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Toward the settlement of the fairness issues in ultimatum games*

A bargaining approach

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It has been suggested that modest demands by first movers in ultimatum games are motivated by fairness. Here we present a bargaining framework in which the main characteristic of the ultimatum game is embedded in an infinite horizon fixed-cost bargaining game where a quit move is a legitimate response. We show that the threat of quitting which in theory is empty, has nonetheless a significant attenuating effect on the demands of strong players. The fairness argument is therefore invalid since no moderation of demands is seen when the quit move is forbidden.

Key words: Ultimatum; Fairness; Bargaining

JEL classification: C72, C78, C92

1. Introduction

Authors from two disciplines, economics and psychology, have recently pointed to the important role played by fairness in restraining *Homo oeconomicus* in his competitive endeavors [Güth (1988), Kahneman, Knetsch and Thaler (1986)]. In his 'anomalies' column published in the *Journal of Economic Perspectives*, Richard Thaler (1988) has given particular attention to deviations from rationality by both negotiators playing what Güth, Schmittberger, and Schwarze (1982) termed ultimatum games. Fairness considerations, it is argued, constrain people in powerful positions from exploiting their strategic advantage. The importance of this theme can hardly

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be exaggerated. Ultimatums are the building blocks of any finite horizon sharing problem. Thus, the less than predictable results in discount bargaining games reported, for example, by Binmore, Shaked, and Sutton (1985), Neelin, Sonnenschein and Spiegel (1988) and Ochs and Roth (1989) can be traced to failures in the simplest bargaining situation: the ultimatum game. The argument proposed in this paper is different from the one above: what may appear to be fair is *in fact* a manifestation of strategic reasoning.

The starting point for this paper is the different behavior exhibited in playing two forms of bargaining games for which theory predicts similar or identical outcomes: ultimatum and infinite horizon sequential fixed-cost bargaining games. In an ultimatum game, two players are given an infinitely divisible sum p (the 'pie') to be shared between them. Player 1 makes an offer and player 2 can then either accept the offer – in which case the game terminates and the players receive their agreed upon shares – or choose to reject the offer and the game terminates with both players receiving nothing. In an infinite horizon sequential fixed-cost bargaining game, two players, player 1 and player 2 bearing costs c_1 and c_2, respectively, alternate in making offers concerning how to divide a pie. Time is divided into discrete periods, $t=0,1,\dots$. At any period t in the bargaining, one player proposes to the other some partition $(x, p-x)$ of the pie. If the other player accepts this proposal, the game ends with player 1 sharing a gross sum of x and player 2 a gross sum of $p-x$. If the proposal is rejected, the game proceeds to period $t+1$ and the roles of the two players are reversed. The game commences with player 1's proposal and terminates only when agreement is reached. When the game terminates at time t the players receive their agreed upon shares minus the accumulated costs. If player i's cost per period is c_i, her net share amount to *gross share* $-tc_i$.

The descriptions of both the ultimatum and the sequential bargaining games can be rephrased as games in extensive form with perfect information. In both cases any partition of the pie is supported by a pair of strategies in Nash equilibrium. By requiring that a strategy pair supporting a partition be in Nash equilibrium in all subgames, i.e. be subgame perfect [Selten (1975)], and aided by the assumption of common knowledge of all aspects of the game, a reduction in the multitude of Nash equilibrium is obtained.

Because player 2 prefers any positive amount to nothing, the unique subgame perfect partition for the ultimatum game assigns zero to player 2. As for the sequential bargaining game, Rubinstein (1982) has shown that if $c_1 < c_2$, player 1 receives the entire amount p in the first period and if $c_1 > c_2$, player 1 receives c_2 in the first period.

Both games share the characteristic that according to subgame perfect rationality the strong player – the player who makes the offer in the ultimatum game and the player with the smaller cost in the sequential fixed-cost game – is expected to be apportioned virtually the whole sum in the first period of bargaining. Yet, in the ultimatum context, it has been shown consistently that player 1 refrains from taking full advantage of her position [Güth et al. (1982), Forsythe et al., and Sefton, in press; Hoffman et al. (1992), Roth et al. (1991), Weg and Smith, in press).[1] Almost always, her offers are significantly larger than zero, averaging about 35% of the pie with 50% the most common offer. While the distributions of offers as a whole do vary, this rather strong deviation from rationality persists.

