Ultimata bargaining: generosity without social motives

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Ultimata Bargaining: Generosity Without Social Motives*

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Abstract

We show and explain how generosity beyond that explainable by social preferences can manifest in bargaining. We analyze an *ultimata game* with two parties vying to coalesce with a randomly chosen proposer. They simultaneously demand shares of the surplus. The proposer must then make an offer that meets at least one demand, or else the game either continues with a new round or breaks down with all earning zero. Self-interest, altruism, and inequity aversion univocally predict miniscule demands due to inter-party competition; proposers thus obtain the lion's share. We experimentally observe that proposers coalesce with the less demanding party by strategically matching demands, like ultimatum bargaining, but also give non-strategically to the other party, like dictator giving. The observations are incompatible with concave utilities, as implied by social preferences, but are compatible with reference dependent preferences.

JEL–Codes: C72, C78, D72
Keywords: demand commitment, ultimata bargaining, non-cooperative, laboratory experiment, social preferences, reference dependence

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1 Introduction

When interests are misaligned in groups, agreement may be reached through negotiation. A common feature of many such contentions is the asymmetry of bargaining power. The consequent exercise of power determines the extent to which the competing interests of heterogeneous individuals in a group or diverse groups in society are served, as is relevant in committees, directorial boards, and parliamentary negotiations, for example. Social preferences such as altruism (Andreoni and Miller, 2002; Cox et al., 2007), fairness (Bolton and Ockenfels, 2000; Fehr and Schmidt, 1999), or a combination of the two (Kohler, 2011; Tan and Bolle, 2006) have been proposed as explanations for the under-realization of such power and for generosity to others in settings such as dictator and ultimatum games. The purpose of this study is to investigate the nature of generosity in bargaining that manifests without social preferences.

We do so by experimentally testing a specific "demand commitment" game of majority bargaining. Demand commitments are known from parliamentary decision making, where members of parliaments first state their demands on the motion to be voted on (these "platforms" are formulated e.g. prior to elections and in parliamentary debates), the respective committee then drafts a proposal to be moved by the committee chair, and the parliament finally votes on it. The members of parliament are assumed to commit to their demands and reject proposals that do not meet them, in order to maintain their reputation. Thus, proposals are implemented if and only if they satisfy the demands of a majority coalition. Modeling demand commitments in political bargaining has been popularized by researchers such as Winter (1994a,b), Cardona-Coll and Mancera (2000), and Montero and Vidal-Puga (2007, 2011). The model analyzed here follows Vidal-Puga (2004) and Breitmoser (2009).

In our three-player *ultimata game*, two parties simultaneously make ultimatum demands for their respective surplus shares. The proposer is then informed of these ultimata, after which he proposes how to share the surplus. Proposals are implemented if they satisfy at least one ultimatum (in the three-player majority game). The proposer needs to satisfy only the lower of the two ultimata, offer the more demanding player nothing, and retain the lion's share. Knowing this, non-proposers should competitively undercut each other by demanding less, a la Bertrand, until demands are close to zero in equilibrium. Hence, competitive ultimata confer all the bargaining power to the proposer. The novelty of this model is the control that it imposes on social preferences: as we show below, the same state of welfare asymmetry holds true regardless of whether we assume self interest, linear altruism, or linear inequity aversion. If preferences are non-linear, e.g. CES, positive demands can result in equilibrium, but they should be moderate nonetheless, still leaving most of the cake to the proposal maker. We experimentally test if this intuitively appealing, theoretically robust, yet distributively lopsided state occurs in laboratory bargaining. If it does not occur we can observe how and understand why.

Our use of a three-player format to control for social preferences by sharply restricting their scope, rather than to test for the role of social motives by allowing them, stands in contrast to the existing literature on (three-player) bargaining games. Güth and van Damme (1998) test a three-player ultimatum game where only one of two non-proposers has veto power. They find that generous offers are due to the proposer's fear of rejection rather than their sense of fairness, and that responders reject low offers made to them not their fellow non-proposer. Güth et al. (1996) show that when responders are put in the proposer role, even they try to exploit the other responders by behaving deceitfully, indicating a lack of fairness concerns at the collegial level. In Kagel and Wolfe's (2001) game, offers rejected by a randomly chosen responder yields zero earnings for him and the proposer, and a consolation prize for the responder. The fairness models of Bolton and Ockenfels (2000) and Fehr and Schmidt (1999) predict lower rejection rates in the treatment with consolation prizes, because responders are averse to the inequity that arises between both responders when one suffers from rejection and the other gets a consolation prize. Kagel and Wolfe, however, find similar rejection rates in both treatments.

An alternative interpretation of the demand commitments that proposers have to satisfy in order for proposals to be implemented in our game is borrowed from the ultimatum game of Poulsen and Tan (2007). There, proposers were allowed to "acquire and use information" on responders' minimum acceptable offer (i.e. demands) via an option whereby offers would be automatically conditioned on demands. In their game, responders effectively move first by setting the ultimata, with which money maximizing proposers will comply, and thus have all the power. In contrast, when we couple the freewill that our proposers have over the use of "acquired information" on demands, together with the simultaneous and thus competitive ultimata, they possess all the power. Put differently, the strategic complementarity of competitive ultimata increases the proposer's equilibrium payoff because offers and demands are strategic substitutes—social preferences regardless.

Our main results are as follows. Non-proposers demand for and are offered substantial shares. Proposers strategically satisfy the lower of two demands to avoid rejection, like ultimatum bargaining (Güth et al., 1982), but also give non-strategically to the other party, like dictator giving (Forsythe et al., 1994). Unlike for dictator and ultimatum games, however, neither self-interest nor social preferences can account for generosity in the ultimata game. Our analysis shows that a non-concave model of reference dependence, in the spirit of Shalev (2000, 2002), Kőszegi and Rabin (2006, 2007), Butler (2008), and Kőszegi (2010), is compatible with the observations. Our study offers evidence that accords with previous research supporting the relevance of reference dependence in social interactions. Neilson (2006) theoretically shows that inequity aversion is a special case of reference dependence in the sense that it results if preferences are self-referently separable. The empirical relevance of social reference points has been established in Dana et al. (2006, 2007), Andreoni and Bernheim (2009), and Bicchieri and Chavez (2010). Knez and Camerer (1995) show the relevance of social comparisons in a three-player ultimatum game experiment where asymmetric outside options to responders induced higher expectations, more rejections, and demands increasing with offers made to fellow responders.

