline{t}_i$ for $c_i > {}^{p}\!/\!_{2}$, which concludes the proof of property F&S 5.

Combining properties F&S 3, 4, and, 5 finally yields the intervals of acceptance thresholds $\underline{t}_i$ described in statement 3.

B.3. Proof of statement 4

The proof of statement 4 is divided into two properties:

Property F&S 6 For $\beta_i > {}^{1}\!/\!_{2}$ and $c_i < {}^{C}\!/\!_{2}$ responders may have an upper acceptance threshold $\bar{t}_i > C + p - 3c_i$.

Proof For $\beta_i > {}^{1}\!/\!_{2}$, $c_i < {}^{C}\!/\!_{2}$ and $\bar{t}_i \geq {}^{p}\!/\!_{2}$ upper threshold $\bar{t}_i$ must satisfy condition

$$-\alpha_i C + (1 + 2\alpha_i)c_i = \beta_i p + (1 - 2\beta_i)\bar{t}_i \tag{32}$$

yielding

$$\bar{t}_i = \frac{(1 + 2\beta_i + 2\varepsilon_i)c_i - (\beta_i + \varepsilon_i)C - \beta_i p}{(1 - 2\beta_i)} \tag{33}$$

which (for $\beta_i > {}^{1}\!/\!_{2}$) is strictly decreasing in β_i and strictly increasing in ε_i implying

$$\inf_{\beta_i, \varepsilon_i}(\bar{t}_i) = \lim_{\beta_i \to 1} \bar{t}_i(\varepsilon_i = 0) = C + p - 3c_i \tag{34}$$

and

$$\max_{\beta_i, \varepsilon_i}(\bar{t}_i) = \min\{p, \lim_{\substack{\beta_i \to {}^{1}\!/\!_{2} \\ \beta_i > {}^{1}\!/\!_{2} \\ \varepsilon_i \to \infty}} \bar{t}_i\} = \min\{p, \infty\} = p\ . \tag{35}$$

As for all $C < p$ and $c_i \leq {}^{C}\!/_2$ the min in (34) is always greater ${}^{p}\!/_2$, condition (33) applies concluding the proof of property F&S 6.

Property F&S 7 For $\beta_i > {}^1\!/_2$ and $c_i \geq {}^{C}\!/_2$ responders may have an upper acceptance threshold $\bar{t}_i > p - C + c_i$.

Proof For $\beta_i > {}^1\!/_2$, $c_i \geq {}^{C}\!/_2$ and $\bar{t}_i \geq {}^{p}\!/_2$ condition

$$\beta_i C + (1 - 2\beta_i)c_i = \beta_i p + (1 - 2\beta_i)\bar{t}_i \tag{36}$$

applies, yielding threshold

$$\bar{t}_i = \frac{\beta_i}{(1 - 2\beta_i)}(C - p) + c_i \tag{37}$$

which is strictly decreasing in β_i. Consequently

$$\inf_{\beta_i}(\bar{t}_i) = \lim_{\beta_i \to 1} \bar{t}_i = p - C + c_i \tag{38}$$

and

$$\max_{\beta_i}(\bar{t}_i) = \min\{p, \lim_{\substack{\beta_i \to 1/2 \\ \beta_i > 1/2}} \bar{t}_i\} = \min\{p, \infty\} = p. \tag{39}$$

As $p - C + c_i > {}^{p}\!/_2$ for all $c_i \geq {}^{C}\!/_2$, condition (36) applies, proving property F&S 7.

By combining all properties one obtains statement 4.

C. Translation of instructions

The instructions in the experiment were written in German. The following chapter reproduces an English translation of the first and second stage. The third stage mentioned in the general instructions is not relevant for this study and is therefore not enclosed. Emphasizes like, e.g., bold font are taken from the original text.

Instructions

Welcome and thank you very much for participating in this experiment. Please read the following instructions carefully and cease communication of any kind with other participants. If there is something unclear, please don't ask loudly into the room but rather raise your arm and wait for a supervisor to approach you, who will answer your questions. Instructions are identical for all participants. All decisions will remain anonymous. The experiment consists of altogether 3 parts. You will get separate instructions for each part. You may earn money in every round. How much money you earn depends on your own decisions, decisions of other participants and of chance moves.

In the experiment all amounts will be denominated in "ECU" (*Experimental Currency Unit*). Hereby 15 ECU equals €2.20. Your entire income at the end of the experiment is the sum of your incomes of all rounds. There are two different roles. One half of participants has role A, the other half role B. Roles will be assigned to you at random at the beginning and will remain unchanged during the entire experiment. **However, you will not be informed about your role before the end of the experiment.**

Instructions 1. Part

Basic Principle

Each participant A will randomly be assigned to one participant B.