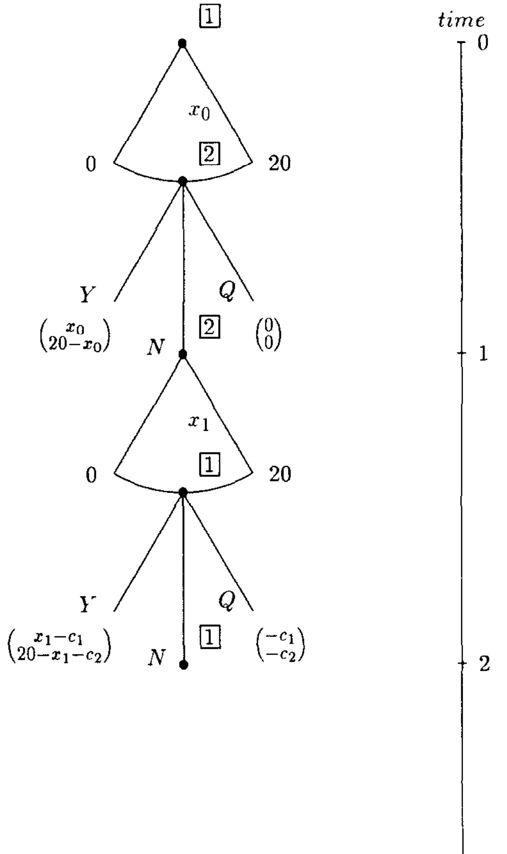
Contrary to what might be expected given the behavioral tendencies in playing ultimatum games, Rapoport, Weg, and Felsenthal (1990) and Weg and Zwick (1991) found that a significant proportion of the demands by the strong player in the infinite horizon fixed-cost games consists of the whole sum, in accordance with subgame perfect predictions. These two contrasting behaviors in situations that normatively require the same or similar extreme allocations demand explication. The argument for fairness advocated by Güth and Tietz (1990) and Kahneman et al. (1986) should be equally valid in both situations.

We argue, however, that Player 1 does not take full advantage of the situation in ultimatum games, not for the sake of fairness but from the fear of loss. Player 1 knows that a small offer to player 2 will most likely be rejected, hence she is better off making an offer that is not insignificant. Player 1's behavior then, is motivated by strategic rather than fairness considerations. She is best characterized as searching for the highest acceptable demand in the given environment [Bolton (1991), Mitzkewitz and Nagel (1991), and Zwick, Rapoport and Howard (1992)].

We demonstrate the validity of our argument by broadening the response repertoire to an offer in the infinite-horizon fixed-cost games, allowing a quit move that terminates the game with both players receiving nothing (null side values) but still liable for any accumulated cost. Quitting is instantaneous and does not add to the accumulated cost. Fig. 1 illustrates the bargaining on a pie of $20. The Rubinstein fixed cost bargaining game is obtained by deleting all 'Q' branches. This generalization preserves an important aspect of ultimatum games – the impending breakdown of the bargaining process – while keeping the normative outcomes identical to those of standard infinite horizon fixed-cost sequential games.

The distinction between having or not having access to a null side value is strategically inessential.[2] It follows that quitting is not a credible move! Psychologically, this is quite surprising. If player 1 can demand the whole pie when she is the strong player in the infinite horizon fixed-cost game, can she pretend that the threat of quitting by player 2 is inconsequential with regard to her demand? Such a claim would stand in sharp contrast to behavior in

[1]For a survey of the recent literature see Güth and Tietz, 1990.
[2]A proof is provided in appendix 1.



x_t is portion for player 1 at time t, $(t = 0, 1, \cdots)$
Y means x_t is accepted
N means x_t is rejected
Q means quit

Fig. 1. Fixed-cost extensive form bargaining game with quit moves.

the similar situation of traditional ultimatum games. Yet, in what follows we show that a null-valued quit move has significant deterring effects – a result which supports strategic as opposed to fairness considerations as the source for moderate demands in ultimatum games.

2. Methods

2.1. Subjects

Thirty-six subjects, male and female undergraduate students, in groups of six participated in a single experimental session that lasted approximately 60 minutes. Subjects were recruited through a classified advertisement placed in the campus newspaper promising monetary reward contingent on performance in a bargaining situation.

