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Information in ultimatum games: An experimental study

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Abstract

This study reports on an experiment using variations of the ultimatum game. The experiment controls the amount and type of information known to the responder in the game. In two treatments, she knows both the absolute (money) and relative (fairness) payoffs from an offer. In the other two, she knows either only the absolute or only the relative payoffs. The predictions of four models for these treatments are tested: subgame-perfection, Bolton's comparative equilibrium, Ochs and Roth's absolute threshold, and Ochs and Roth's percentage threshold hypothesis.

JEL classification: C9; C72

Keywords: Experiment; Ultimatum game; Fairness; Uncertainty; Framing; Contingent weighting

1. Introduction

In his "Anomalies" series for the *Journal of Economic Perspectives*, Thaler discusses the importance of the ultimatum game to the study of economics:[1]

> Any time a monopolist (or monopsonist) sets a price (or wage), it has the quality of an ultimatum. Just as the Recipient in an ultimatum game may reject a small but positive offer, a buyer may refrain from purchasing at a price that leaves a small bit

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[1]In an ultimatum game, player 1 (the Proposer) makes an offer to player 2 (the Responder). The offer consists of a proposal dividing a sum of money (the pie or π) between the two players. Usually this offer takes the form of "player 2 can have \$x, player 1 will get \$(π-x)." Player 2 can either accept or reject the offer made. If she accepts, the pie is divided as proposed and the game ends. If she rejects, neither player receives any money, and the game also ends.

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of consumer surplus but is viewed as dividing the surplus in an unfair manner. (Thaler, 1988, p.203)

Any trading mechanism can be thought of as a bargaining game over the surplus generated from the exchange. The posted price system with which we are most familiar can be modeled as an ultimatum game between a seller and a buyer, with the buyer as Responder. However, while there is one slight difference: when the buyer is considering purchasing an item, she knows the amount of surplus she will be receiving from the transaction; she may not know the total amount of surplus to be divided—that is, she may not know the cost to the seller and, by extension, the difference between her value and his cost. Of course, she has some prior belief about the seller's cost, perhaps she's seen the item for sale in other stores, or has an idea about the markup a given store uses, but when deciding whether to accept or reject this specific transaction (offer), the buyer (Responder) generally does not know the amount of surplus that will be generated (size of the pie). An ultimatum game in which the Responder does not know the size of the pie might thus provide a better description of a posted-price exchange than the classic version.

Ultimatum bargaining is not only a model for transactions, but also a building block for more complicated, and more descriptive types of bargaining. Given its importance in models of strategic behavior, it has been studied extensively through experimental methods. This research has found that Proposers make larger offers than game-theoretic analysis would predict. Responders also reject small but positive offers, again contrary to the predictions of game theory.[2] One popular explanation for these outcomes is that subjects care about fairness: in addition to valuing their absolute payoffs (money earned from the game), subjects care about their payoffs relative to those of their bargaining partner (fairness of the division). This study was designed to differentiate between and to test various descriptions of fairness preferences.[3] The results are consistent with the notion that subjects care about both money and fairness. However the framing of the game being played affects its outcome—offers made in percentage terms rather than in dollar amounts induce higher demands, and thus "fairer" outcomes. An explanation for this effect from the *contingent weighting* literature (Tversky et al., 1988) is offered which suggests placing more "weight" or value on the fairness part of one's preferences when offers are made in percentage terms and relative payoffs are particularly salient.

The experiment consists of four treatments in which subjects divide a $10 pie in an ultimatum game. The treatments are depicted in Table 1 below and are designated by a two-character code. The first character represents the form in which offers are made (dollar amounts [$] or percentages [%]) and the second represents the state of the Responder's knowledge (Informed about the size of the pie [I] or Uninformed [U]).

The subgame-perfect equilibrium (offer ϵ, accept) is the same in all four experimental treatments. However, two empirical differences emerge across the treatments. First, in the treatments in which offers are made in dollars, uninformed Responders face and accept

[2] The outcomes of many ultimatum game experiments and their variations are summarized in Thaler (1988), Güth and Tietz (1990) and Roth (1995).

[3] The experiment was not designed to demonstrate that subjects in experiments care about fairness, but rather to investigate how those preferences emerge in various situations; i.e. to answer the question, under what conditions are fairness considerations more or less important in strategic behavior?

Table 1
Treatments

	Responder's information about pie size	
	Informed	Uninformed
Dollars	$I	$U
Offer made in percentage	%I	%U

substantially lower offers than their informed counterparts: the average offer in treatment $U is significantly lower than the average offer in treatment $I. Second, treatments $I and %I in which the situations are identical except for the description of the offer, evoke different Responder behavior: rejection rates and average demands made by Responders in treatment %I are significantly higher than those made in any other treatment, including treatment $I. This result is consistent with individuals placing greater value on fairness when relative payoffs are particularly salient.

Section 2 describes the experimental procedure and design. Section 3 outlines the theoretical predictions of the experiments and Section 4 describes the results. Section 5 presents some analysis and Section 6 summarizes the conclusions of the experiment. Section 7 describes other related experiments and their outcomes and Section 8 concludes the argument.

