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AN EXPERIMENTAL ANALYSIS OF ULTIMATUM BARGAINING

Werner GÜTH, Rolf SCHMITTBERGER and Bernd SCHWARZE*

Universität zu Köln, 5000 Köln 41, West Germany

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There are many experimental studies of bargaining behavior, but surprisingly enough nearly no attempt has been made to investigate the so-called ultimatum bargaining behavior experimentally. The special property of ultimatum bargaining games is that on every stage of the bargaining process only one player has to decide and that before the last stage the set of outcomes is already restricted to only two results. To make the ultimatum aspect obvious we concentrated on situations with two players and two stages. In the 'easy games' a given amount c has to be distributed among the two players, whereas in the 'complicated games' the players have to allocate a bundle of black and white chips with different values for both players. We performed two main experiments for easy games as well as for complicated games. By a special experiment it was investigated how the demands of subjects as player 1 are related to their acceptance decisions as player 2.

1. Introduction

A game in strategic or extensive form, which is played to solve a distribution problem, is called a bargaining game. Such a game has perfect information if all its information sets are singletons, i.e., there are no simultaneous decisions and every player is always completely informed about all the previous decisions. Consider a bargaining game with perfect information whose plays are all finite. Such a game is called an ultimatum bargaining game if the last decision of every play is to choose between two predetermined results. Often a game itself does not satisfy this definition, but contains subgames for which this is true.

In 2-person bargaining one usually speaks of an ultimatum if one party can restrict the set of possible agreements to one single proposal which the other party can either accept or reject. Since in an ultimatum bargaining game the set of possible outcomes is narrowed down to only two results before the last decision is made, this explains our terminology.

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The speciality of ultimatum bargaining games can be illustrated as follows: Since the length of the play is bounded from above, there is always a player i who has to make the final decision. Now for all other players the game is over in the sense that they cannot influence its outcome any longer. So all that player i has to do is to make a choice which is good for himself. We can say that player i finds himself in a 1-person game. Now consider a player j who makes his choice just before player i terminates the game. If j knows what player i considers as good or bad, player j can easily predict how player i will react. Thus in a certain sense we can say that player j, too, is engaged in a 1-person game. In the same way one can see that every player in an ultimatum bargaining game finds himself in a 1-person game. This shows that in ultimatum bargaining games strategic interaction occurs only in the form of anticipating future decisions. There is no mutual interdependence resulting from simultaneous moves or infinite plays.

The obvious solution concept for ultimatum bargaining games is the subgame perfect equilibrium point [Selten (1975)]. The subgame perfect equilibrium behavior can be easily computed by first determining the last decisions, then the second last ones, etc. Most ultimatum bargaining games have only one perfect equilibrium point. The delicate problem to select one of many equilibrium points as the solution of the game is of only minor importance.

In the economic literature bargaining processes are often modelled as ultimatum bargaining games [see, for instance, Ståhl (1972), and Krelle (1976)]. Here we do not discuss whether ultimatum bargaining games can adequately represent real bargaining situations [see Harsanyi (1980), and Güth (1978)]. We are mainly interested in ultimatum bargaining behavior because it allows one to analyse in detail certain aspects of bargaining behavior.

In any multistage bargaining process the parties have to anticipate future decisions. The specialty of ultimatum bargaining games is that these are the only strategic considerations and that especially the last decision is the most simple choice problem. The individually rational decision behavior will therefore be rather obvious even if subjects do not have a strategic training. Our experiments allow us to explore the following questions: Will subjects behave optimally? And if not why and in which direction will they deviate from their optimal decisions? Our approach is to investigate first the most simple bargaining models. Only when knowing what drives the individual decisions in simple games, one can be sure how to interpret the results of more complex situations. Our distinction of 'easy' and 'complicated' games is a small step in this direction. There are so many experimental studies of bargaining behavior that we do not even try to give special references; for instance, many of the 'Contributions to Experimental Economics', edited by H. Sauermann, deal with bargaining problems. But surprisingly enough, as far as we know, nearly no experiments have been performed to analyse ultimatum bargaining behavior. Because of their special structure ultimatum bargaining games are useful to investigate experimentally how bargainers anticipate the decision behavior of their opponents. This is especially true for games with only few players and rather short plays.

Consider a game which does not satisfy the definition of an ultimatum bargaining game only because the players can choose between more than just two bargaining results at the last decision stage. Such a game will be called a bargaining game with ultimatum aspect [Güth (1976)]. Fouraker and Siegel (1963) have investigated the bargaining behavior in such games. In their interesting study they confronted their subjects with a bilateral monopoly where first the seller states the price and then the buyer determines his demand at this predetermined price.

Fouraker and Siegel distinguish between complete and incomplete information as well as single and repeated transaction experiments. We restrict our attention to single transaction experiments. It is obvious from the repeated prisoners' dilemma-experiments that a player will not completely exploit the ultimatum aspect if he can be punished later on. Furthermore, we can neglect the incomplete information experiments. Since the players do not know the types of their opponents, games with incomplete information do not satisfy the requirement of perfect information [Harsanyi (1968), and Selten (1982)]. According to their data Fouraker and Siegel consider the subgame perfect equilibrium point to be reasonably consistent with the observed bargaining behavior. In 11 of 20 experiments price and quantity were chosen exactly as predicted by the equilibrium solution. Our data will indicate that this result will change if the payoff distribution according to the equilibrium point is more extreme. Fouraker and Siegel also vary this payoff distribution. Whereas in Experiment 2 the equilibrium payoff of the seller is much higher than the one of the buyer, these payoffs are equal in Experiment 1. For us it is a surprise that nevertheless the number of equilibrium results in Experiment 2 is only slightly smaller than in Experiment 1. According to our data subjects punish an opponent, who exploits the ultimatum aspect, if this is not too costly for them.

It seems that the strategic asymmetry of both players was more acceptable in the experiments of Fouraker and Siegel. This can be due to their special scenario. In highly industrialized countries most consumer markets are considered as seller markets. 'Buyers' therefore might be used to have less strategic power. In an abstract bargaining situation, where the bargaining parties have to divide a given amount of money, an asymmetric power relationship is probably less acceptable.