2.2. Experimental design

Each of the 'infinite horizon' bargaining games consists of bargaining over a pie of \$20 with unequal costs per period of \$2.00 and \$0.10. In practice, a game is terminated if the negotiations reach the fourteenth period, which in fact occurred only twice. The experiment has a $2 \times 2 \times 3$ factorial structure consisting of game type (with or without a quit move), costs pattern ($c_1 < c_2$ or $c_1 > c_2$), and iteration (whether the subject playing player 1 holds this role for the first, second, or third time). The last two factors are of the within-subject type, which means that during a single session subjects played only one of the game types.

A session consists of fourteen steps (the first two for practice); the group is randomly partitioned so that three games of a single costs pattern are played in parallel. The factorial design and the requirement for balance imply that each subject plays six times under each cost pattern: three times as player 1 and three times as player 2. Subjects interact in a computer environment in which offers, acceptances, rejections, and quits (when available) are transmitted through terminals. Subjects do not know against whom they are playing nor do they see each other's screens. The actual payoff to a subject is the average payoffs of two games, selected randomly from the non-practice games. The instructions to subjects are presented in appendix 2.

3. Results

Fig. 2 (fig. 3) presents the frequency distribution of first (final) period offers to the strong player by iteration (1 and 3), costs pattern, and game type. Most offers were integers, but those which were not, were rounded to units for use in the figures. The figures are arranged in such a way so as to facilitate the forming of a quick impression in comparing games with a quit move to games without a quit move. One can detect a number of very uncharacteristic offers. In games both with and without the quit option, some subjects playing player 1 offered less than half of the pie to the strong player during the first period. Naturally, these were rejected (Fig. 2, $c_1 > c_2$). When extremely high offers to the strong player, such as \$18.00, were made, they appear almost invariably in the context of no-quit games. The single (rejected) demand in the first period of \$19.50 (rounded to 20 in fig. 2) during the third iteration by a strong player 1 ($x_1 < c_2$) in a quit game seems to be an outlier; it is completely isolated from the rest of the demands in this combination of conditions.

Table 1 presents the mean first and final accepted offers to the strong

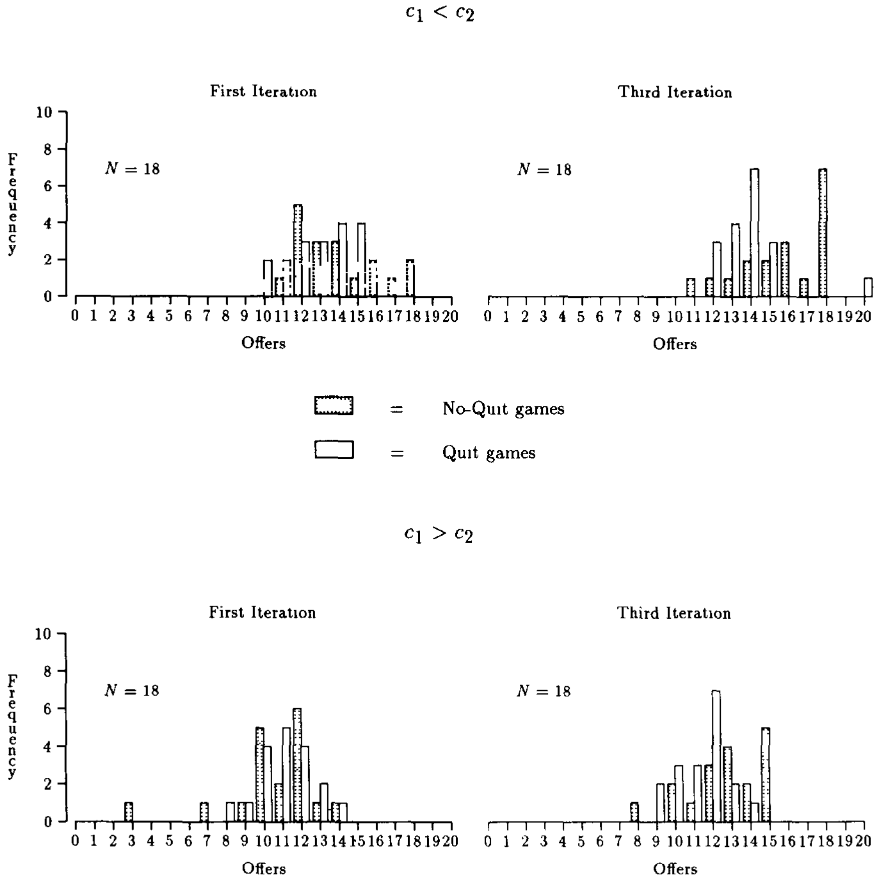


Fig. 2. First period offers to the strong player.

player as a proportion of the pie, their standard deviations, the number of games ending in agreement, forced termination or quit, and the percentage of games that ended in the first period.