Participant A obtains the amount of 15ECU and has to decide how to divide it between himself and B. He can keep it for himself, or he can give something, or everything to B.

Realization

For now you will not be informed about your role! Therefore, in this part also the B–participants decide in the Role of A. Only if your actual role is A, your decision will be taken to calculate both, A's, as well as B's payoff. Participant A then obtains a payoff according to his decision, and B a payoff according to the decision of participant B assigned to him in this round. You will not be informed about the result of this part before the end of the experiment.

Instructions 2. Part

Basic Principle

Each participant A will randomly be assigned to one participant B.

Participant A obtains the amount of 15ECU and has to decide how to divide it between himself and B. He can keep it for himself, or he can give something, or everything to B.

Participant B has to decide for each of the 16 **possible** decisions* of A, whether he "accepts" or "rejects" it.

A's decision will then be compared to those of B:

- If B decided that he would "reject" A's actual offer, then A obtains a payoff c_A and B a payoff c_B. Values c_A and c_B change from round to round and you will be informed about their particular value at the beginning of a round.
- If B decided that he would "accept" A's actual offer, then the 15ECU will be divided according to A's decision.

Realization

For now you will not be informed about your role! Therefore you are asked to also decide in the other role. Only your decisions in your actual role will be used for the calculation of A's as well as B's payoffs. Altogether you have to make decisions for both roles and 15 different (c_A, c_B)-combinations.

Those decisions you make in your **actual** role will be stored in a database for every (c_A, c_B)-combination. Therefore the database only includes decisions from A participants made in role A and decisions from B-participants made in role B.

At the end of the entire experiment **four** (c_A, c_B)-combinations will be drawn by lot. For each of those four combinations a different participant in the other role will be assigned to you. This will never be the same person assigned to you in the first part of the experiment. Both, your payoff and the payoff of the participant assigned to you (in the other role) is then calculated according to the decisions made by the two of you.

Your income from the 2. part equals the sum of all incomes of the four allotted (c_A, c_B)-combinations. You will not be informed about the result of this part before the end of the experiment.

⋆ A decision of A is one of 16 possible: (0 for A and 15 for B), (1 for A and 14 for B), (2 for A and 13 for B), (3 for A and 12 for B), (4 for A and 11 for B), (5 for A and 10 for B), (6 for A and 9 for B), (7 for A and 8 for B), (8 for A and 7 for B), (9 for A and 6 for B), (10 for A and 5 for B), (11 for A and 4 for B), (12 for A and 3 for B), (13 for A and 2 for B), (14 for A and 1 for B), (15 for A and 0 for B).

References

Adams, J. S. (1965). Inequity in social exchange. In Berkowitz, L., editor, *Advances in Experimental Social Psychology*, pages 265–299. Academic Press, London and New York.

Andreoni, J. (1989). Giving with impure altruism: Applications to charity and Ricardian equivalence. *The Journal of Political Economy*, 97(6):1447–1458.

Bazerman, M. (1993). Fairness, social comparison, and irrationality. In Murnighan, J. K., editor, *Social Psychology in Organizations: Advances in Theory and Research*, pages 184–203. Prentice Hall, Englewood Cliffs, NJ.

Becker, G. S. (1974). A theory of social interactions. *Journal of Political Economy*, 82(6):1063–1093.

Binmore, K., Morgan, P., Snaked, A., and Sutton, J. (1991). Do people exploit their bargaining power? An experimental study. *Games and Economic Behavior*, 3(3):295–322.

Bolton, G. E. (1991). A comparative model of bargaining: Theory and evidence. *The American Economic Review*, 81(5):1096–1136.

Bolton, G. E., Brandts, J., and Ockenfels, A. (2004). Fair procedures – evidence from games involving lotteries. Working Paper, Penn State University.

Bolton, G. E. and Ockenfels, A. (2000). ERC: A theory of equity, reciprocity, and competition. *The American Economic Review*, 90(1):166–193.

Bornstein, G. and Yaniv, I. (1998). Individual and group behavior in the ultimatum game: Are groups more "rational" players? *Experimental Economics*, 1(1):101–108.

Brosig, J., Weimann, J., and Yang, C.-L. (2003). The hot versus cold effect in a simple bargaining experiment. *Experimental Economics*, 6(1):75–90.