Another explanation is that subjects in the experiments of Fouraker and Siegel could not see each other. They might not even have been sure whether they actually face an opponent or a preprogrammed strategy. In our experiments all subjects could see each other. But since bargaining pairs were determined stochastically, none of them knew his opponent.

In the following we describe the scenario which was used to observe ultimatum bargaining behavior experimentally. Afterwards the data collected in the experiments will be discussed in detail and compared. In the concluding section we summarize our main results and indicate some perspectives for the future study of ultimatum bargaining behavior.

2. Description of experiments

It is well-known in the economic literature [Selten (1978)] that subjects do not anticipate future decisions in the way which characterizes the individually rational decision behavior in ultimatum bargaining games. Players tend to neglect that there is a last stage which is so important for the normative solution. Thus it is more than doubtful whether the special structure of ultimatum bargaining games will be fully recognized if the bargaining process is more complicated in the sense that the number of stages is very large.

Now we are interested in ultimatum bargaining behavior since in these games strategic interaction occurs only in the form of anticipation. To make sure that all subjects are aware of the special game situation, the easiest non-trivial ultimatum bargaining games with only two players and two decision stages have been used to test ultimatum bargaining behavior.

The experiments can be partitioned into two subgroups: In one group the two subjects have to determine only how to distribute a given amount of money. These experiments will be called 'easy games'. In the experiments of the second group they have to distribute certain amounts of black and white chips which do not have the same value for both of them. These experiments will be called 'complicated games'. Whereas the optimal decision behavior in easy games is obvious, complicated games require a slightly more thorough analysis of the game situation. Comparing the results for easy and complicated games will show how the complexity of the game model influences bargaining results.

Before every experiment subjects were introduced to the bargaining situation in an informal way. The oral instructions were given according to the rules listed in the appendix. Each experiment consisted of several games which were played simultaneously. The group of $2k$ subjects was first subdivided by chance into two subgroups of equal size k. All subjects in one of the two subgroups were determined to be player 1 in the corresponding ultimatum game. They were informed in advance that their opponent will be chosen by chance out of the other subgroup. So no player 1 knew his opponent for sure. The k easy games differed only with respect to the amount c which was to be distributed among the two subjects. All experiments were games with complete information.

The number k of games ranged from 9 to 12. So the chances to meet a specific subject as player 2 were rather low for all players 1. All subjects were seated in the same room at desks which were far enough from each other to exclude verbal communication. Furthermore, players 1 and players 2 were at opposite sides of the room. Each participant could see all the others and had a complete control that the experiment was performed according to the instruction rules in the appendix. We did not observe attempts to exchange messages during the experiments. Between experiments communication was not restricted.

2.1. Easy games

In an easy game the two subjects were first determined to be player 1 and player 2. The subject chosen to be player 1 then declares which amount a_1 he claims for himself. The difference between the amount c (>0), which can be distributed, and a_1 is what player 1 wants to leave for player 2. Given the decision of player 1 player 2 has to decide whether he accepts player 1's proposal or not. If 2 accepts, player 1 gets a_1 and player 2 gets $c-a_1$. Otherwise both players get zero.

Every subject in the subgroup of players 1 got a form (table 1) which informed him about the total amount c to be distributed. Player 1 had to write down the amount of money a_1 which he demands for himself. Then the forms were collected and distributed by chance to the subjects in the other subgroup. Player 2 had to indicate whether he accepts the proposal of player 1 or not. Two tickets were attached to each form, one for player 1 and one for player 2. On each ticket there was a capital letter, indicating the game, and the player number. So, for instance, $X1$ is on the ticket of the subject who is player 1 in game X. We called $X1$ the sign of this subject. The subjects had to show their tickets to get their payoffs.

Table 1

The form given to subjects engaged in easy games.

The amount c to be distributed is c = DM ...
Player 1 can demand every amount up to c = DM ...

Sign of player 1: ... 1

Decision of player 1: I demand DM ...

Sign of player 2: ... 2

I accept player 1's demand: ...
I refuse player 1's demand: ...
(indicate the decision you prefer by an 'X'!)

Let us shortly discuss the rational decision behavior in easy games. Indivisibility of money implies that there is a minimal positive amount ε of money. Consider now an easy game: A rational player 2 will always prefer the alternative which yields more for him and will choose conflict only if this does not cost him anything. Thus the optimal decision for player 1 is to demand $c-\varepsilon$ for himself and to leave the minimal positive amount ε to player 2. This clearly illustrates the ultimatum aspect of easy games: The decision of player 1 implies that player 2 can only accept his minimum or choose conflict.

2.2. *Complicated games*

The experiments of complicated games were performed in a similar way. In a complicated game player 1 first has to divide a bundle of 5 black and 9 white chips. In order to do this player 1 determines a vector (m_1, m_2) indicating the decision for one bundle (I) with m_1 (≤ 5) black and m_2 (≤ 9) white chips and the complementary bundle (II) with $(5-m_1)$ black and $(9-m_2)$ white chips. After the decision of player 1 player 2 has to decide whether he wants to have bundle (I) or bundle (II). The other bundle is given to player 1. Player 1 got DM 2 for each chip. Player 2 was paid DM 2 for a black chip and DM 1 for a white chip. Both players were informed about these values.

The form given to the subjects engaged in a complicated game is shown in table 2. Again several examples were calculated to make sure that every subject completely understood the rules of the game. Some subjects had difficulties to learn how the distribution of chips determines the money payoffs.

In the complicated game the rational decision behavior is not so obvious. A rational player 2 will always choose the bundle which yields a higher payoff for him. For player 1 it is evident that he has to design bundles I and II such that the bundle, which player 2 will prefer, contains as few white

Table 2

The form given to subjects engaged in complicated games.

Sign of player 1:... 1

Decision of player 1: Player 2 has to choose between

(I) ... black chips and ... white chips
(not more than 5 black and 9 white chips), or

(II) the remaining chips.