Table 2 presents the results of a repeated measures analysis of variance (implemented through MANOVA (Krishnaiah, 1980)) on the first and final accepted offers to the strong player. As predicted, type of game (whether quitting is available) is highly significant. In all cases (except in iteration 1, $c_1 > c_2$), first and final offers to the strong player are lower when the quit move is available. Iteration effect is significant in both first and final accepted offers. In both periods, offers to the strong player increase with playing experience. However, this increase is much larger, in the first period, for no-quit games than for quit games, accounting for the game type by iteration

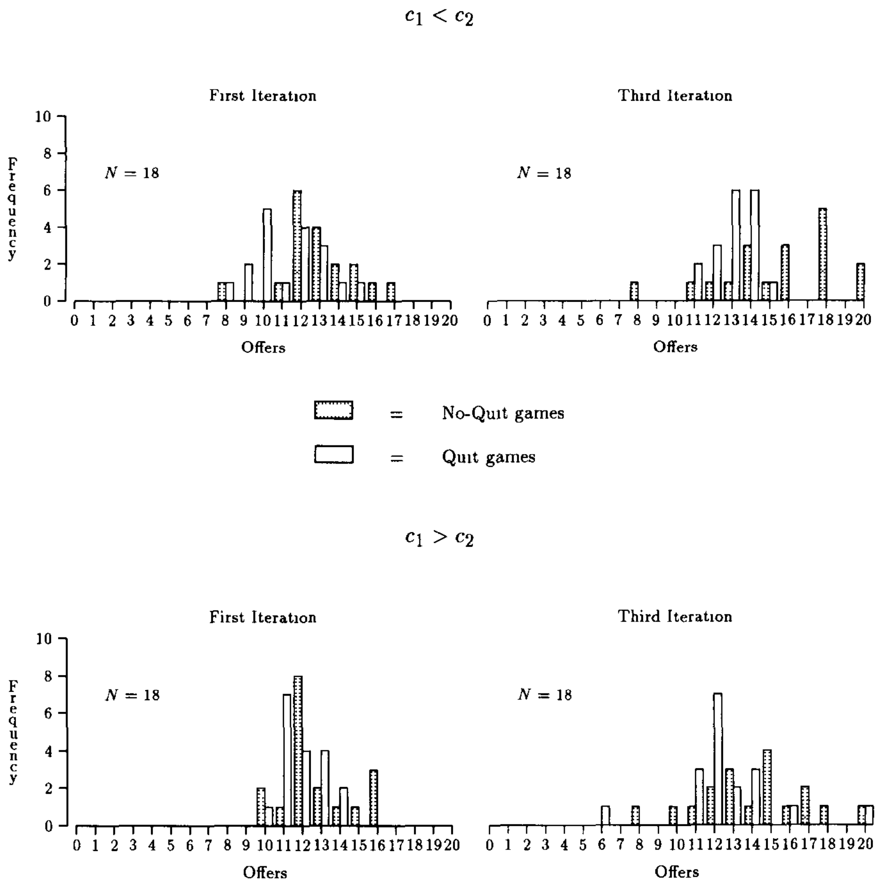


Fig. 3. Last period offers to the strong player.

interaction. In addition, costs pattern is significant in the first period, reflected in the fact that a weak player 1 ($c_1 > c_2$) offers to the strong player in the first period less than what a strong player 1 ($c < c_2$) demands for him/her self. However, the strength of player 1 does not significantly affect the final outcome.

Because the distributions of offers to the strong player are of variable spreads and nonsymmetric, it may be difficult to accept their means, standard deviations and the analysis which rely on them[3] as faithful representations of the whole story. But it is the existence of extreme offers to the strong player (which is the very cause of the difficulty) that is of

[3]The analysis actually depends also on the correlations among the dependent measures.