Chambers, J. M., Cleveland, W. S., Kleiner, B., and Tukey, P. A. (1983). *Graphical Methods for Data Analysis.* Wadsworth & Brooks/Cole Pub. Co., Belmont, Calif.

Charness, G. and Rabin, M. (2002). Understanding social preferences with simple tests. *The Quarterly Journal of Economics*, 117(3):817–869.

Cubitt, R. P., Starmer, C., and Sudgen, R. (1998). On the validity of the random lottery incentive system. *Experimental Economics*, 1(2):115–131.

Dickinson, D. L. (2000). Ultimatum decision-making: A test of reciprocal kindness. *Theory and Decision*, 48(2):151–177.

Dufwenberg, M. and Kirchsteiger, G. (2004). A theory of sequential reciprocity. *Games and Economic Behavior*, 47(2):268–298.

Ellingsen, T. (1997). The evolution of bargaining behavior. *The Quarterly Journal of Economics*, 112(2):581–602.

Engelmann, D. and Strobel, M. (2004). Inequality aversion, efficiency, and maximin preferences in simple distribution experiments. *The American Economic Review*, 94(4):857–69.

Fehr, E. and Schmidt, K. M. (1999). A theory of fairness, competition, and cooperation. *The Quarterly Journal of Economics*, 114(3):817–868.

Fischbacher, U. (1999). Z-tree: A toolbox for readymade economic experiments. Working Paper No. 21, Institute for Empirical Research in Economics – University of Zurich.

Fischer, S., Güth, W., and Pull, K. (2004). Is there as-if bargaining? Working Paper. forthcoming: *The Journal of Socio-Economics*.

Forsythe, R., Horowitz, J. L., Savin, N. E., and Sefton, M. (1994). Fairness in simple bargaining experiments. *Games and Economic Behavior*, 6(3):347–369.

Fudenberg, D. and Maskin, E. (1986). The folk theorem in repeated games with discounting or with incomplete information. *Econometrica*, 54(3):533–554.

Gale, J., Binmore, K. G., and Samuelson, L. (1995). Learning to be imperfect: The ultimatum game. *Games and Economic Behavior*, 8(1):56–90.

Goodman, P. (1977). Social comparison processes in organizations. In Staw, B. and Salancik, G., editors, *New Directions in Organizational Behavior*, pages 97–132. St. Clair Press, Chicago, IL.

Greiner, B. (2004). An online recruitment system for economic experiments. In Kremer, K. and Macho, V., editors, *Forschung und wissenschaftliches Rechnen 2003*, pages 79–93. Gesellschaft für Wissenschaftliche Datenverarbeitung, Göttingen. GWDG Bericht 63.

Güth, W. (1976). Towards a more general study of v. Stackelberg-situations. *Journal of Institutional & Theoretical Economics*, 132(4):592–608.

Güth, W. (1995). An evolutionary approach to explaining cooperative behavior by reciprocal incentives. *International Journal of Game Theory*, 24:323–344.

Güth, W. and Napel, S. (2002). Inequality aversion in a variety of games – an indirect evolutionary analysis. *Discussion Papers on Strategic Interaction*, 23–2002. forthcoming: *The Economic Journal*.

Güth, W., Schmidt, C., and Sutter, M. (2003). Fairness in the mail and opportunism in the internet: A newspaper experiment on ultimatum bargaining. *German Economic Review*, 4(2):243–265.

Güth, W., Schmittberger, R., and Schwarze, B. (1982). An experimental analysis of ultimatum bargaining. *Journal of Economic Behavior & Organization*, 3(4):367–388.

Güth, W. and Tietz, R. (1986). Auctioning ultimatum bargaining positions - how to act if rational decisions are unacceptable? In Scholz, R. W., editor, *Current Issues in West German Decision Research*, pages 60–73. Peter Lang, Frankfurt.

Güth, W. and Tietz, R. (1990). Ultimatum bargaining behavior - a survey and comparison of experimental results. *Journal of Economic Psychology*, 11(3):417–449.

Henning-Schmidt, H., Li, Z.-Y., and Yang, C. (2004). Why people reject advantageous offers – non-monotone strategies in ultimatum bargaining. *Bonn Econ Discussion Papers*, 22/2004. Working Paper.

Hilton, J. F. and Gee, L. (1997). The size and power of the exact bivariate symmetry test. *Computational Statistics & Data Analysis*, 26(1):53–69.

Hoffman, E., McCabe, K., Shachat, K., and Smith, V. L. (1994). Preferences, property rights, and anonymity in bargaining games. *Games and Economic Behavior*, 7(3):346–380.