2. Experimental procedure and design[4]

Subjects were recruited from a variety of large undergraduate lecture classes at Harvard University Summer Session, 1992 and Fall, 1992 courses. Each treatment was run in two sessions by the same experimenter, scheduled within one day of each other. Evidence that economics students play ultimatum games differently from all other students is mixed (Carter and Irons, 1991, Kagel et al., 1992); to avoid such a debate, no economics classes were used for recruiting. Subjects were told that they could stay after class, complete a questionnaire and participate in a decision problem both of which together would take 30 to 45 minutes to earn a guaranteed $5, possibly more. Subjects who remained were seated along the outside aisles of the classroom and asked to complete a decision-making questionnaire (unrelated to the ultimatum game) for which they would be paid $5 at the end of the session. Ultimatum game instructions were then distributed according to their assigned seating. A composite version of the instructions was read aloud, with any questions answered publicly.[5] A short quiz about the decisions to be made, and the payoffs which resulted from those decisions, was given and subjects' answers checked—and mistakes corrected—privately. All treatments involved subjects splitting a $10 pie, although not all subjects knew the size of the pie in all treatments.[6] At this point the proposers made their offers in writing and those offers were distributed to the appropriate Responders. Responders replied to their offers; these responses were shown to (but not left with) the appropriate Proposer. All subjects then completed a short

[4]All instructions, raw data and original subject responses are available from the author.

[5]Reading instructions aloud makes information common.

[6]In uninformed treatments Responders were never told the actual size of the pie, although they could calculate it in the %U treatment by comparing the percentage of the pie they accepted with their earnings.

questionnaire about their perceptions of the game, brought their materials to the experimenters, were paid individually \$5 plus their earnings, and left. All subjects participated in one and only one ultimatum decision, eliminating opportunities either for reputation effects or for learning by subjects.

Two methodological considerations are worth addressing here: preferences for fair outcomes on the part of the Proposers and unknown priors about the pie size on the part of the Responders. There is evidence that some Proposers have a preference for fairness, and is willing to give up money in order to produce equal monetary outcomes (Forsythe et al. (1994) and Hoffman et al. (1992) dictator game data). If this is so, a random assignment of subjects to treatments should equalize the proportion of these "fair" types in the role of Proposer in each of the four treatments. By focusing on *comparisons* among the four treatments, offers from these types of subjects should wash out. If anything, this washing out should serve to make the data from the various treatments more alike, which is what the traditional game-theoretic subgame prefect equilibrium predicts. Ironically then, having Proposers with preferences for fairness will tend to *support* the game-theoretic hypothesis.[7]

A similar random-assignment argument holds for the distribution of prior beliefs about the size of the pie (when it is unknown) held by Responders. If the sample is sufficiently random, these priors should be distributed identically in the two uninformed treatments, influencing outcomes in both treatments similarly. So by comparing differences between these two treatments, the differences in subjects' priors are not being measured.[8]

3. Predictions

I examine four hypotheses about outcomes in this experiment.

- The subgame-perfect equilibrium (with pure self-interest) predicts no differences among these four treatments; Responders should accept any positive amount or percentage.[9] Thus offers and responses should be identical in all four treatments \$I, \$U, %U and %I. This hypothesis will be referred to as the *equivalence* hypothesis and will be used as the null hypothesis in statistical tests.
- Bolton (1991) comparative equilibrium relaxes the assumption that the Responder will accept all positive offers. Bolton describes a utility function containing arguments of

[7]One reader objected strongly to this idea, claiming it is tantamount to saying that "theory X implies A=B=1 is confirmed by evidence that A=B=2 because you have confirmed A=B!" This objection is exactly correct and, had offers in the four treatments been similar, such support for the equivalence hypothesis would be suspect. However, there were significant differences in behavior among the four treatments, thus the experiment confirms A≠B.

[8]If subjects use the offers they face to update their beliefs about the size of the pie, however, and those offers vary between the two uninformed treatments, then differences in those posteriors are being measured.

[9]Here, the smallest offer possible is 1¢ which translates into an offer of 0.1% in the percentage treatments (for a \$10 pie). Since the Proposer always knows the size of the pie, this translation is simple for him to do. There is some debate as to whether the Responder will accept only strictly positive offers, or if an offer of 0 will be accepted. Sometimes an alternative subgame-perfect equilibrium is described, whose payoffs are (π, 0). Actual behavior departs so radically from anything considered small that we will not dwell here on the subtleties of either the translation or the zero-offer issues.

both absolute payoffs (money) and relative payoffs (an index of fairness).[10] This theory predicts that offers and demands in treatments in which the pie size is known, \$I and %I, will be identical, as the form of the offer has no effect on its acceptance.[11] This hypothesis will be referred to as the *comparative equilibrium* hypothesis.

- Ochs and Roth, 1989 suggest that the minimum that a given Responder will accept may be a constant dollar amount but need not be particularly small. They thus predict that the acceptance patterns from treatments where the Responder can calculate her absolute (money) payoff should be the same–all the Responder cares about is getting her absolute minimum threshold; the size of the pie doesn't enter the analysis at all. Thus offers in three treatments \$I, \$U and %I should be identical. This hypothesis will be referred to as the *absolute threshold* hypothesis.
- Ochs and Roth, 1989 also suggest that the minimum a given Responder will accept may be a fixed percentage of the pie. Thus the acceptance patterns from treatments where the Responder can calculate her relative payoff should be the same—if the Responder receives her minimum percentage she will accept, regardless of her beliefs about the absolute amount of money she will receive. Thus offers in three treatments \$I, %U and %I should be identical. This hypothesis will be referred to as the *percentage threshold* hypothesis.

4. Results

The offers and responses from these four treatments are shown in Figs. 1–4.

Means, standard deviations and sample sizes of offers for each treatment are summarized in Table 2.