Table 1

Means and standard deviations of first and final accepted offers to the strong player, number of games ending in agreement, quit, or forced termination, and percent of games ending in the first period

Iteration	Costs pattern	Game type	First period Mean	First period S.D.	Final period Mean	Final period S.D.	Ending[a] A	Ending[a] F	Ending[a] Q	% ending in first period
1	$c_1<c_2$	No quit	0.70	0.11	0.65	0.10	18	0	–	77.78
		Quit	0.64	0.09	0.56	0.09	18	0	0	61.11
	$c_1>c_2$	No quit	0.53	0.12	0.64	0.10	18	0	–	33 33
		Quit	0 55	0.07	0.58	0.05	16	0	2	44.44
2	$c_1<c_2$	No quit	0.72	0.11	0.69	0.10	17	1	–	61.11
		Quit	0.68	0.08	0 61	0 09	18	0	0	61 11
	$c_1>c_2$	No quit	0.62	0.09	0.66	0.09	18	0	–	72.22
		Quit	0.56	0.06	0.58	0.12	18	0	0	0.00
3	$c_1<c_2$	No quit	0.79	0.11	0.80	0.13	17	1	–	77.78
		Quit	0.69	0.09	0.65	0.06	17	0	1	66.67
	$c_1>c_2$	No quit	0.64	0.10	0.71	0.15	8	0	–	55.56
		Quit	0.56	0.07	0.63	0.14	17	0	1	33.33

[a]A = Agreement; F = Forced termination; Q = Quit.

Table 2

Analysis of variance results – first and final accepted offers to the strong player[a].

Effects	First offers d.f.	First offers F	Final accepted offers d.f.	Final accepted offers F
Game type (GT)	1,34	6.22*	1,30	15.32*
Iteration (ITER)	2,33	11.05*	2,29	12.82*
Costs pattern (CP)	1,34	80.55*	1,30	1.82
CP × ITER	2,33	1.24	2,29	2.60
CP × GT	1,34	1.34	1,30	1.85
ITER × GT	2,33	4.00*	2,29	0.59
CP × ITER × GT	2,33	2.02	2.29	0.31

[a]*means $p<0.05$ and all F statistics are exact.

particular interest to us. For this reason, we present the upper quartiles of these offers – the offer exceeded by 25% of all offers (normalized as a proportion) – in table 3. These are classified according to first or final period offers, costs pattern, iteration, and game type.

Both first and final offers to the strong player increase with playing experience. This increase is much larger for no-quit games than for quit games. In fact, first period demands for quit games do not change at all. We conclude that experience in playing quit games does not affect upper quartile offers while it does influence these offers in no-quit games.

There is a substantial difference in upper quartile offers between no-quit and quit games. Our figures for the quit games are comparable to those of

Table 3
Upper quartiles of first and final offers to the strong player (proportions).

Iteration	Costs pattern	Game type	First period	Final period
1	$c_1 < c_2$	No quit	0.80	0.70
		Quit	0.70	0.62
	$c_1 > c_2$	No quit	0.60	0.70
		Quit	0.60	0.61
2	$c_1 < c_2$	No quit	0.80	0.75
		Quit	0.70	0.67
	$c_1 > c_2$	No quit	0.70	0.70
		Quit	0.60	0.65
3	$c_1 < c_2$	No quit	0.90	0.90
		Quit	0.70	0.70
	$c_1 > c_2$	No quit	0.75	0.80
		Quit	0.60	0.70

Güth et al. (1982) for which upper quartile offers are 0.72 and 0.75 for naive and experienced subjects, respectively, and to those of Forsythe et al. (in press) for which the upper quartiles are between 0.55 and 0.60, depending on the experiment.

The most striking behavior is in games in which player 1 is the strong player ($c_1 < c_2$). In these games, by the third iteration player 1's first period upper quartile is 90% ($18.00) of the pie for no-quit games and only 70% ($14.00) for quit games. We can view these outcomes from a slightly different perspective. Although not shown in the table, it is quite remarkable that by the third iteration, 59% (28%) of the games end with at least 80% of the pie allocated to the strong player when player 1 is the strong (weak) player in the no-quit games. This is a far cry from the corresponding figures (0% and 11%) for the quit games. It is important to note that these last figures are comparable to those obtained in playing ultimatum games.

Thus, our impressions from the analysis of variance, although based on imperfect adherence to statistical assumptions, seem to be corroborated by looking at the upper quartile demands.

It is also of some interest that although the weaker player seldom exercises his option to opt out in the quit condition (4 times out of 108 games, see table 1), the availability of this option is enough to cause player 1 to ask less when she is the strong player than what she asks for in the no-quit game condition. The quit move seems to play a symbolic function unaccounted for by direct experience.

4. Discussion

Our data lend support to the argument that players do not take full advantage of the situation in *sequential* bargaining games with a quit option not for the sake of fairness but, most likely, from the fear or loss. This conclusion follows from a comparison of behavior in no-quit bargaining games to behavior in games with null quit moves.