Sign of player 2:...2

Decision of player 2:

I choose vector (I) of black and white chips ...
I choose the remaining vector of chips (II) ...
(indicate the decision you prefer by an '*X*')

chips as possible. Knowing this some easy calculations show that the optimal decision of player 1 is given by $(m_1, m_2)=(5,0)$ or $(0,9)$. This will induce player 2 to choose I in the first case and II in the second case. The equilibrium payoff for player 1 is DM 18, whereas player 2 receives DM 10. If player 2 would deviate, he would get DM 9 whereas player 1's payoff would be DM 10, i.e., a deviation of player 2 would cost player 1 much more than player 2 himself.

The complicated game is a well-known distribution procedure [see, for instance, Kuhn (1978), Steinhaus (1948), Güth (1979)], often called 'the method of divide and choose'. In the economic literature it is mostly applied to the problem of cutting cakes fairly. In our example there are two different 'cakes' and two individuals with different preferences.

The method of divide and choose yields an envyfree allocation [Pazner and Schmeidler (1974)] which is even Pareto-optimal in our special case. In general, this method determines an allocation which is not Pareto-efficient [Güth (1976)]. Observe that a complicated game has other envyfree and Pareto-optimal allocations beside the equilibrium allocation. If player 2 receives the bundle $(5,1)$ of 5 black and 1 white chips and player 1 gets the residual bundle $(0,8)$, this allocation is also envyfree and Pareto-efficient. The same is true if player 2 receives the bundle $(5,2)$ and player 1 the residual bundle $(0,7)$. All other Pareto-efficient allocations are not envyfree. Furthermore, the equilibrium payoff of player 1 is his maximal payoff in the set of envyfree allocations. This demonstrates that the method of divide and choose allows player 1 to exploit the preferences of player 2. Player 2 would prefer to be the one who determines two bundles I and II between which player 1 has to choose.

3. Experimental results

The subjects were graduate students of economics (University of Cologne) attending a seminar to get credit for the final exams. It is almost sure that none of the students was familiar with game theory. After pilot studies in the summer semester of 1978 the main experiments were performed at the beginning of the next winter semester.

3.1. *Easy games*

For the sake of completeness we also show the results of the pilot experiment with easy games in table 3. The results of one game, specified by a capital letter in column (1), appear in one line. The second column of table 3 gives the amount c to be distributed. The third one the demand of player 1. A '1' in the fourth column indicates that player 2 accepted, whereas a '0' says that 2 refused player 1's proposal. Conflict resulted in three (games C, G and H) of the nine games in table 3.

Table 3
Pilot study of easy games.

Game	c = amount to be distributed (DM)	Demand of player 1 (DM)	Decision of player 2
A	1	0.60	1
B	1	0.60	1
C	1	0.90	0
D	1	0.50	1
E	1	0.50	1
F	1	0.51	1
G	1	1.00	0
H	1	1.00	0
I	1	0.50	1

In the same way the results of the main experiments with easy games are given in tables 4 and 5. The experiments of easy games listed in table 4 were performed first. We refer to these results as unexperienced decision behavior in easy games.

These experiments have been repeated after one week. Of course, a subject usually had to face a different amount c to be distributed and to expect a different opponent. The results of the second experiment of easy games are given in table 5; we refer to them as experienced decision behavior in easy games.

Tables 4 and 5 contain the results of 21 games each. In both tables there are three games with an amount $c=4;\ 5;\ 6;\ \ldots;\ 10$ DM. According to the unexperienced decision behavior conflict seems to be rather exceptional (it results in only two of the 21 games). Since in table 5 there are 6 cases of conflict, the total amount paid to the subjects is lower in table 5 (DM 116) than in table 4 (DM 137).

One could try to explain the greater frequency of conflict according to the experienced behavior by an increase of the average demand of players 1. The average demand of players 1 is DM 4.38 in table 4 and 4.75 in table 5. But the average demand of players 1 is a rather rough measure for the demand behavior of players 1 since it neglects the variation in the total amount c to be distributed. A certain absolute increase of player 1's demand is more significant if only DM 4 can be distributed than in the case of DM 10. Empirically it is not true that player 2 always chooses the alternative which yields a higher payoff. The decision behavior of players 2 also depends on the difference in the payoffs which player 1 has proposed.

Although the sum of all payoffs in table 4 is higher than in table 5, the average payoff of players not involved in conflict is greater according to table 5, i.e., the higher frequency of conflict in table 5 is connected to games with a

Table 4
Naive decision behavior in easy games.

Game	c = account to be distributed (DM)	Demand of player 1 (DM)	Decision of player 2
A	10	6.00	1
B	9	8.00	1
C	8	4.00	1
D	4	2.00	1
E	5	3.50	1
F	6	3.00	1
G	7	3.50	1
H	10	5.00	1
I	10	5.00	1
J	9	5.00	1
K	9	5.55	1
L	8	4.35	1
M	8	5.00	1
N	7	5.00	1
O	7	5.85	1
P	6	4.00	1
Q	6	4.80	0
R	5	2.50	1
S	5	3.00	1
T	4	4.00	0
U	4	4.00	1

Table 5
Experienced decision behavior in easy games.

Game	c = amount to be distributed (DM)	Demand of player 1 (DM)	Decision of player 2
A	10	7.00	1
B	10	7.50	1
C	9	4.50	1
D	9	6.00	1
E	8	5.00	1
F	8	7.00	1
G	7	4.00	1
H	7	5.00	1
I	4	3.00	0
J	4	3.00	0
K	5	4.99	0
L	5	3.00	1
M	6	5.00	0
N	6	3.80	1
O	10	6.00	1
P	9	4.50	1
Q	8	6.50	1
R	7	4.00	0
S	6	3.00	1
T	5	4.00	0
U	4	3.00	1

relatively low amount c to be distributed. The average payoff of players 1 not engaged in conflict is DM 4.38 (DM 5.05) in table 4 (5), whereas for players 2 it is DM 2.83 (DM 2.68).

Altogether one gets the impression that in the second experiment players 1 were more daring than in the first one. This caused on one side a higher frequency of conflict and on the other side a higher payoff of those players 1. whose more ambitious demands were nevertheless accepted by their opponents.