Section 2 presents the game and analyzes it under assumptions of self-interest and various forms of social preferences. Section 3 describes experimental design and logistics. Section 4 presents the results. Section 5 shows how they are compatible with reference dependence preferences. Section 6 discusses and concludes.

2 The game

The game has three players, $N = \{1,2,3\}$, and proceeds in rounds. In each round, a proposer is drawn randomly. Non-proposers state demands, and the proposer is informed of the demands and states a proposal. If the proposal satisfies at least one demand, then it is implemented. Otherwise a new round begins with probability .95, and the game ends in disagreement (payoff being zero) with probability .05. In the experiment, the subjects can allocate €24 at a smallest currency unit of 1 Cent. The following theoretical analysis assumes that the smallest currency unit be 0, and the set of feasible allocations therefore is, with $C = 24$,

$$\mathbf{X} = \left\{ \mathbf{x} \in \mathbb{R}^N \mid \mathbf{x} \geq 0 \text{ and } \sum_{i \in N} x_i \leq C \right\}. \tag{1}$$

The unique equilibrium demands are €0 if players maximize pecuniary payoffs (assuming subgame perfection; for a related result, see Breitmoser, 2009). The proposer therefore gets the whole cake €24 (if the smallest currency unit is 1 Cent, the equilibrium demands are €.02 or less rather than €0 in general). Intuitively, the players undercut each other's demands in a way similar to Bertrand competition and they end up demanding their marginal costs (which is zero).

Behavior in the respective one-shot game is theoretically very similar to that in the infinite horizon game, as strategically the continuation payoffs are irrelevant in view of the inter-party demand competition (and indeed, this holds true for all outcome-based utility functions). By adopting the infinite horizon game, we implicitly allow for renegotiation after failing to reach an agreement and for uncertainty of breakdown, because they mirror features found in real world bargaining. This is common to many majority bargaining models including those without demand commitment, e.g. Baron and Ferejohn (1989) and Harrington (1990). It also allows us to test for stationarity, as further discussed next.

The following derives the equilibrium predictions if players have social preferences. Let their common utility function be $U : \mathbb{R}^N \to \mathbb{R}$ (the symmetry assumption simplifies the notation, but all our results generalize for appropriate adaptations of notation). Here, $U(x_i, x_{-i})$ is the utility of i under the payoff profile $(x_i, x_{-i}) \in \mathbb{R}^N$. Throughout, we assume that U is continuous in $\mathbf{x} \in \mathbb{R}^N$, that it is symmetric in the sense that changes of one's opponents is irrelevant, $U(x_i, x_j, x_k) = U(x_i, x_k, x_j)$, and that all players would prefer to switch with better-earning opponents if everything else is held constant,

$$\forall \mathbf{x} \in \mathbb{R}^n : \quad x_i > x_j \;\Rightarrow\; U(x_i, x_j, x_k) > U(x_j, x_i, x_k). \tag{2}$$

For example, inequity aversion (Fehr and Schmidt, 1999) is described through

$$U(x_i, x_{-i}) = x_i - \alpha \sum_{j \neq i} \max\{x_j - x_i, 0\} - \beta \sum_{j \neq i} \max\{x_i - x_j, 0\}, \tag{3}$$

with $0 \leq \beta \leq \alpha < 1/3$. The value of α measures the degree of envy toward players that are better off than oneself, and the value of β measures the degree of guilt towards players that are worse off than oneself. Fehr-Schmidt utilities are a special case of what we call *quasi-linear preferences*: every player generally prefers getting an additional dollar at the expense of his opponents. That is,

$$\forall d > 0, \forall \alpha \in [0,1]: \quad U(x_i, x_j, x_k) < U\big(x_i + d, x_j - \alpha d, x_k - (1-\alpha)d\big). \tag{4}$$

Further examples of preferences that are quasi-linear in this (rather weak) sense are linear altruism, self-interest, and all non-linear preferences with sufficiently high elasticities of substitution between own payoff and opponents' payoffs. The alternative range of circumstances with low elasticity of substitution is analyzed below.

Our first result characterizes the set of stationary subgame perfect equilibria for quasi-linear preferences. A subgame perfect equilibrium is stationary if all demands and proposals are independent of the actions in previous rounds. Demands and proposals may still depend on the identities $i \in N$ of proposer and demanders in the current round, and they may be asymmetric between players. The assumption of stationarity is not technically necessary, but it allows us to avoid the comparably tedious discussion of how the continuation payoffs depend on the proposal if the demands are prohibitive (in fact, it yields a simple definition of "prohibitive demands" in the first place). We will say that demands are *prohibitive* if the proposer is best off satisfying neither demand and settling for the continuation payoff.

Proposition 1 (Quasi-linear preferences)**.** *Assume the utility function is weakly concave and quasi-linear* (4)*. In all stationary SPEs, the demands satisfy $d_i = 0$ in all subgames, and the proposer payoff is C.*

Proof. Fix a stationary SPE and let $(\tilde{u}_1, \tilde{u}_2, \tilde{u}_3)$ denote the players' expected utilities in case agreement is not reached in the first round. By stationarity, these "continuation utilities" are constant in all rounds. First, consider any subgame where a proposal has to be made; let $i \in N$ be the proposer, let $j,k \in N$ be the other two players, and let d_j, d_k be their current demands. In general, the utility maximizing proposal is of the form $(C-d-e, d, e)$ where

$$(d,e) \in \underset{(d',e') \geq 0}{\arg\max}\, U(C-d'-e', d', e') \quad \text{s.t. } d' \geq \min\{d_i, d_j\}.$$

Under quasi-linearity (4), $d = \min\{d_j, d_k\}$ and $e = 0$ obtains. The demands (d_j, d_k) are *prohibitive* if $U(C - d^*, d^*, 0) < \tilde{u}_i$ with $d^* = \min\{d_j, d_k\}$.