Offers in treatment \$I are similar to those of other \$10 pie ultimatum game experiments. The mean offer in \$I was \$4.50. In Carter and Irons (1991) the mean offer for the noneconomist group was \$4.56. Prasnikar and Roth (1992) report a mean offer over ten rounds of \$4.16 and Forsythe et al. (1994) have a mean offer of \$4.67.

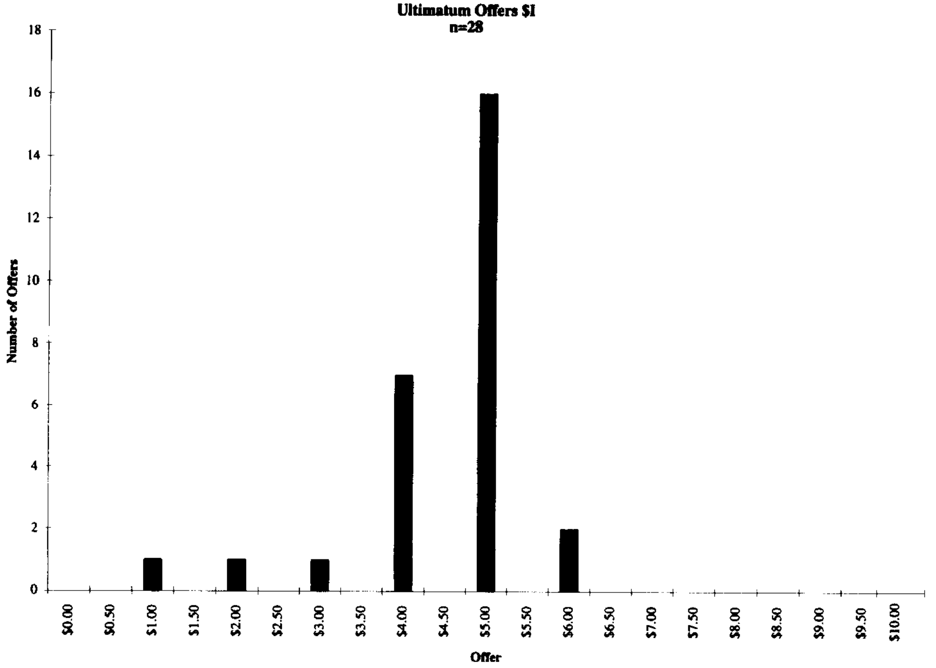
The classical ultimatum game's rejection rate is also comparable to those of other one-shot ultimatum games. Seven percent of offers were rejected in this condition compared with a rejection rate of 8.3% in a similar treatment of Hoffman et al. (1992) [12] and a rejection rate of 4.17% in Forsythe et al. (1994).

The average offer in the classical ultimatum game treatment (\$4.50) is 93¢ greater than the average offer in the uninformed version of this game (\$3.57). The difference between average offers in the percentage-informed and -uninformed treatments is positive but not as large (28¢). Comparing average offers between dollar-offer treatments and percentage-

[10]Players behave as expected-utility maximizers; in an ultimatum game, the Responder would accept an offer of $z \leq \pi/2$ only if the utility from accepting the offer z were greater than or equal to the utility of rejecting the offer. Since Proposers know this, they offer enough to make Responders indifferent between accepting and rejecting the offer which, depending on the preferences in question, may very well be significantly more than ε.

[11]If the random sampling hypothesis is correct and priors are identically distributed among the uninformed treatments, and if subjects do not update their beliefs about the size of the pie as a result of the offers they face, then Bolton's equilibrium suggests that demands and offers should be identical in the two uninformed treatments as well.

[12]The Random/Divide treatment was the one-shot ultimatum game most similar to that run in this study.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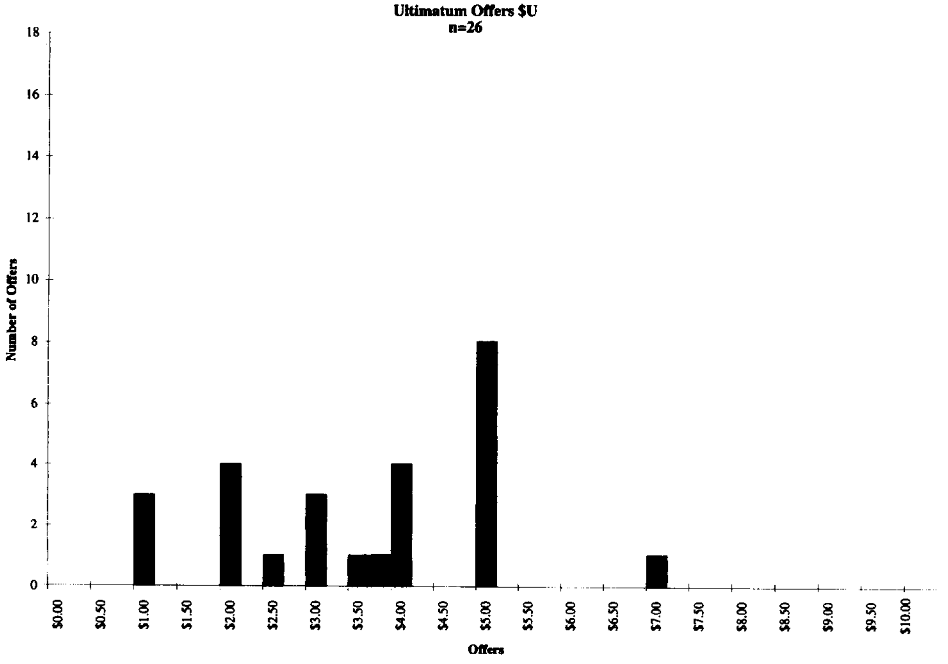
Offer

Fig. 1.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Offers

Fig. 2.