One can try to explain the variation of the demands, i.e., the demand behavior of players 1 in easy games, by the variation of the amounts c to be distributed. To do this we calculated how the following three hypotheses:

$$a_1^1 = \alpha c + \beta, \quad (1)$$

$$a_1^1 = \alpha c^{\beta}, \quad (2)$$

$$a_1^1 = \alpha e^{\beta c} \quad (3)$$

can explain the demand behavior of players 1 in table 4 as well as in table 5. The results are listed in table 6 whose first column gives the functional form (1), (2) or (3) of the hypothesis. In the second and third column appear the values of the parameters α and β for table 4 (5) denoted by α_4 (α_5) and β_4 (β_5), respectively. The correlation coefficient r_4^2 and r_5^2 for tables 4 and 5 in the fourth column of table 6 indicate how much of the variation of players 1's demands can be explained by the variation of c. It can be seen that the non-linear hypotheses yield better explanations in both cases and, furthermore, that all hypotheses yield better results for the experienced demand behavior of table 5. Of course, these results should be considered more as an illustration of players 1's demands and not as a valid statistical analysis since there are not enough data available.

The acceptance behavior of players 2 listed in table 4 (5) is visualized in fig. 1 (2). Since player 2 has only the choice to accept (indicated by '1') or to refuse (indicated by '0') a given demand of player 1, his payoff $c - a_1$ in case of acceptance, i.e., for $a_2 = 1$, is of special interest. This amount can be regarded as the costs of player 2 for choosing conflict. The decision of player 2 may also depend on the share $(c - a_1)/c$ of player 2 according to player 1's proposal. One would expect that player 2 is more likely to refuse a given demand of player 1 if his payoff $(c - a_1)$ as well as his share $(c - a_1)/c$ in case of acceptance are comparatively low. Beside one exceptional case (player R2 in table 5) where the rather moderate demand $a_1 = $ DM 4 was refused at costs of DM 3 for player 2, it can be seen with the help of figs. 1 and 2 that the experimental results are in line with our intuitive expectations.

Table 6
Statistical analysis of the demand behavior in easy games.

Hypothesis	α_4	(α_5)	β_4	(β_5)	r_4^2	(r_5^2)
$a_1 = \alpha c + \beta$	0.460	(0.562)	1.210	(0.817)	0.488	(0.630)
$a_1 = \alpha c^{\beta}$	1.054	(0.999)	0.731	(0.796)	0.511	(0.650)
$a_1 = \alpha e^{\beta c}$	1.947	(1.947)	0.111	(0.121)	0.511	(0.653)

3.2. *Consistency of demands in easy games*

After testing twice the behavior in easy games we became interested to learn how the demand behavior of a subject, i.e., his decisions as player 1, is related to his acceptance behavior, i.e., his decisions as player 2 [similar questions for other game situations are analysed by Stone (1958)]. Would a certain subject accept as player 2 an offer to distribute c which he would suggest as player 1? In order to investigate this question, we performed a third experiment of the easy game with $c = 7$ DM in the following way: All of the 37 subjects participated in the experiment as player 1 as well as player 2. First every subject had to decide as player 1 which amount a_1 he demands

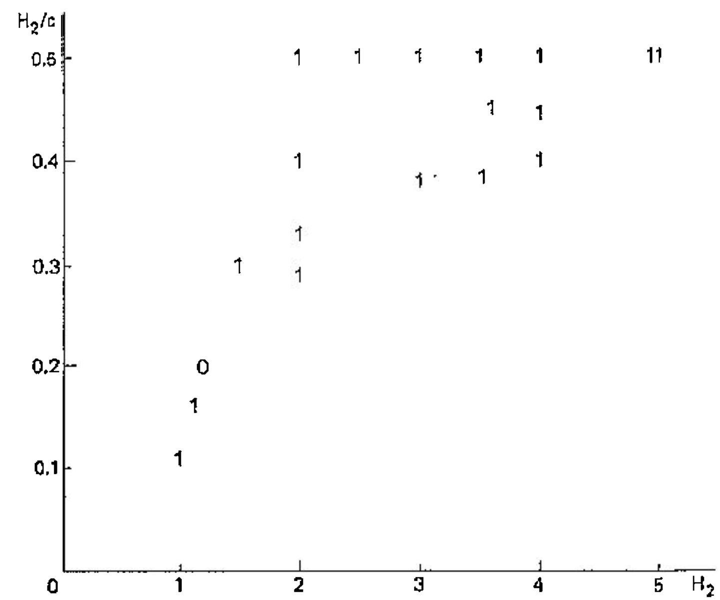

Fig. 1. Naive acceptance behavior in easy games.

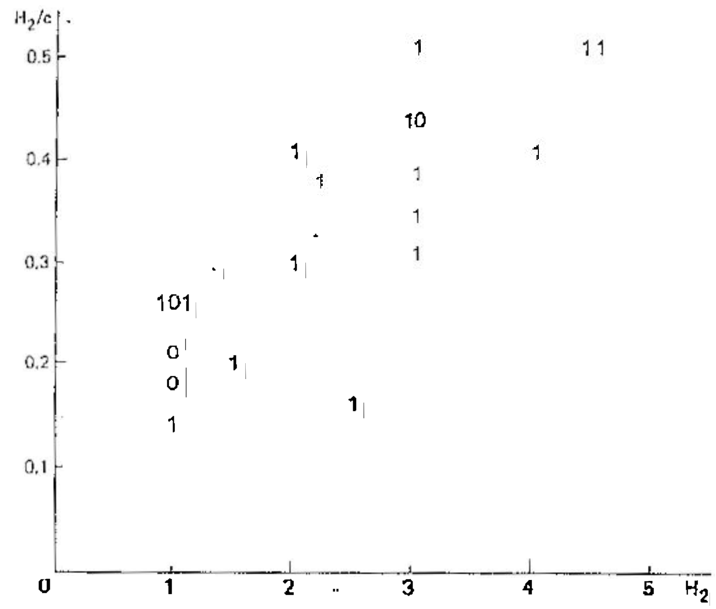

Fig. 2. Experienced acceptance behavior in easy games.

for himself. Then every subject got another form which asked him to state his minimal acceptance payoff a_2 as player 2. If $c-a_1 \geqq a_2$, player 2 accepts player 1's demand which yields the payoff a_1 for player 1 and $c-a_1$ for player 2. Conflict results if $c-a_1<a_2$. The subjects were told in advance that it will be determined by chance which of the other 36 player 2's decisions a_2 will be opposed to the own decision a_1 as player 1. Since every subject had to hand in his sign as player 1 and as player 2, we were able to identify uniquely his decisions as player 1 and as player 2.