Second, consider any subgame where demands have to be stated, and as above, let i and j,k be proposer and demanders (respectively). Assume the equilibrium demands are not prohibitive and denote them as (d_j, d_k). By quasi-linearity, $U\big(d, 0, C - d\big) > U\big(0, d, C - d\big)$ for all $d > 0$, and by continuity, this implies that for all $d > 0$ there exists $\varepsilon > 0$ such that

$$U\big(d, 0, C - d\big) > 0.5 \cdot U\big(d + \varepsilon, 0, C - d - \varepsilon\big) + 0.5 \cdot U\big(0, d + \varepsilon, C - d - \varepsilon\big).$$

Hence, in equilibrium, non-prohibitive demands have to satisfy $d_j, d_k = 0$, and as shown above, this implies the proposer payoff C.

It remains to show that equilibrium demands are non-prohibitive regardless of the identity of the proposer. Assume the opposite, and fix proposer i such that demanders j,k are best off making prohibitive demands (as long as the other one does so). Thus

$$U(d', C - d', 0) \leq \min\{\tilde{u}_j, \tilde{u}_k\} \quad \text{for} \quad d' : U(C - d', d', 0) = \tilde{u}_i \tag{5}$$

with d' as the highest demand that i considers non-prohibitive (which follows from the definition of "prohibitive" demands, see above). Let $(\tilde{x}_i, \tilde{x}_j, \tilde{x}_k)$ denote the "continuation" payoffs in the SSPE (i.e. the expected payoffs in case the first round ends in disagreement). By weak concavity of U, $\tilde{u}_i \leq U(\tilde{x}_i, \tilde{x}_j, \tilde{x}_k)$, and by definition of the game $\tilde{x}_i + \tilde{x}_j + \tilde{x}_k \leq C$. Without loss, assume $\tilde{u}_j \leq \tilde{u}_k$. Thus, (5) implies

$$U(d', C - d', 0) \leq \tilde{u}_j \leq U(\tilde{x}_j, \tilde{x}_i, \tilde{x}_k) \quad \text{or} \quad U(C - d', d', 0) \leq \tilde{u}_i \leq U(\tilde{x}_i, \tilde{x}_j, \tilde{x}_k).$$

for all $d' \in [0, C]$, and thus $\tilde{x}_k = 0$ under quasi-linearity. Since the payoffs are bounded below by zero in all subgames, $\tilde{x}_k = 0$ implies that k's payoff is zero in all subgames, and since $U(0, d, C - d) < U(d, 0, C - d)$, this implies $\tilde{u}_k < \tilde{u}_j$, the contradiction. □

Thus, the equilibrium prediction is independent of whether players are egoistic, linearly inequity averse, or linearly altruistic, and it is equally extreme in all cases. Further, preferences for social efficiency are compatible with quasi-linearity, too, as all allocations induce the same sum of payoffs, namely C. Therefore, equilibrium demands are positive only if preferences are non-linear. The best known example of non-linear social preferences is the CES family of distributive preferences, i.e.

$$U(x_i, x_{-i}) = \Big((1-\alpha)\cdot(1+x_i)^\beta + \alpha/2\cdot(1+x_j)^\beta + \alpha/2\cdot(1+x_k)^\beta\Big)^{1/\beta} \tag{6}$$

with $\alpha \in [0, 0.5]$ as the degree of altruism and $s = 1/(1-\beta)$ as the elasticity of substitution. We assume $\beta \in (-\infty, 1]$ to ensure concavity.

Without linearity, the donation to the third player may be positive, although any such donation is strategically irrelevant. For every utility function U, there exists a value $e^* \geq 0$ and function $e(d) \geq 0$ such that if the demands are (d_1, d_2) with $e^* \leq d_1 < d_2$, the proposer gives d_1 to pay the player with the lower demand, and he gives $e(d_1)$ to the other. For all $d \in (0, C)$, $e(d)$ is

$$e(d) \in \underset{e' \in [0, C-d]}{\arg\max}\ U(C - d - e', d, e'). \tag{7}$$

Under continuity and weak concavity, e is unique. In the case of CES preferences,

$$e(d) = \max\left\{0, \frac{(1-\alpha)^{1/(\beta-1)}}{(\alpha/2)^{1/(\beta-1)} + (1-\alpha)^{1/(\beta-1)}}\cdot(C+2-d) - 1\right\}, \tag{8}$$

results. That is, $e(d)$ is continuous and decreasing in d, and by definition it is non-negative and bounded. Thus it has a unique fixed point in $[0, C]$ which we will denote as e^*. Our next result shows that the equilibrium demands are $d = e^*$, possibly positive, if $e(d)$ is continuous and weakly decreasing in d. As shown, this assumption covers CES preferences, but in fact, it is rather general and covers all non-linear forms of social preferences assumed in the literature (that we are aware of).[1]

Proposition 2 (Non-linear preferences)**.** *Assume U is strictly concave in (x_i, x_j, x_k) and implies that e as defined in* (7) *is continuous and weakly decreasing in d. There exists e^* such that in all stationary SPEs, the equilibrium demands (d_j, d_k) satisfy $\max\{d_j, d_k\} \leq e^*$ in all subgames, and the proposer payoff is $C - 2e^*$.*

Remark 3. There is a plethora of payoff equivalent and interchangeable equilibria. In all cases where at least one player demands e^* or less, the proposer allocates e^* to both—out of "altruism" he does not give less in this case, even if both demand less

[1] It is possible to define social preferences that violate the assumption that $e(d)$ is weakly decreasing, however. Nested CES preferences are one example. Such functions are not used in the literature.

than e^*.