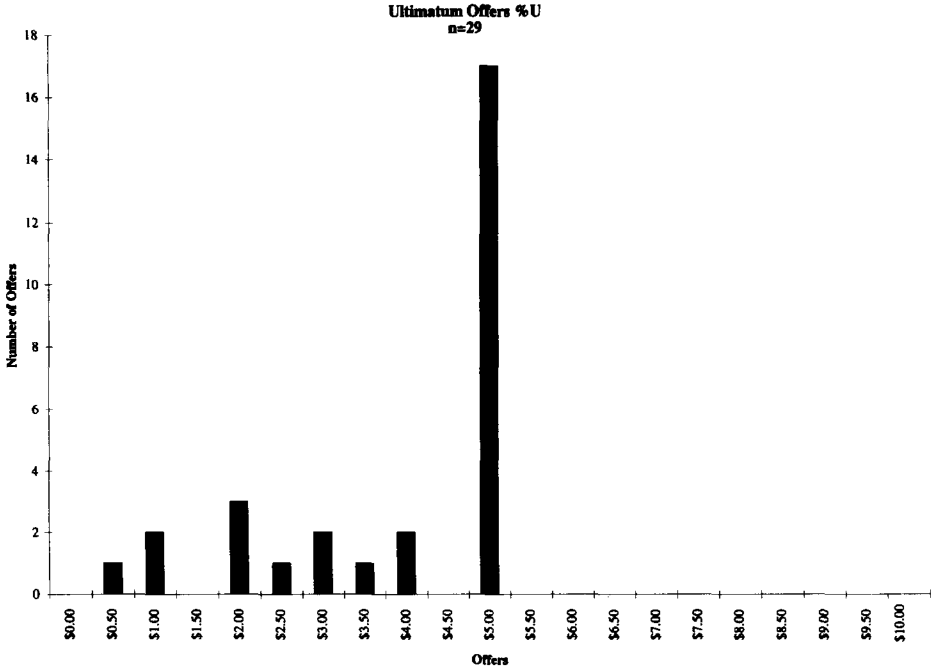
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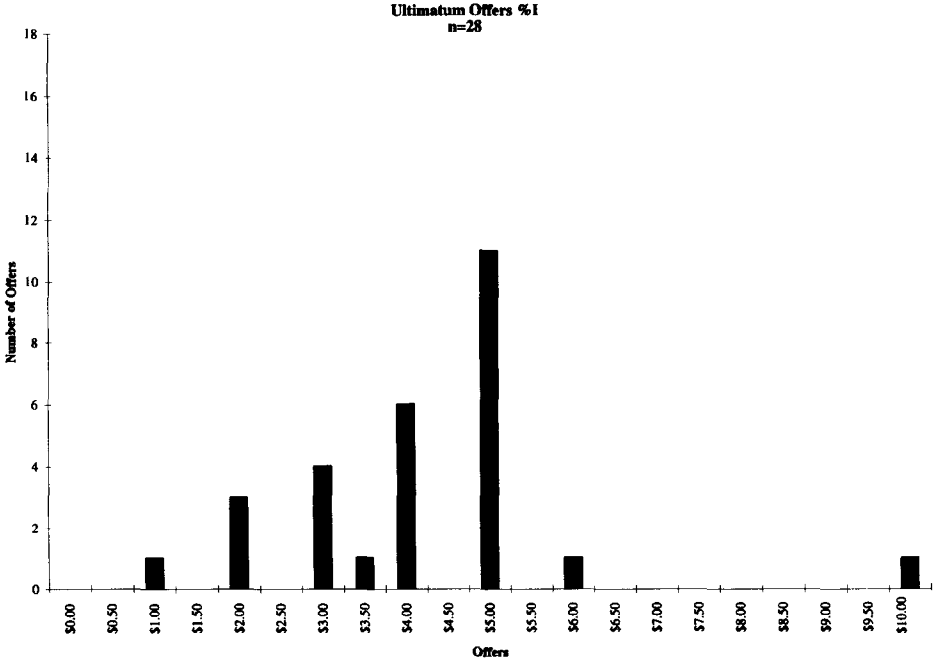
Fig. 3.


Ultimatum Offers %I
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Offers

Fig. 4.

Table 2
Means, standard deviations and sample sizes of observed offers

	Responder's information about pie size	
	Informed	Uninformed
Offers made in dollars	\$I \$4.50 (1.07) n=28	\$U \$3.57 (1.56) n=26
Offer made in percentage	%I \$4.20 (1.67) n=28	%U \$3.92 (1.51) n=29

offer treatments suggests no regularities (+30¢ in the informed case, −35¢ in the uninformed case).

5. Analysis

5.1. *Offers*

The Wilcoxon rank-sum test compares each set of observations with each other and reports the probability that the underlying distributions are the same.[13] Table 3 below reports the p-values for comparisons between each treatment.

The main result from this analysis is that the offers in the classical ultimatum game (\$I) are significantly greater than those in the game in which offers are made in dollars and the Responder is uninformed about the size of the pie (\$U) (p<0.01). Weaker statistical support is found for other comparisons.[14]

That *any* of these offer distributions differ is not consistent with the equivalence hypothesis. The absolute-threshold hypothesis also predicted that offers in treatments \$I and \$U would be identical, which was not the case.