It should be mentioned that the decision of player 2 in this experiment is more complicated compared to the former experiments of easy games. Here a player 2 has to consider all possible decisions of player 1, while in the former experiments player 2 was only asked to react to a specific choice of player 1.

Although a subject had to expect a different subject as his opponent, we were mainly interested how a subject's decision a_1 as player 1 is related to his decision a_2 as player 2. In table 7 the decisions of one subject are listed in one line. The second column gives the demand a_1 as player 1 and the third column the acceptance level a_2 as player 2, whereas the sum a_1+a_2 of demands appears in the fourth column. If this sum is greater than/equal to/smaller than $c=7$ DM, this is indicated by '+'/'0'/'–' in the fifth column of table 7.

Table 7
Consistency of payoff demands in easy games.

Index of subject	a_1 = demand as player 1	a_2 = demand as player 2	a_1+a_2 = sum of demands	Consistency of demands
1	4.00	3.00	7.00	0
2	3.50	2.50	6.00	–
3	3.50	3.50	7.00	0
4	3.50	3.50	7.00	0
5	4.00	3.00	7.00	0
6	3.50	3.50	7.00	0
7	4.00	3.00	7.00	0
8	5.00	3.50	8.50	+
9	3.50	3.50	7.00	0
10	3.50	3.50	7.00	0
11	3.50	3.50	7.00	0
12	3.50	2.00	5.50	–
13	5.00	1.00	6.00	–
14	3.50	1.00	4.50	–
15	3.50	5.00	8.50	+
16	4.00	2.50	6.50	–
17	4.00	3.00	7.00	0
18	4.00	3.00	7.00	0
19	5.00	1.00	6.00	–
20	6.99	0.01	7.00	0
21	3.50	2.00	5.50	–
22	4.00	2.50	6.50	–
23	4.00	3.50	7.50	+
24	3.50	3.00	6.50	–
25	5.00	2.00	7.00	0
26	4.00	1.00	5.00	–
27	3.50	2.00	5.50	–
28	4.00	1.00	5.00	–
29	3.50	3.00	6.50	–
30	3.50	2.50	6.00	–
31	4.50	3.50	8.00	+
32	4.00	3.00	7.00	0
33	4.00	0.10	4.10	–
34	3.50	3.50	7.00	0
35	4.00	1.00	5.00	–
36	7.00	3.50	10.50	+
37	4.00	2.50	6.50	–

5 decision vectors are in conflict (+), 15 consistent (0) and 17 in anticonflict (–). Thus 32 of the 37 subjects revealed a modest demand behavior in the sense that the payoff $c-a_1$ was not smaller than their acceptance level a_2 as player 2. Nearly half of the 37 vectors (a_1, a_2) were even in anticonflict. These subjects were willing to accept demands of player 1 which were higher than their own aspiration levels a_1.

In case of conflict subjects leave less to player 2 than they themselves are willing to accept as player 2. They must consider themselves as exceptionally tough or ambitious since otherwise they would have to expect conflict. The subject in the 15th row of table 7 probably misunderstood the situation.

In case that (a_1, a_2) is consistent, the subject leaves as player 1 to player 2 exactly what he is just willing to accept as player 2. Such a subject reveals that he considers the payoff vector (a_1, a_2) as the obvious outcome. So, for instance, in 7 of the 15 cases of consistency the equal split (3.50 DM; 3.50 DM) is proposed. In the other consistent pairs subjects asked as players 1 for more than as players 2 which indicates their attempt to exploit the ultimatum aspect.

The average share a_1/c demanded by players 1 is only 55% in table 7 compared to 64.9% in table 4 and 69% in table 5, i.e., in the consistency test players 1 were more modest than in the former experiments. This can be explained by the fact that in the consistency test subjects had to decide as player 1 and as player 2. Knowing to be player 1 in one game and player 2 in another game, might have caused some subjects to care for a fair bargaining result. Of course, a rational decision maker would not allow his decision in one game to depend on his choice in another game. But one cannot expect in real life that players are able and willing to distinguish so clearly between the decision in one game and the one in another game situation.

3.3. Complicated games

In the pilot study with complicated games the payoffs were one tenth of the payoffs as given in the description of the game. In the second column of table 8 is the bundle $I=(m_1, m_2)$ as designed by player 1. The third column gives the payoff vector $H(I)=(H_1(I), H_2(I))$ which results if player 2 chooses bundle I for himself, whereas the payoff vector $H(II)=(H_1(II), H_2(II))$ for the choice of bundle $II=(5-m_1, 9-m_2)$ by player 2 appears in the fourth column of table 8. The actual choice I or II of player 2 is listed in the last column of table 8. It can be seen from table 8 that players 2 always chose the bundle which yielded a higher payoff H_2. In the pilot study of complicated games only one player 1, namely subject 11, proposed the equilibrium solution.

Table 8
Pilot study of complicated games.

Game	Decision $I=(m_1, m_2)$ of player 1	$(H_1(I); H_2(I))$ (DM)	$(H_1(II); H_2(II))$ (DM)	Decision of player 2
A	(3, 5)	(1.20; 1.10)	(1.60; 0.80)	I
B	(5, 2)	(1.40; 1.20)	(1.40; 0.70)	I
C	(0, 8)	(1.20; 0.80)	(1.60; 1.10)	II
D	(3, 4)	(1.40; 1.00)	(1.40; 0.90)	I
E	(2, 4)	(1.60; 0.80)	(1.20; 1.10)	II
F	(4, 7)	(0.60; 1.50)	(2.20; 0.40)	I
G	(4, 3)	(1.40; 1.10)	(1.40; 0.80)	I
H	(2, 5)	(1.40; 0.90)	(1.40; 1.00)	II
I	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	I

The same subjects who participated in the main experiments of easy games were afterwards confronted with the complicated game. The results of the main experiments with the complicated game are listed in tables 9 and 10. In a first test the payoffs were the same as in the pilot study. The results of this first test are listed in table 9; we refer to them as decision behavior in complicated games with low payoffs. After one week the experiment was repeated with the rather high payoffs as determined by the description of the game. These results — we refer to them as decision behavior in complicated games with high payoffs — are listed in table 10.