Remark 4. In this non-linear case, strict concavity of U is assumed to ensure uniqueness of the optimal proposals in all cases (i.e. in response to all demand vectors) and to establish non-prohibitiveness of demands. In the quasi-linear case, weak concavity is sufficient for both, as corner solutions arise in all cases.

Proof. Fix an SSPE and let $(\tilde{u}_1, \tilde{u}_2, \tilde{u}_3)$ denote the continuation utilities (as above). Define e^* as the unique fixed point of e in $[0, C]$. In response to demands (d_j, d_k), the optimal proposal takes the form $\big(C - d - e(d), d, e(d)\big)$ if $\min\{d_j, d_k\} =: d \geq e^*$ (by the definition of e), or it takes the form $\big(C - 2e^*, e^*, e^*\big)$ if $\min\{d_j, d_k\} =: d \leq e^*$ (by definition of e and strict concavity of U). Demands (d_j, d_k) are called "prohibitive" if the respective optimal proposer utility is less than his continuation utility $\tilde{u}_i$.

Now, consider a subgame where the players make non-prohibitive demands in the fixed SSPE and let (d_j, d_k) denote these demands. We claim $\max\{d_j, d_k\} \leq e^*$, and for contradiction, assume the opposite. First, consider the case $d_j = d_k$. By condition (2), $d_j > e^*$ and the assumption e be decreasing in d,

$$U\big(d_j, e(d_j), C - d_j - e(d_j)\big) > U\big(e(d_j), d_j, C - d_j - e(d_j)\big), \tag{9}$$

and thus continuity of U implies that there exists $\varepsilon > 0$ such that

$$\begin{aligned} &U\big(d_j - \varepsilon, e(d_j - \varepsilon), C - d_j - \varepsilon - e(d_j - \varepsilon)\big) \\ &\qquad > 0.5 \cdot U\big(d_j, e(d_j), C - d_j - e(d_j)\big) + 0.5 \cdot U\big(e(d_j), d_j, C - d_j - e(d_j)\big). \end{aligned}$$

Hence, j benefits by unilaterally deviating to $d' = d_j - \varepsilon$. Second, consider the case $d_j \neq d_k$; without loss, assume $d_j < d_k$. Now (9) and continuity implies that there exists $\varepsilon > 0$ such that

$$U\big(d_j - \varepsilon, e(d_j - \varepsilon), C - d_j - \varepsilon - e(d_j - \varepsilon)\big) > U\big(e(d_j), d_j, C - d_j - e(d_j)\big).$$

Hence, k benefits by unilaterally deviating to $d' = d_j - \varepsilon$.

Finally, non-prohibitiveness of equilibrium demands follows from concavity of U and can be established as follows. Similar to above, the opposite implies (under concavity) that for all $d' \in [e^*, C]$

$$U(d', C-d'-e(d'), e(d')) \leq \tilde{u}_j \leq U(\tilde{x}_j, \tilde{x}_i, \tilde{x}_k)$$
$$\text{or} \quad U(C-d'-e(d'), d', e(d')) \leq \tilde{u}_i \leq U(\tilde{x}_i, \tilde{x}_j, \tilde{x}_k),$$

again using $(\tilde{x}_j, \tilde{x}_i, \tilde{x}_k)$ to denote the continuation payoffs. Set d' such that $U(C-d'-e(d'), d', e(d')) = U(\tilde{x}_i, \tilde{x}_j, \tilde{x}_k)$. By concavity, $U(d', C-d'-e(d'), e(d')) \geq U(\tilde{x}_j, \tilde{x}_i, \tilde{x}_k)$ follows, and equality obtains only if $\tilde{x}_j = d'$, $\tilde{x}_i = C-d'-e(d')$, $\tilde{x}_j = e(d')$, but by $\delta = 0.95 < 1$, $\tilde{x}_i + \tilde{x}_j + \tilde{x}_k < C$, the contradiction. □

Thus, non-linear preferences can explain positive donations to the third player. For example, in the Cobb-Douglas case $\beta \to 0$, sufficiently high altruism ($\alpha = 0.3$) implies values of $e(d) \in [3,4]$ and a fixed point $e^* \approx 4$. Higher demands can be explained by assuming higher degrees of altruism or lower elasticity of substitution, but in any case, the equilibrium demands are competitive and equate with e^*. In turn, combinations of high demands d and moderate donations $e(d)$ to the third player cannot be explained by social preference theory. In particular, the following is implied under either of the above assumptions.

Corollary 5 (Concave utilities). *If the equilibrium demands are d and the proposer makes a proposal of the form $(C-d-e, d, e)$, then $e = d$.*

3 The experiment

The experimental game is exactly as described in the previous section. The experiment was computerized (using z-Tree, see Fischbacher, 2007) and conducted in the experimental economics laboratory in a German university. Subjects were students from various faculties, recruited via a mass email announcement of the experiment. There was a total of five sessions. Each session was partitioned into two sub-sessions, to each six subjects were randomly assigned. Subjects never interacted with those from other sub-sessions. Sessions were partitioned to increase the number of independent observations, and ran simultaneously to increase the sense of anonymity. Each session contained 12 subjects. A total of 60 subjects participated. Each subject was allowed to participate only once.

Each session comprised 10 repetitions ("stages") of the game, each comprising a number of "rounds." In each stage, subjects were randomly re-matched into groups of three. Roles were randomly reassigned in each round. Neutral language was used. Subjects were randomly assigned partitioned computer terminals that enforced privacy. They read experimental instructions and answered a control questionnaire for us to check their understanding. At the end of the experiment, subjects were informed of their payments, and anonymously collected their payments from a third party one week after the experiment. Payments included a € 4 participation fee and the earnings from one randomly chosen "winning stage" ranging from € 0 to € 24 per subject. The average pay-out per subject was € 11.12 for, on average, less than 1 hour per session.