5.2. *Responses*

The percentages of rejections are listed in Table 4.

One interesting result is the high frequency of rejections in the %I treatment, even though offers in that treatment are not significantly different than offers in any of the other three treatments. Statistically comparing the proportion of rejections (independent of offers) in each treatment suggests more rejections in treatment %I than in all other treatments, at the 5% level for %U and \$U just missing it for \$I (p=0.0154 for %U, p=0.0239 for \$U and p=0.0618 for \$I).[15] Further evidence of the causes underlying these high rejection rates in treatment %I is presented in the next subsection.

[13]Also called the Mann–Whitney U test, this test is discussed in Siegel (1956, pp.116–126).

[14]Offers in \$I are greater than those in %I (p<0.10), offers in %I are greater than those in \$U (p<0.10) and offers in %U are greater than those in \$U (p<0.10). Comparisons between %U and \$I and between %U and %I show no significant differences.

[15]The test used is based on a binomial distribution (calling an accepted offer a success and a rejected offer a failure). The test for comparing the means of two samples from a binomial distribution has a t-distribution.

Table 3
P-values for offer differences between treatments

	$U	%U	%I
$I	0.0045 [a]	0.1554	0.0895
$U	—	0.0943	0.0844
%U	—	—	0.4682

[a] Significant at the 1% level.

Table 4
Percentage of rejections

	Responder's information about pie size	
	Informed	Uninformed
Offers made in dollars	7%	4%
Offer made in percentage	21%	3%

5.3. *Questionnaire responses*

In addition to providing the data above, subjects were asked about their strategy and beliefs in a post-experimental questionnaire.[16] In all treatments, Responders were asked to provide the lowest offer they would have accepted (in percentage treatments, the lowest percentage offer and in dollar treatments the lowest dollar offer). Answers such as "I would have accepted anything" were coded as the subgame-perfect prediction of 1¢ or 0.1%. In treatments with an unknown pie size, the Responders were also asked their beliefs about the size of the pie. Means and standard deviations for the answers to these questions are presented in Table 5.

Figs. 5–8 show the reported demands for the four treatments.

5.4. *Analysis of responses*

An analysis similar to that used on offers can test whether Responders' demands in different treatments could have been generated from the same distributions. Reported demands in treatment %I are significantly higher than those in all other treatments ($p<0.01$). This result was not predicted by any of the discussed theories, but is consistent with the high levels of rejections actually observed in treatment %I[17], (see Table 6).

[16]The questionnaire was administered after Responders had made their decisions but before they were paid. Thus in the $U and %U treatments, Responders did not know the true size of the pie at the time they were answering the questions discussed. In the %U treatment they did not know their dollar earnings and in the $U treatment they did not know the percentage of the pie they had accepted or rejected. This procedure can be contrasted with other studies which used the strategy method in which subject's answers to these sorts of questions were their contingent responses in the game (Güth et al., 1982, Mitzkewitz and Nagel, 1993). For an excellent discussion of the merits of the strategy method versus the decision method used in this study (see Rapoport et al., 1993, pp.31,32).

[17]Some care should be used in interpreting these data as they are self-reported demands. The statistical analysis reports the probability that these demands were randomly generated from the same distribution. The significance of the results and the higher rejection rates in treatment %I suggests that these data accurately reflect varying demands on the part of subjects.

Table 5
Means and standard deviations from questionnaire answers

	Responder's minimum demand	Responder's belief about pie size
\$I	\$2.11 (1.54)	—
\$U	\$1.68 (1.96)	\$9.10 (9.12) [a]
%U	\$1.50 (1.58)	\$7.00 (3.81)
%I	\$3.23 (1.37)	—

[a] The mean and standard deviation omitting an outlier who believed the pie to be \$50 are 7.46 (3.75).

Table 6
P-values for reported demands between treatments

	\$U	%U	%I
\$I	0.0729	0.0627	0.0045 [a]
\$U	—	0.4564	0.0000 [a]
%U	—	—	0.0001 [a]

[a] Significant at the 1% level.

The difference in demands is inconsistent with the percentage threshold hypothesis which predicted demands in %I would be the same as those in %U and \$I. The difference in demands between %I and \$I suggests a framing effect. Subjects seem to care more about fairness when it is salient—the weight they put on the fairness aspect of their preferences increases when offers are made in percentage terms.