Compared to an easy game situation the equilibrium payoff vector (1.80 DM; 1.00 DM) in table 9 or (18 DM; 10 DM) in table 10 is less extreme in complicated games since it yields comparatively high payoffs for both players. There are two possibilities $I=(m_1, m_2)$ for player 1 to suggest the rational solution, namely $(m_1, m_2)=(5, 0)$ and $(m_1, m_2)=(0, 9)$. In 6 of the 17 games in table 9 players 1 suggested the rational solution, whereas in table 10 this was done in 9 of 15 games. Thus compared to our results for easy games players 1 in complicated games rely more often on the rational decision behavior although it is more difficult to derive. This indicates that

Table 9
Decision behavior in complicated games with low payoffs.

Game	Decision $I=(m_1, m_2)$ of player 1	$(H_1(I); H_2(I))$ (DM)	$(H_1(II); H_2(II))$ (DM)	Decision of player 2
A	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	I
B	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	I
C	(5, 2)	(1.40; 1.20)	(1.40; 0.70)	I
D	(3, 5)	(1.20; 1.10)	(1.60; 0.80)	I
E	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	II
F	(4, 5)	(1.00; 1.30)	(1.80; 0.60)	I
G	(5, 2)	(1.40; 1.20)	(1.40; 0.70)	I
H	(5, 8)	(0.20; 1.80)	(2.60; 0.10)	I
I	(4, 3)	(1.40; 1.10)	(1.40; 0.80)	I
J	(5, 2)	(1.40; 1.20)	(1.40; 0.70)	I
K	(4, 4)	(1.20; 1.20)	(1.60; 0.70)	I
L	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	I
M	(4, 3)	(1.40; 1.10)	(1.40; 0.80)	I
N	(4, 2)	(1.60; 1.00)	(1.20; 0.90)	I
O	(3, 3)	(1.60; 0.90)	(1.20; 1.00)	I
P	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	I
Q	(5, 0)	(1.80; 1.00)	(1.00; 0.90)	I

Table 10
Decision behavior in complicated games with high payoffs.

Game	Decision $I=(m_1, m_2)$ of player 1	$(H_1(I); H_2(I))$ (DM)	$(H_1(II); H_2(II))$ (DM)	Decision of player 2
A	(5, 0)	(18; 10)	(10; 9)	I
B	(5, 1)	(16; 11)	(12; 8)	I
C	(5, 1)	(16; 11)	(12; 8)	I
D	(5, 0)	(18; 10)	(10; 9)	II
E	(5, 0)	(18; 10)	(10; 9)	II
F	(5, 0)	(18; 10)	(10; 9)	I
G	(5, 0)	(18; 10)	(10; 9)	I
H	(3, 4)	(14; 10)	(14; 9)	I
I	(5, 0)	(18; 10)	(10; 9)	I
J	(5, 0)	(18; 10)	(10; 9)	II
K	(4, 1)	(18; 9)	(10; 10)	II
L	(4, 1)	(18; 9)	(10; 10)	II
M	(1, 8)	(10; 10)	(18; 9)	I
N	(0, 9)	(10; 9)	(18; 10)	II
O	(5, 0)	(18; 10)	(10; 9)	II

subjects did not deviate from the optimal behavior because of their difficulties in solving the game. The main reason seems to be that the rational solution is not considered as socially acceptable or fair.

In one of their bilateral monopoly experiments Fouraker and Siegel (1963) have an equilibrium payoff vector which is comparable to the one of complicated games. In the other experiments the equilibrium payoffs of both players are equal. Although we, too, observed a strong tendency to behave optimally in complicated games, the results of Fouraker and Siegel favor even more the normative solution. It seems fair to say that this is probably due to the greater acceptability of the equilibrium payoff distribution in their experiments. As already indicated in the Introduction, the different results of Fouraker and Siegel may be related to the special scenario which they have used.

In one of the six (four of the nine) games of table 9 (10) in which player 1 suggested the rational solution, player 2 did not accept this, i.e., player 2 chose the bundle which implied lower payoffs for both players. The results for easy games showed already that players 2 are willing to suffer a monetary loss if they consider the demand of player 1 as unacceptable. Now if only player 2 deviates from the rational solution, he himself suffers a loss of DM 0.10 (table 9) or DM 1 (table 10), whereas player 1's loss is DM 0.80 or DM 8. Since on the other side of the equilibrium payoff vector (DM 1.80; DM 1) or (DM 18; DM 10) yields a considerably higher payoff to player 1, it is no surprise that sometimes players 2 chose the bundle which implies lower payoffs for both players. If player 2 is not willing to accept the payoff vector implied by the normative solution, he can cause a payoff vector with much more balanced individual payoffs at relatively low costs by deviating from the rational solution.

Although the number of games in table 10 is smaller than in table 9, the rational solution has been suggested more often by players 1. On one side this tendency towards rationality can be explained by the fact that the subjects were more familiar with complicated games in the repeated experiment. On the other side payoffs in table 10 are much higher than those of table 9. This might have caused some players 1 to consider their decisions more carefully.

If player 1 wants an equal split, he can propose this either by $I=(4, 4)$ or the corresponding bundle II or by $I=(4, 1)$ and the corresponding bundle II. If player 2 accepts the equal split, the payoff vector is (DM 12; DM 12) in the first case and (DM 10; DM 10) in the second one. In both cases it pays for player 2 to accept the equal split; if he deviates player 2 would suffer a loss while player 1 would gain by such a deviation. It is, of course, better to design $(m_1, m_2)=(1, 5)$ or the corresponding bundle (4, 4) since this implies higher payoffs for both players.