4 Results

Table 1 lists the mean demands and proposals in all rounds, and Figure 1 provides a graphical overview of demands, proposals, and proposals in relation to demands. The proposals $\mathbf{x} \in \mathbf{X}$ are stated in response to a profile (d_1, d_2) of demands. The lower of the two demands $d_l = \min\{d_1, d_2\}$ is strategically relevant for the proposer (assuming $d_l \leq 16.40$), while the higher one $d_h = \max\{d_1, d_2\}$ is strategically irrelevant. Our analysis therefore focuses on (d_l, d_h) rather than (d_1, d_2). Using this notation, the theoretically predicted proposals under quasi-linear preferences are $x_p = 24 - d_l$ to the proposer, $x_l = d_l$ to the party with the lower demand, and $x_h \approx 0$ to the other.

Figure 1f shows the distribution of demands. Mode and median are at 8, which is the ex ante expected payoff, and the mean is 8.78 with standard deviation 3.05. Table 1a suggests that demands initially decline notably but they fluctuate largely above eight. To investigate this rigorously, we econometrically estimate the demand strategies next, controlling for interdependence (via two-level random effects, on Session and Subject in Session), reciprocal of game number ($= 1/G$, to be able to gauge convergence for $G \to \infty$), and round number minus 1 ($= R$).[2] The demand estimate is

$$x_d = \underset{(0.3095)}{8.3479^{**}} + \underset{(0.4168)}{1.6346^{**}} \cdot G^{-1} - \underset{(0.1639)}{0.1092} \cdot R. \tag{10}$$

For $G \to \infty$, the demand converges to the intercept 8.348, as suggested by Table 1a.

[2]Significance at the 5% level is denoted by * and significance at the 1% level by **.

Table 1: Means and standard deviations of demands proposals

(a) Demands in rounds 1–10

1	2	3	4	5	6	7	8	9	10
9.758 (3.326)	9.395 (3.094)	9.208 (2.902)	8.369 (2.883)	8.342 (3.696)	9.104 (3.916)	8.679 (2.472)	8.372 (2.383)	7.764 (2.203)	8.649 (2.954)

(b) Proposals in rounds 1–10

	1	2	3	4	5	6	7	8	9	10
x_p	11.04 (3.624)	12.2 (3.844)	12.42 (3.823)	11.37 (4.877)	12.53 (4.03)	13.7 (4.60)	11.16 (4.849)	12.9 (3.939)	13.44 (4.041)	14.17 (3.461)
x_l	7.776 (1.351)	7.4 (1.675)	7.211 (2.589)	8.375 (4.645)	7.005 (2.859)	6.755 (3.343)	7.475 (0.925)	7.4 (1.401)	5.915 (2.492)	6.729 (2.157)
x_h	5.185 (3.444)	4.4 (3.982)	4.368 (4.099)	4.25 (3.767)	4.46 (3.444)	3.545 (4.538)	5.37 (4.651)	3.7 (3.816)	4.65 (3.675)	3.105 (3.776)

Note: x_p is the payoff that the proposer allocates to himself, x_l is the payoff of the player with the low demand $d_l \in \min\{d_1, d_2\}$, and x_h is the payoff of the player with the high demand $d_h \in \max\{d_1, d_2\}$.

Result 1 (Demands)**.** *Demands do not violate stationarity (as R is insignificant), but they are not competitive and the mean demand converges to above eight—much in excess of theoretical predictions, indicating the lack of ultimata competition.*

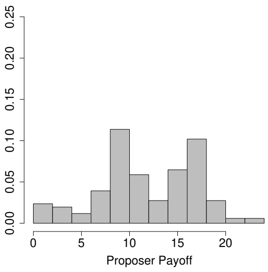
To understand the lack of convergence of demands, let us now look at the proposals. We focus on final proposals, i.e. those that satisfied at least one demand, as the other proposals are strategically uninformative.[3] Table 1b provides the proposal means, distinguishing between x_l (the payoff of the player with the low demand d_l) and x_h (the payoff of the player with the high demand d_h). Wilcoxon tests confirm $x_p > x_l$ and $x_l > x_h$ ($p \approx 0$ in both cases). Figure 1g plots the proposals in relation to lower demand and higher demand, respectively. The diagonal $x_l = d_l$ is lined with observations, implying proposers strategically match lower demands, while nonstrategic donations to the player with the higher demand are less systematic.

As above, we estimate the proposal function econometrically, controlling for G, R, d_l, d_h, and two-level random effects. In estimating x_h, we add x_l to test for substitution effects (the econometric equivalent of $e(d)$ as defined above).

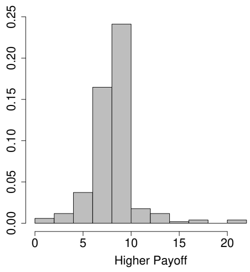
[3]Most proposals were final and therefore informative, however; $163/200$ of the games actually ended in the first round, $35/200$ ended in a later round, and $2/200$ games ended in disagreement.

Figure 1: Further information on the distribution of proposals

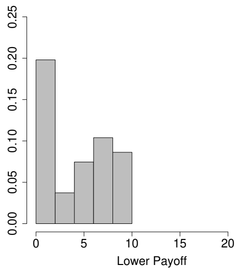
(a) Payoff proposed by proposer to himself



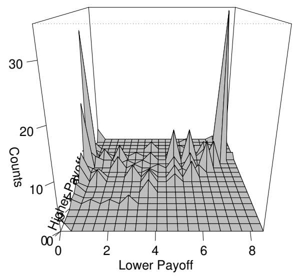
(b) Payoff x_l proposed to low demander



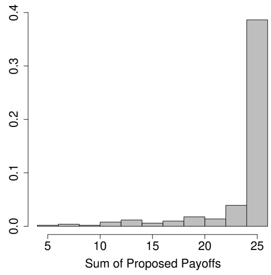
(c) Payoff x_h proposed to high demander