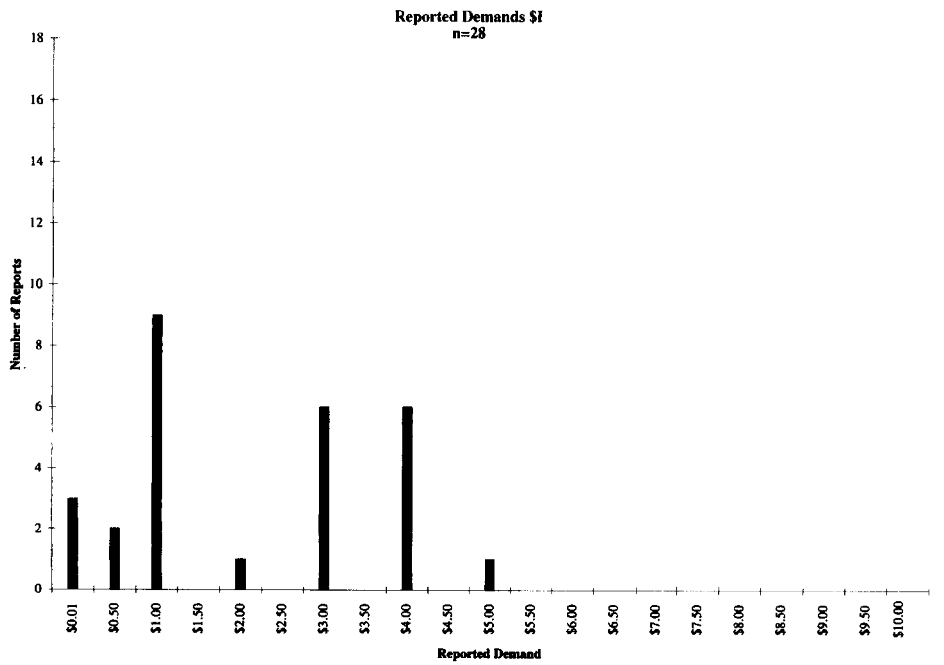

Fig. 5.

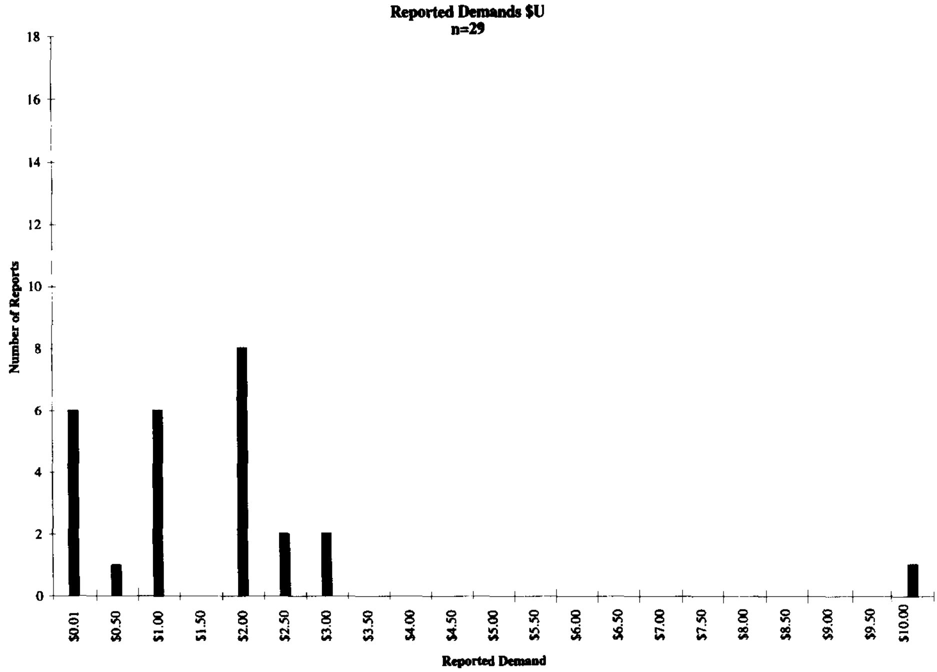
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Fig. 6.

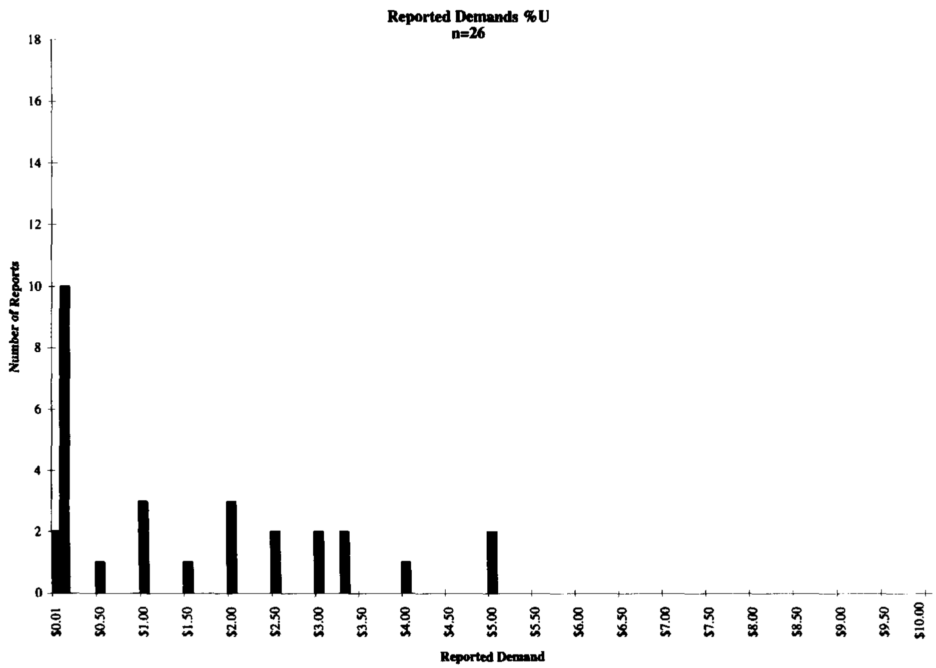
Reported Demands %U
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Fig. 7.