In table 9 only one player 1 suggests an equal split, namely the one with high payoffs, whereas in table 10 three players 1 suggest the equal split with low payoffs. This indicates that in the repeated experiment there is a stronger tendency to suggest an equal split and that not all players 1 in the repeated experiment were fully aware of the payoff structure. At least for these players 1 it is doubtful whether they have analysed the game situation carefully enough.

In a complicated game player 1 chooses a maximin-strategy if he designs a bundle $I=(m_1, m_2)$ with $m_1+m_2=7$. Due to the special structure of complicated games the choice of a maximin-strategy by player 1 determines uniquely the payoff of player 1 (DM 1.40 in table 9 and DM 14 in table 10). In table 9 five players 1 chose a maximin-strategy, in table 10 this occurs only once. Thus compared to the repeated experiment players 1 in the first experiment seemed to be more risk averse.

Altogether one can say that in the second experiment of complicated games more players 1 tended towards the normative solution while more players 2 were willing to block unbalanced payoff vectors. This behavior of players 2 has its counterpart in a stronger tendency of some experienced players 1 to design bundles which allow more balanced payoff vectors.

4. Conclusions

Ultimatum bargaining games are special bargaining games since interaction of players occurs only in the form of anticipation. In order to make the ultimatum aspect obvious, we concentrated on the easiest non-trivial ultimatum bargaining games with two players and two decision stages. In easy games where a given amount c has to be distributed the normative solution is extreme in the sense that the player who has to decide on the second stage gets only the smallest possible positive payoff. Our experimental results show that in actual life the ultimatum aspect of easy games will not have such extreme consequences: Independent of the game form, subjects often rely on what they consider a fair or justified result. Furthermore, the ultimatum aspect cannot be completely exploited since subjects do not hesitate to punish if their opponent asks for 'too much'.

The typical consideration of a player 2 in an easy game seems to be as follows: 'If player 1 left a fair amount to me, I will accept. If not and if I do not sacrifice too much, I will punish him by choosing conflict.' Correspondingly, a player 1 typically will argue like: 'I have to leave at least an amount $c-a_1$ for player 2 so that he will consider the costs of choosing conflict as too high.' One therefore should expect that the relation of player 1's to player 2's payoff will increase if the amount c increases. To estimate the exact functional form of this relationship, one should perform more experiments of easy games with various amounts c. Especially, one should try to include situations with very high amounts c, for instance $c=100$ DM. It is, of course, very expensive to perform experiments with such high values of c. To deal with high amounts c one might consider experiments where one determines by chance k' ($<k$) out of the k simultaneous games whose payoffs are actually paid. Subjects would face higher amounts c which they can distribute with positive probability although the sum of payoffs in all k games can be even lower than in our experiments.

Another way to perform experiments with higher amounts c, is to auction the positions of player 1 and player 2. Some subjects would bid for the position of player 1 in a given easy game, others for the position of player 2. According to the procedure used by Güth and Schwarze (1983) the position is sold to the highest bidder at the price of the second highest bid. Then the winners of the two independent auctions finally play the game. The payoffs would be their payoffs in the easy game minus the price of their position. Apart from its lower costs this procedure provides new explanatory variables and avoids tendencies toward egalitarian payoff distributions. If the positions are assigned to subjects by chance or arbitrarily, the more fortunate subjects often are reluctant to exploit their 'unjustified' strategic advantages. But if a player had to compete for his position and to pay for it, he might not hesitate to exploit its strategic possibilities.

The consistency test was performed for only one easy game. It would be interesting to study how the results are influenced if the subjects have to face very high amounts c to be distributed. One would expect that the number of decision vectors (a_1, a_2) in conflict will decrease because conflict would imply a serious loss in such games.

For complicated games it was shown that they are special examples for the method of divide and choose which is claimed to yield fair divisions. This indicates that the ultimatum aspect of complicated games is less obvious. As a matter of fact the normative solution of such games is envyfree in the sense of Pazner and Schmeidler (1974). Our results show a clear tendency of players 1 to exploit the ultimatum aspect of such a bargaining situation. Although several subjects tried to cause balanced payoff vectors, the tendency toward the normative solution with unbalanced payoffs was much stronger.

Ultimatum bargaining games are standard examples to demonstrate how poorly the characteristic function reflects the strategic possibilities [Güth (1978)]. The characteristic function of an easy game is, for instance, completely symmetric in spite of player 1's strategic advantage. That is why cooperative solution concepts are not very informative. They either consider all efficient and individually rational payoff distributions of easy games as stable or prescribe the equal split as the unique solution. Our results show that efficiency does not hold in general. There are cases of conflict in easy games and non-efficient agreements in complicated games. Obviously some subjects tried to cause egalitarian payoff distributions. But there was a much stronger tendency to exploit the ultimatum aspect. Cooperative game theory is therefore of only little help when explaining ultimatum bargaining behavior.

In easy games all possible strategies of player 1 are maximin-strategies. For player 2 the equilibrium strategy is also a maximin-strategy. For complicated games the equilibrium strategy of player 2 is also a maximin-strategy. But for player 1 the situation is different in complicated games. Here a maximin-strategy of player 1 requires that both bundles contain 7 chips. In 5 of 17 complicated games with low payoffs we observed that player 1 did choose a maximin-strategy. In the case of high payoffs only 1 of 15 players has chosen a maximin-strategy. This shows that the tendency to avoid any risk is of only minor importance, especially for experienced subjects.

Appendix: Instruction rules

A.1. Instruction rules for easy games

You will be faced with a simple bargaining problem with only two bargainers, player 1 and player 2. In each bargaining game both players have to distribute a given amount $c=$ DM ... among themselves. The rules of the bargaining game are as follows:

First player 1 can determine any amount $a_1=$ DM ... between 0 and c which he demands for himself. The difference $c - a_1$ is what player 1 offers to player 2.

Player 2 will be informed about player 1's decision a_1. Knowing player 1's proposal player 2 can either accept this proposal or choose conflict.

If player 2 accepts player 1's proposal, player 1 gets a_1 and player 2 the residual amount $c - a_1$. In case of conflict both players get zero.