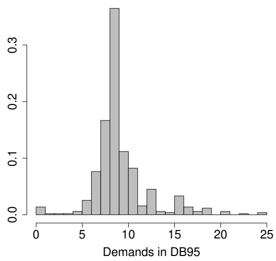
(d) Bivariate payoffs proposed to opponent



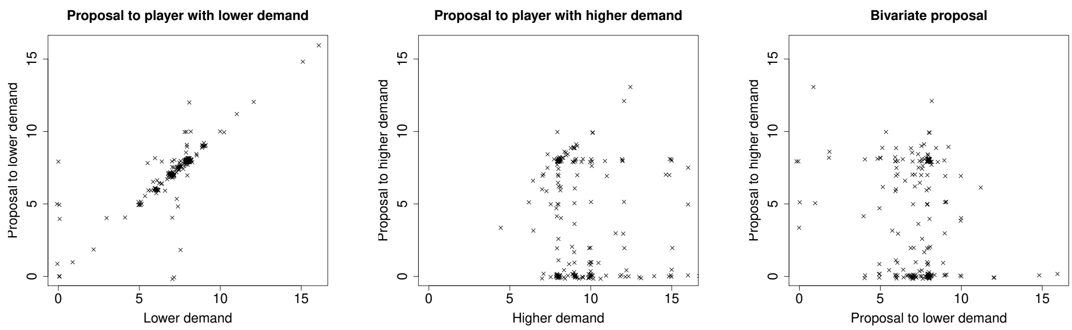
(e) Sum of all payoffs proposed by proposer



(f) Distribution of demands



(g) Proposals in relation to the demands in *DB95*



Note: The points are slightly perturbed, and the proposals that satisfied neither demand are excluded.

$$
\begin{aligned}
x_p &= \underset{(1.0821)}{16.088^{**}} - \underset{(0.8556)}{2.1635^{**}} \cdot G^{-1} - \underset{(0.3369)}{0.3478} \cdot R - \underset{(0.1295)}{0.4801^{**}} \cdot d_l + \underset{(0.0831)}{0.0617} \cdot d_h \\
x_l &= \underset{(0.6176)}{0.6523} + \underset{(0.5451)}{0.2592} \cdot G^{-1} + \underset{(0.2114)}{0.0866} \cdot R + \underset{(0.0789)}{0.6871^{**}} \cdot d_l + \underset{(0.0509)}{0.1533^{**}} \cdot d_h \\
x_h &= \underset{(1.0443)}{7.6161^{**}} + \underset{(0.8244)}{1.9548^{*}} \cdot G^{-1} + \underset{(0.3247)}{0.2684} \cdot R + \underset{(0.1438)}{0.1774} \cdot d_l - \underset{(0.0828)}{0.1526} \cdot d_h - \underset{(0.1133)}{0.5226^{**}} \cdot x_l
\end{aligned}
$$

First, look at the projected limits of the proposals as G tends to infinity. Given that the demands stabilize around 8.35, x_p stabilizes at 12.60 ($= 16.088 - 0.48 * 8.35 + 0.0617 * 8.35$), the proposal to the low demanding player x_l stabilizes at 7.67, and the proposal to the high demanding one stabilizes at 3.82 (note that these numbers almost exactly add up to 24, which underlines their credibility). That is, the offers to the high demanders are not only significant during the experiment, but there is not even a clear trend suggesting that they will decrease notably below the level observed in the experiment (see also x_h in Table 1b). The observed limit of 3.82 is compatible with Cobb-Douglas altruism, as discussed above, but not with quasi-linear utilities such as linear altruism or inequity aversion.

Result 2 (Proposals)**.** *Proposers get the lion's share, lower demands are strategically satisfied, but non-strategic offers to the high demanders are far higher than predicted and decrease hardly as subjects gain experience.*

The previous two results indicate that preferences are not quasi-linear as assumed by Proposition 1. Proposition may apply, however. To verify this, look at how the payoffs change if the low demand d_l decreases by €1. The proposer payoff increases only by €0.48, and the low-demanding player's payoff does not decrease by a full €1, but only by €0.68. The difference €0.20 actually goes to the third player, the high demander (note the interaction with decreasing x_l, i.e. $dx_h/dd_l = 0.177 - 0.553 * 0.687 = -0.203$). In turn, if the low demand increases, then the non-strategic donation to the high demander decreases by 20%. Qualitatively, this observation is compatible with CES preferences, and in particular with the comparative statics of $e(d)$ as defined above.

Result 3 (Assumptions of Proposition 2 are satisfied)**.** *The payment to the low demander indeed approximates d, the lesser of the two demands. The donation e to the high* *demander is highly volatile and most frequently zero. However, positive donations occur, and empirically e is highly significantly decreasing in d.*

Finally, if the high demand increases, then both the proposer payoff and the low demander's payoff increase, while the high demander's payoff decreases (by about 22% of his demand increase)—although the high demand (as well as its increase) is strategically irrelevant. In this way, the proposer punishes greedy demands. In turn, if the high demand decreases, then the payoff of the high demander increases by 22%. Thus, the following result.

Result 4 (Non-competitive demands)**.** *There is no empirical benefit from being the high demander, as* $x_l < x_h$ *is highly significant, and being the high demander, one should decrease the demand.*

The central observation is the discrepancy between the Results 3, which confirms that the assumptions of the theoretical analysis are correct, and 4, there is indeed no benefit to being the high demander, to the Result 1, subjects are very reluctant to decrease demands below eight. See also Table 1a and the econometric estimate Eq. (10), which indicates convergence toward 8.35.

Thus, while the assumptions of the theory are not violated empirically, the logical conclusion derived under the assumption of concavity, Corollary 5 (competitive demands), is clearly violated. The discrepancy seems actually quite large. Demands stay at €8, the payoff to the third player tends to be below €4.