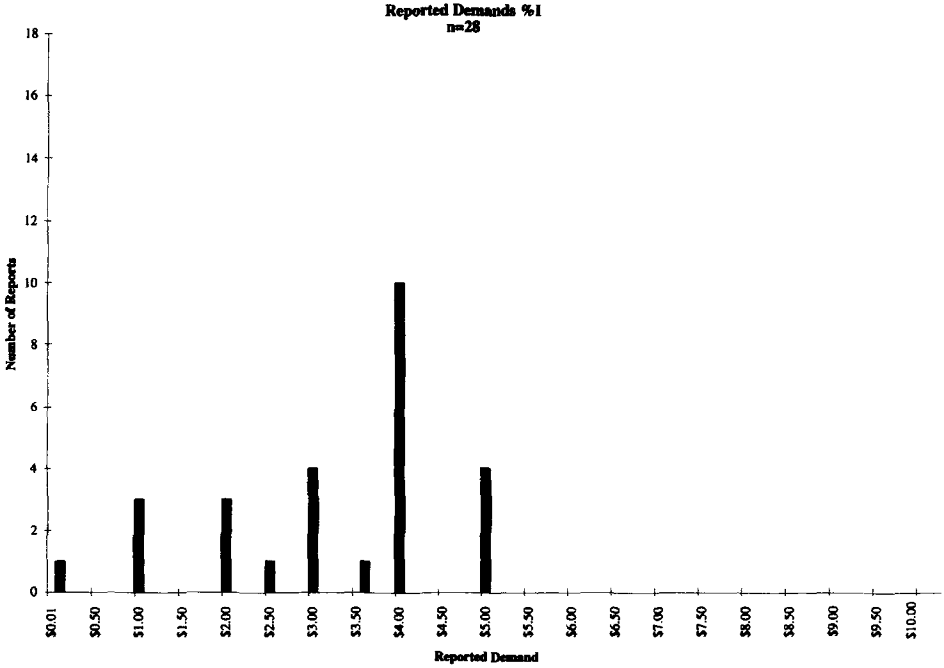

Fig. 8.

6. A summary of results, their implications and some explanations

There are three main results emerging from this study.

1. Offers in $I are significantly greater than offers in $U ($p<0.01$). This result is consistent with the comparative hypothesis and the percentage threshold hypotheses but inconsistent with the equivalence hypothesis or with the absolute threshold hypothesis.
2. Demands in %I are significantly greater than those in any other treatment ($p<0.01$) and in particular are greater than those in treatment %U. This is not consistent with the percentage threshold hypothesis.
3. Demands in %I are significantly greater than those in any other treatment ($p<0.01$), and in particular, are greater than demands in treatment $I. This is not consistent with predictions of any of the theories presented.

One of the more intriguing explanations of result (3) involves models of contingent weighting (Tversky et al., 1988). In these models the marginal tradeoffs between two attributes of a gamble depends on the manner in which one's value is elicited. In this setting, the marginal tradeoffs between money and fairness depends on the form of the offer (dollars or percentages). This fairness becomes more salient in percentage treatments, and the marginal utility for fairness at each money level would be higher in percentage treatments than in absolute treatments. This prediction is certainly borne out in treatments $I and %I, where demands are higher (more fair) in the latter treatment than in the former. However, this model must be modified to accommodate the lack of such an effect in the uncertain treatments ($U and %U) where demands are indistinguishable (p=0.4564).

7. Other ultimatum experiments and their outcomes

Perhaps the most consistent finding of past ultimatum experiments is that subjects do not play the subgame-perfect equilibrium strategy. The robust result is that Proposers offer significantly more than ε to Responders and that Responders sometimes reject positive offers. The outcomes of many ultimatum game experiments and their variations are summarized in Thaler (1988), Güth and Tietz (1990) and Roth (1995).[18]

This study uses incomplete and imperfect information in an attempt to illuminate the factors involved in this behavior and to separate various theories explaining it. A similar approach has been used in studies of Nash bargaining. Roth and Malouf (1979) examined and accepted the hypothesis that "when the players know both their opponents' monetary payoffs as well as their [opponents'] utilities, the outcome of (Nash) bargaining will be influenced by interpersonal comparisons, in the direction of equal gains" (p.585). This is consistent with the data reported here in which information about the size of the pie, and the other player's payoff led Proposers to offer more and Responders to more often reject low offers (demand more).[19]

Four recent experiments have examined ultimatum games with varying information conditions, two of which control the Responders' priors and two of which involve unknown priors on the part of Responders. None of these previous experiments involved treatments where offers were made in percentages rather than in dollars.

Mitzkewitz and Nagel (1993) compared "offer" and "demand" versions of the ultimatum game. In both games, the Proposer was informed about the size of the pie and the Responder knew only its probability distribution. The offer game is similar to the one used in this study (but run with controlled priors over the pie).

Rapoport et al. (1992) controlled and manipulated the variability of the prior distribution of the pie size given to the Responder. They always informed the Proposer about the actual size of the pie and gave the Responder a distribution from which the pie size was drawn. The mean of this distribution was constant, although its range varied between treatments. As the range of this prior increased, Proposers decreased their offers and Responders accepted these smaller offers more often.

[18]Some of the more interesting variations include: auctioning the roles of Proposer and Responder (Güth and Tietz, 1986); comparing subject pools by college major (Carter and Irons, 1991), by culture (Roth et al., 1991), and by gender (Eckel and Grossman, 1992); using comments as cues to behavior (Kravitz and Gunto, 1992); controlling Proposer's beliefs about the Responder's minimal acceptance levels (Harrison and McCabe, 1992); only using subjects who understand the subgame-perfect equilibrium (Ortona, 1991); comparing the ultimatum game with the related dictator game (Forsythe et al., 1994), with the best shot public goods provision game (Prasnikar and Roth, 1992); investigating how the assignment of roles of Proposer and Responder and the description of the problem affects the outcome (Hoffman et al., 1992); examining ultimatum games when the players' decisions are not known to the experimenter (Bolton and Zwick, 1995); and having subjects play ultimatum games in which they have to earn a minimum amount to "survive" (Schotter et al., 1993).