(Illustration of bargaining rules by various numerical examples). The experiment will proceed as follows:

There will be $k = \ldots$ bargaining games with different amounts c to be distributed. First it will be decided by chance who of you will be players 1 and who of you will be players 2 in the k bargaining games. All players 1 will be seated at the (isolated) desks on one side, whereas players 2 will be seated at the (isolated) desks on the other side of the room.

Each player 1 will receive a decision form which informs him about the amount c to be distributed. This is also the maximal amount player 1 can ask for. Every player 1 has to fill in his decision a_1. When determining his decision a_1, player 1 does not know who of the $k = \ldots$ players 2 will be his opponent.

After all players 1 have made their decision, their decision forms are distributed by chance among the $k = \ldots$ players 2. Knowing the amount c to be distributed and player 1's demand a_1 each player 2 has to decide whether he accepts the payoff proposal $(a_1, c - a_1)$ of player 1 or not.

Each player has 10 minutes for his decision. When all decisions have been made, the decision forms will be collected. As described above the payoffs are $a_1 = \text{DM} \ldots$ for player 1 and $c - a_1 = \text{DM} \ldots$ for player 2 if player 2 accepts the proposal $(a_1, c - a_1)$. Otherwise both players receive DM 0. To get your money you have to keep the ticket which is attached to your decision form.

If you have any questions, we will be happy to answer them now. During the experiment it is forbidden to ask questions or to make remarks.

A.2. *Instruction rules for complicated games (with high payoffs)*

You will be faced with a simple bargaining problem with only two bargainers, player 1 and player 2. In each bargaining game both players have to distribute a bundle of 5 black and 9 white chips among themselves. Player 1 will get DM 2 for each chip. Player 2 will be paid DM 2 for a black chip and DM 1 for a white one. The rules of the bargaining game are as follows:

First player 1 can determine a bundle (m_1, m_2) of m_1 black and m_2 white chips with $0 \leq m_1 \leq 5$ and $0 \leq m_2 \leq 9$.

Player 2 will be informed about player 1's decision (m_1, m_2). Knowing player 1's decision (m_1, m_2) player 2 can choose between the bundle (m_1, m_2) of m_1 black and m_2 white chips or the residual bundle $(5 - m_1, 9 - m_2)$ with $5 - m_1$ black and $9 - m_2$ white chips. Player 1 receives the bundle which has not been chosen by player 2.

The payoff of each player is determined by the value of all the chips which he received. If, for instance, player 2 chooses the bundle (m_1, m_2), his payoff is $m_1 \cdot \text{DM } 2 + m_2 \cdot \text{DM } 1$. Player 2's payoff is DM 2 times the number of chips which he received.

(Illustration of bargaining rules by various numerical examples). The experiment will proceed as follows:

There will be $k = \ldots$ bargaining games. First it will be decided by chance who of you will be players 1 and who of you will be players 2 in the k bargaining games. All players 1 will be seated at the (isolated) desks on one side, whereas players 2 will be seated at the (isolated) desks on the other side of the room.

Each player 1 will receive a decision form. Every player 1 has to determine a bundle $\text{I} = (m_1, m_2)$ of m_1 black and m_2 white chips. By this he offers player 2 to choose between the bundle $\text{I} = (m_1, m_2)$ and the residual bundle $\text{II} = (5 - m_1, 9 - m_2)$ of $5 - m_1$ black and $9 - m_2$ white chips. When determining his decision $\text{I} = (m_1, m_2)$, player 1 does not know who of the $k = \ldots$ players 2 will be his opponent.

After all players 1 have made their decision, their decision forms are distributed by chance among the $k = \ldots$ players 2. Knowing the two bundles $\text{I} = (m_1, m_2)$ and $\text{II} = (5 - m_1, 9 - m_2)$ each player 2 has to decide whether he wants the bundle $\text{I} = (m_1, m_2)$ or the bundle $\text{II} = (5 - m_1, 9 - m_2)$.

Each player has 15 minutes for his decision. When all decisions have been made, the decision forms will be collected. As described above your payoff will be determined by the bundle of black and white chips which you received. To get your money you have to keep the ticket which is attached to your decision form.

If you have any questions, we will be happy to answer them now. During the experiment it is forbidden to ask questions or to make remarks.

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PRICE DISPERSION IN OLIGOPOLY

Chaim FERSHTMAN

The Hebrew University of Jerusalem, Jerusalem, Israel

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In the world of perfect markets consumers are assumed to respond instantly to every small price change. However, in the real world it is not clear that any small price change will have a great impact on consumers' decisions and that, regardless of their habit, they will shift from one brand to the other. The purpose of this paper is to examine oligopolistic price competition under the assumption that consumers are non-responsive to small price differences. The paper proves the existence of equilibrium in which firms do not necessarily charge the same price; however some of the firms charge their monopolistic price and others charge prices close to that price.

1. Introduction

Economists have always been suspicious about any irrationality in the consumer's behavior. Therefore rational behavior, which is, according to Becker (1962), '. . . a consistent maximization of a well ordered function such as utility function . . .' is assumed in every traditional model of competition among firms. The perfect frictionless markets derived from such behavior, are far away from the economic realities we encounter every day. In the world of perfect markets a small change of price by a firm will immediately have a great impact on the quantity demanded. However, in economic reality the purchasing process is much more complicated than is usually assumed in the perfect market models, and it is not clear that any small price change will have a great impact on the consumers' decisions and that, regardless of their habits, they will shift from one brand to the other.

Since purchasing and consuming involve habits that consumers acquire over time,[1] there is a tendency to consume the same brands and not to change them according to slight price changes. Moreover as Leibenstein (1976, p. 196) points out many purchases are made by agents on behalf of the consumer (for example by other members of the households), therefore implying '. . . the existence of instances in which individuals are non-responsive to some change in price'. The same criticism about perfect markets was made by Phelps and Winter (1970): 'In the world as it is, a price decrease of a penny will not instantly attract a large crowd of buyers.'

[1]Theoretical models of habit formation are investigated in Pollak (1970, 1976).

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