Hoffman, E., McCabe, K., and Smith, V. (1996). Social distance and other-regarding behavior in dictator games. *The American Economic Review*, 86(3):653–660.

Hollander, M. and Wolfe, D. A. (1999). *A general theory of equilibrium selection in games*. John Wiley & Sons, Inc., New York. 2nd edition.

Huck, S. and Oechssler, J. (1999). The indirect evolutionary approach to explaining fair allocations. *Games and Economics Behavior*, 28(1):13–24.

Knez, M. J. and Camerer, C. F. (1995). Outside options and social comparison in three-player ultimatum game experiments. *Games and Economic Behavior*, 10(1):65–94.

Koçkesen, L., Ok, E. A., and Sethi, R. (2000). The strategic advantage of negatively interdependent prefereces. *Journal of Economic Theory*, 92(2):274–299.

Konow, J. (2003). Which is the fairest one of all? A positive analysis of justice theories. *Journal of Economic Literature*, 41(4):1188–1239.

Levine, D. K. (1998). Modeling altruism and spitefulness in experiments. *Review of Economic Dynamics*, 1(3):593–22.

McKelvey, R. D. and Palfrey, T. R. (1995). Quantal response equilibria for normal form games. *Games and Economic Behavior*, 10(1):6–38.

McKelvey, R. D. and Palfrey, T. R. (1998). Quantal response equilibria for extensive form games. *Experimental Economics*, 1(1):9–41.

Myerson, R. (1978). Refinements of the Nash equilibrium concept. *International Journal of Game Theory*, 7:73–80. Reprinted in Varoufakis, Yanis, ed. (2001). *Game theory: Critical concepts in the social sciences. Volume 2. Refinements*, pp. 159-166. Routledge, London and New York.

Oxoby, R. J. and McLeish, K. N. (2004). Sequential decision and strategy vector methods in ultimatum bargaining: Evidence on the strength of other-regarding behavior. *Economics Letters*, 84(3):399–405.

Rabin, M. (1993). Incorporating fairness into game theory and economics. *The American Economic Review*, 83(5):1281–1302.

Rapoport, A. (1997). Order of play in strategically equivalent games in extensive form. *International Journal of Game Theory*, 26(1):113–136.

Rosenthal, R. W. (1989). A bounded-rationality approach to the study of noncooperative games. *International Journal of Game Theory*, 18(3):273–291.

Roth, A. E. (1995). Bargaining experiments. In Kagel, J. H. and Roth, A. E., editors, *The Handbook of Experimental Economics*, pages 253–348. Princeton University Press, Princeton, NJ.

Roth, A. E., Prasnikar, V., Okuno-Fujiwara, M., and Zamir, S. (1991). Bargaining and market behavior in Jerusalem, Ljubljana, Pittsburgh, and Tokyo: An experimental study. *The American Economic Review*, 81(5):1068–1095.

Schmitt, P. M. (2004). On perceptions of fairness: The role of valuations, outside options, and information in ultimatum bargaining games. *Experimental Economics*, 7(1):49–73.

Selten, R. (1967). Die Strategiemethode zur Erforschung des eingeschränkt rationalen Verhaltens im Rahmen eines Oligopolexperiments. In Sauermann, H., editor, *Beiträge zur experimentellen Wirtschaftsforschung*, pages 136–168. Mohr, Tübingen.

Selten, R. (1975). Reexamination of the perfectness concept for equilibrium points in extensive games. *International Journal of Game Theory*, 4(1):25–55. Reprinted in Kuhn, Harold W. (ed.) (1997). *Classics in Game Theory*, pp. 317-54. Princeton University Press, Princeton, NJ.

Selten, R. (1987). Equity and coalition bargaining in experimental three-person games. In Roth, A. E., editor, *Laboratory Experimentation in Economics - Six Points of View*, pages 42–98. Cambridge University Press, Cambridge, Mass.

Selten, R. (1991). Properties of a measure of predictive success. *Mathematical Social Sciences*, 21(2):153–167.

Selten, R. and Krischker, W. (1983). Comparison of two theories for characteristic function experiments. In Tietz, R., editor, *Aspiration Levels in Bargaining and Economic Decision Making*, pages 259–264. Springer, Berlin, Heidelberg, New York and Tokyo.

Sethi, R. and Somanathan, E. (2001). Preference evolution and reciprocity. *Journal of Economic Theory*, 97(2):273–297.

Smith, V. L. (1982). Microeconomic systems as an experimental science. *The American Economic Review*, 72(5):923–955.