One possible explanation for this is that decreasing the demand below eight does not imply empirically that one will be the low demander with probability 1. Aggregated over all rounds, the probability of winning with the demand $d = 8.1$ is 0.388, the probability of winning with $d = 8.0$ is 0.547, and the probability of winning with $d = 7.9$ is 0.717 (all, assuming ties are resolved by uniform draws). Thus, the probability of winning does increase substantially. Given this, players with CES preferences that are compatible with a €4 donation to the third player (e.g. $\alpha = 0.4$ or less, and $\beta = -0.2$ or higher) are strictly best off undercutting demands of 8. Assuming the high demander gets €4, the *expected utility* (for $\alpha = 0.4$ and $\beta = -0.2$) from demanding $d = 8$ is 7.70, and the expected utility from demanding $d = 7.9$ is 7.96. In fact, the expected utility from demanding $d = 7$ ($EU = 7.82$) is still higher than that from demanding 8. The relations are similar for other utility parameters, and overall we infer from the reluctance to demand eight that concavity is not satisfied.

Result 5 (Concavity violated)**.** *Subjects' utilities are not concave in the payoff profile.*

Since social preferences are generally represented by concave utility functions, we conclude that social preferences do not explain fair demands and donations in this case.

5 Reference dependence

Technically, the failure of concave utilities to explain the observations lies in the fact that they imply diminishing marginal returns. If utility is concave in the payoffs, then the decrease of utility from getting $x_i = 8$ to getting $x_i = 7$ is smaller than the decrease in utility when the payoff declines from 7 to 6, from 6 to 5, or even from 5 to 4. Hence, players should accept taking the loss from 8 to 7 in order to reduce the risk of dropping down to 4. Apparently, the subjects think differently.

They seem to consider the drop from 8 to 7 to be worse than the drop from say 5 to 4. Thus, in this region the utility function seems to be convex, violating diminishing marginal returns. This suggests that subjects' utilities have the well-known *S*-shape proposed by the Prospect theory (Kahneman and Tversky, 1979). In the loss region, utility is convex, and only in the gain region, it is concave. This corresponds with a reference point of 8, i.e. that payoffs below 8 induce a loss, and payoffs above 8 are counted as gain. This reference point is reasonable in this context, as the fair share is easy to compute ($24/3 = 8$), it equates with the ex-ante equilibrium payoffs (the reference point proposed by Shalev, 2000, 2002, and Kőszegi and Rabin, 2006, 2007), and it also appeals to a sense of fairness, although in a different way than social preferences. The corresponding utility function is

$$U(x_i, x_j, x_k) = \begin{cases} (x_i - 8)^\alpha, & \text{if } x_i \geq 8 \\ -\beta \cdot (8 - x_i)^\alpha, & \text{if } x_i < 8. \end{cases} \tag{11}$$

Now, if the utility is steep enough around the reference point 8, i.e. if α is low enough, then undercutting demands of 8 does not pay off. Theoretically, this obtains only in the limiting case $\alpha \to 0$, but practically, the noisiness of demands implies that reasonable α are sufficient to explain the reluctance. Given our data, $\alpha < 0.4$ is empirically sufficient. With the same numbers as those used above (for CES preferences), demanding $d = 8$ induces the expected utility (using $\alpha = 0.38$ and $\beta = 2.25$) of -1.726, demanding $d = 7.9$ induces -1.769, demanding $d = 7.8$ induces -1.957, and further decreases of the demand induce further decreases of the expected utility. Thus, the mode demand $d = 8$ is compatible with reference dependence.

Result 6 (Reference dependent demands)**.** *The demands are compatible with reference dependent preferences if* $\alpha < 0.4$.

This raises the question whether the empirical donations e to the third player fit into this picture. As summarized in Result 3, the donation e is volatile, has the mode at zero, and it is decreasing in d (see also Figures 1g and 1c). The mode at zero and the high volatility suggest that subjects actually play logit response for e (or more generally, have random utility) rather than best responses and that the utility maximizing choice is $e = 0$. In turn, the observations are not compatible with social preferences even after accounting for quantal response. For, if the utility maximizing choice would be some $e > 0$, then under the standard assumption of i.i.d. logistic errors, the mode should be $e > 0$ (see McKelvey and Palfrey, 1998, and Turocy, 2010, for quantal response equilibria in extensive-form games, and Breitmoser et al., 2010, for QREs in dynamic games such as the one considered here).

Finally, the conjunction of reference dependence and logistic errors also explains the observation that e is decreasing in d. The larger d, the smaller is the proposer payoff $C - d - e$ (keeping e constant), and in particular, the closer the proposer payoff is to his reference point of 8. Thus, the proposer's utility is comparably steep if d is high, which implies that he is less likely to choose high e. In turn, if d is low, then the proposer payoff is rather high, his utility is rather flat in e, and thus he is more likely to choose high e under logistic errors. Note that this effect is more pronounced if the curvature if U is strong, i.e. if α is low, which corresponds with the above explanation for the demands.

Result 7 (Reference dependent offers)**.** *The donations e to the third player are compatible with reference dependence (in particular for low* α*) and logistic errors.*

Thus, we conclude that "fair" demands and "generous" donations, which are incompatible with social preferences, are compatible with reference dependent preferences.

6 Discussion and conclusion

We theoretically and experimentally analyzed the *ultimata bargaining*, where a cake worth €24 is to be divided. First, two of the three players state demands, and in response the proposer has to propose an allocation satisfying at least one demand. The observed demands stabilized around €8, the payoff allocated to the low demander was approximately equal to his demand (i.e. €8), and the average payoff to the high demander was €4. These results are incompatible with social preferences, which are restricted from manifesting as generosity by construct of our game. The results are, however, compatible with reference dependent preferences taking the ex ante expected payoffs, which coincide with the equal split, as reference point.