[19]Forsythe et al., 1991 also examined Nash bargaining with varying information. They focused on the incidence of strikes (no agreement—similar to rejections here) in information conditions when the uninformed player knew the distribution from which the pie is drawn, but not the size of the pie itself. As in Roth and Malouf (and unlike in Forsythe et al.), in this study subjects are *not* given prior probability distributions about the size of the pie (the hidden information).

Straub and Murnighan (forthcoming) ran a comprehensive survey/experiment asking subjects to respond to ranges of ultimatum offers when the pie size was known and when it was unknown (with no priors provided to the subjects, as in this study), and to make ultimatum offers when the pie size was known and unknown to their Responders. They found a much greater willingness to accept very low offers (1¢) when the size of the pie was unknown than when it was known. Subjects adjusted their offers accordingly, offering significantly less when the size of the pie was private information than when it was public. However the offers subjects faced were pre-selected by the authors rather than endogeneously generated in the experiment.

Finally, Kagel et al., 1992 extended Roth and Malouf's Nash bargaining method to the ultimatum game. The Proposer offered a division of 100 chips valued differently by each player and the Responder accepted or rejected the offer. In the first condition both players knew their own and each other's value per chip. In the second (third) treatment, both players knew their own chip value, but only the Proposer (Responder) knew the other player's chip value. The results from this experiment are similar to the results here; when relative (fairness) payoffs were known by the players (condition one), divisions tended to be more equal than when information was one-sided and only absolute (money) payoffs were known by the players (conditions two and three). Priors were not controlled in this experiment.

These studies reinforce the result that when the size of the pie is not known by the Responder (whether or not she is given prior beliefs about it), offers and demands fall. This paper is the first to examine percentage offers and demands in this context. With these treatments, alternative explanations for these results (involving absolute and relative payoffs) can be separated and tested independently.

8. Conclusions

Ultimatum bargaining is used as a model of posted-price purchasing as well as a building block for more complex (and realistic) kinds of bargaining. Past experimentation has demonstrated that preferences for fairness play a role in laboratory versions of these games. The experiment reported in this paper was designed to determine the importance of this preference for fairness under various informational and salience conditions. Particularly, what role does information about absolute (money) and relative (fairness) payoffs play in determining offers and responses? And when relative (fairness) payoffs are made more salient, by having offers made in percentages, are preferences for fairness more influential than when offers are made in dollars? The experimental design also separated and tested the predictions of four different hypotheses about fair preferences. Three main results were found, which were consistent with none of the four hypotheses.

First, varying the amount of information available to the Responder in a classical ultimatum game had an effect on both the offers made and the demands. When offers were made in dollar form, withholding information about the size of the pie from the responder produces significantly smaller offers (offers in $U are lower than those in $I, $p<0.01$). That there is a difference between offers in these two treatments ($I and $U) suggests rejecting the equivalence hypothesis and the minimum-absolute threshold hypothesis as descriptive theories of how preferences for fairness exhibit themselves in ultimatum games.

Second, there are significantly higher reported demands in treatment %I than in treatment %U ($p<0.01$) and significantly higher rejection rates as well ($p<0.05$) even though offers in the two treatments are not significantly different. This result suggests rejecting the percentage threshold hypothesis as a descriptive theory of how preferences for fairness exhibit themselves in ultimatum games.

Finally, significantly higher demands prevail when offers are made in percentages and the responder is informed (%I) than when offers are made in dollars and the Responder is informed ($I) ($p<0.01$). That there is a difference between Responders' stated demands in the two informed treatments suggests rejecting the comparative hypothesis, along with the other hypotheses named above.[20]

One modification to Bolton's comparative theory which would preserve its descriptive ability might be found in a contingent weighting model. In such a model the weight Responder's place on absolute (money) payoffs as compared with relative (fairness) payoffs vary with the treatment. In particular, when the pie size is known and offers are made in percentages (%I), more weight would be placed on relative (fairness) payoffs than when the pie size is known and offers are made in dollars ($I).

There are experimental extensions of this study as well. One testable implication is the contingent weighting explanation—that the frame of the game matters seems convincing, but how much it matters, and why it matters so clearly when responders are informed but not when they are uninformed about the size of the pie, needs further investigation.

Another direction for extension involves the empirical predictions of these experimental results. That pie divisions were more fair in the classic ultimatum game than in the uninformed version of it ($I versus $U) suggests that in posted-price, monopolistic industries where sellers' costs, and thus the pie size, are known to buyers, surplus division will be more equal than in industries where those costs, and thus the pie size, are unknown or uncertain (as when consumer goods are produced by the seller). That ultimatum bargaining over percentages with known pie sizes (%I) leads to particularly high demands and high rejection rates suggests that, in cases where the pie size is known, both Proposers and Responders should prefer to bargain over dollar amounts.

This experiment was designed to distinguish among a number of theories of how subjects implement their preferences for fairness in bargaining games. None of the theories examined predicted all the results. A number of new experimental proposals is presented which will help us illuminate and explore some of the intricacies of strategic behavior.

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[20]One anonymous referee suggested that the framing effect between the traditional ultimatum game and its percentage frame would vanish after very few repetitions. I disagree. I suspect that repetition will not diminish the framing effect, although it may disappear in a within-subject design in which each subject plays both a traditional and a percentage ultimatum game.

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