Like in the three-player bargaining game of Kagel and Wolfe (2001), we find a lack of support for fairness theories in three-player bargaining games. We went further by seeking for an explanation for generosity in an environment where social preferences have no bite. Our results support the argument put forth by a line of recent work emphasizing the role of reference dependence in social behavior (see e.g. Neilson, 2006, Dana et al., 2006, 2007). Indeed, the role of ex ante expected payoffs as endogenous reference points is implied by the results of Knez and Camerer (1995).

Our paper also shows how an imbalance of strategic power in theory does not necessarily translate to asymmetric welfare distributions in the practice. Such understanding is important, because it can be used to inform choices of group decision procedures, for example. Montero et al. (2008) studied the effect of varying voting weights and rules on strategic power with a voting game following Brams and Affuso (1976). In one of their treatments, one player had a strategic advantage over others. The cake was split unevenly within the minimum winning coalition, with the advantaged player earning the most, while equal splits within the minimum winning coalition were observed with symmetric power. We analyzed a game where a far more extreme imbalance of strategic power and welfare distribution results from self-interest or social preferences. Experimental outcomes were not as grim as theoretically expected, as we observed welfare being distributed amongst all three players.

The ultimata that we observed were not as competitive as predicted, reminiscent to Dufwenberg and Gneezy (2000)'s experimental observation that price competition was not as fierce as expected in their two-firm Bertrand competition game—an effect which diminished with the increase in the number of firms. They posited that beliefs of "crazy" opponents can induce non-competitive equilibria in markets with sufficiently few firms. Similarly, we also consider the role of bounded rationality, namely in terms of logistic errors. Ultimatum competition differs from price competition, however, in that the earnings of non-proposers depend not only on each others' demands but also on the choice of a human proposer—setting the strategic context for social preferences that we are specifically interested in.[4] Moreover, collusion between non-proposers in ultimatum competition seems generally implausible considering the results of Güth et al. (1996), who find of opportunism between "fellow" responders.

Like in other experiments on majority bargaining games, such as by Fréchette et al. (2005), who studied a sequential move demand bargaining game of Morelli (1999) and the random proposer game of Baron (1989), and by Drouvelis et al. (2010) who studied the Baron and Ferejohn (1989) game, we observed the under-realization of proposer power in our simultaneous move ultimata game. While social preferences such as inequity aversion *increases* inequity in the Baron-Ferejohn game (Montero, 2007), the equilibrium prediction in our game is, relative to self-interest predictions, largely invariant to social preferences. This imposes a control for social preferences and allowed us to tease out the motives for generosity beyond social preferences.

Proposers were observed to be strategically accommodating yet non-strategically generous, satisfying the lower of the two demands while leaving something for the other party. Prompted by the findings indicating the role that the fear of rejection plays in motivating generosity (Croson, 1996; Güth and van Damme, 1998; Kagel et al., 1996; Straub and Murnighan, 1995), the ultimata game allows demands to be observed prior to proposing, thereby insulating the proposer from the risk of rejection. Indeed, we found evidence for strategic concerns in the matching of lower of demands, and yet, generosity toward the third player was significant.

Our results clearly show that generosity can exist in an environment without social preferences. Camerer (2003) postulated that offers in ultimatum games are

[4] In their game the winner takes it all, and profits are equally shared if bids are tied, whereas here non-coalitional parties in our game can benefit from the generosity of proposers.

strategically made to avoid rejection, and those in dictator games are driven by concerns for the strategically powerless receiver. These two experimental workhorses are juxtaposed, strategically and endogenously, in the single context of our game. Uncannily, we observed strategic offers and demands comparable to the minimum acceptable offers found in standard ultimatum games and non-strategic offers close to dictator donations (for a survey see Camerer, 2003). If we accept the notion that preferences are context-dependent, then our observations may be explained by a story of mixed motives. Alternatively, a parsimonious explanation is afforded by the model of reference dependence.

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A Experimental instructions and screen shots

Note: the original instructions are in German and are available on request.

Instructions

You are participating in an experiment on decision making. The experiment is divided into 10 stages. In each stage, the computer will assign you to one of four groups, with three participants per group (including you). After each stage, you will be reassigned to a new group. You are paid based on a randomly chosen winning stage. You will get your earnings in Euros. Additionally, you get 4 Euros independently of your actions.

Your task In each stage, 24 Euros are to be allocated. First, a participant will be assigned the *A* role and the other two participants will be assigned the *B* role. These assignments are random, and all group members have the same probability of being assigned the *A* role. Next, the *B* participants state how much of the 24 Euros to claim for themselves. The *A* participant subsequently proposes a division of the 24 Euros. If the claim of at least one *B* participant is satisfied, then the proposed division is implemented, and the stage ends. If no *B* participant's claim is satisfied, then

- with 95% probability, a new round begins, where one of the participants will be randomly assigned the *A* role again, and
- with 5% probability, the current stage ends. In this case, all participants get 0 Euro for this stage.

General In each stage, the three members of a group are referred to as Participant 1, Participant 2, and Participant 3. The numbering is done randomly when a new group is formed (i.e. at the beginning of each stage). Consequently, it may happen that you are referred to as Participant 3 in one stage and as Participant 1 in another stage. The numbering is held constant for the duration of a stage. The assignment to *A* and *B* roles is independent of the numbering, i.e. in the first round of a stage, participant 2 could be assigned the *A* role, and in a possible second round, it could be participant 3. It may also happen that one participant is assigned the *A* role in two or more consecutive rounds (while many consecutive assignments are relatively unlikely).

Numbers have to be entered at two points: when *B* participants state their claims, and when the *A* participant proposes a division. The claims cannot be less than 0 Euro and not greater than 24 Euros. These bounds and all values in between are legitimate claims, including fractional numbers such as "0.80" (= 0 Euro and 80 Cents). Fractions of Cents cannot be claimed. As for division proposals, the same rules apply. No participant can be allocated less than 0 Euro, none more than 24 Euros, and combined no more than 24 Euros can be allocated. It is not necessary that all 24 Euros are allocated.

Figure 2: Screen shots