We can now draw our most important conclusion. The ultimatum game shares with the quit and no-quit versions of the infinite horizon fixed-cost bargaining game the subgame perfect prediction that the strong player is allocated essentially the whole pie. However, only the quit version of our bargaining game shares with the ultimatum game the impending breakdown of the bargaining process. We have shown that by adding this last characteristic to the infinite-horizon fixed-cost game, subjects' behaviour shifted from close to subgame perfect behavior when quit was absent to more moderate behaviour which, had we not experimented with no-quit games, might have been attributed *erroneously* to fairness. We therefore infer that those who are first to move in ultimatum games are almost invariably intimidated by player 2's veto option. At best, fairness behavior may appear as an outcome of a certain balance of power [Binmore, Morgan, Shaked and Sutton (1991)].

The focus of attention, then, shifts to player 2. Why is he willing to reject a small positive offer in favor of a zero outcome? At this point we can only speculate. The functional point of view claims that life has taught him that rejecting an insignificant amount of money, when a larger sum could have been offered, is beneficial to developing a reputation for *toughness* in the long run. Subjects who play ultimatum games in a lab are unable or unwilling to regard the lab exercise in isolation. The lab experiment is an integral part of their life experiences, hence all the knowledge and precedents of life encounters are brought to bear on their decisions. The psychological perspective simply views player 2 as envious of player 1's larger share. He is willing to reject insignificant amounts for the sake of eliminating the source of envy. Player 2 is willing to reject player's 1 offer only when a rejection is not too costly to himself. Such is the case, for example, in the ultimatum game where rejection cost is only an opportunity lost of an otherwise insignificant amount to begin with. In contrast, a rejection (of a small offer) in the infinite-horizon no-quit fixed-cost context incurs a true out of pocket expense that increases with time unless an agreement is reached. Developing a reputation for toughness, or investment in the elimination of envy, is too costly.

Appendix 1

We denote by (c_1, c_2, s_1, s_2) a unit pie fixed-cost bargaining game with quit moves where c_i and s_i are the costs and side values, respectively, for player i. We now prove that a fixed-cost game with quit moves (c_1, c_2, s_1, s_2) such that

$c_1 \neq c_2$ and $s_1+s_2 \leqq 1$ has a unique partition supported by a pair of strategies in subgame perfect equilibrium. The quit games investigated in the present paper are of the form $(c_1, c_2, 0, 0)$.

First, note that the partitions allocating $1-s_2$ to player 1 when $c_1<c_2$ and c_2+s_1 when $c_1>c_2$, are supported by pairs in subgame perfect equilibrium ending the game in the first period. The definitions of the strategies which support these partitions and the verifications that they are in subgame perfect equilibrium are evident. We need to show that in each case no other partition is thus supported.

The proof follows Sutton's (1986) method. Let U_i (u_i) be the least upper bound (greatest lower bound) of all partitions supported by subgame perfect equilibrium when player i opens the bargaining (by proposing an offer) in a subgame. Because of the existence of some subgame perfectly supported partitions, these values are all finite.

Since player i can guarantee himself u_i in a subgame he opens, we have,[4] for $j \neq i$,

$$1-((u_i-c_i) \vee s_i) \geqq U_j.$$

Similarly, since player i can be prevented from gaining more than U_i in a subgame he opens, we have, for $j \neq i$,

$$(U_i-c_i) \vee s_i \geqq 1-u_j.$$

From these inequalities we obtain by substitutions,

$$\begin{aligned}(1-((u_1-c_1) \vee s_1)-c_2) \vee s_2 &\geqq (U_2-c_2) \vee s_2 \geqq 1-u_1\\ &\geqq 1-U_1 \geqq (u_2-c_2) \vee s_2 \geqq (1-((U_1-c_1) \vee s_1)-c_2) \vee s_2.\end{aligned}$$

Hence, on the one hand we have,

$$u_1 \geqq ((u_1-c_1+c_2) \vee (s_1+c_2)) \wedge (1-s_2) \tag{1}$$

and on the other,

$$((U_1-c_1+c_2) \vee (s_1+c_2)) \wedge (1-s_2) \geqq U_1. \tag{2}$$

Now when $c_1<c_2$ the solution of (1) is $1 \geqq u_1 \geqq 1-s_2$ and the solution of (2) is $1-s_2 \geqq U_1 \geqq 0$. Since $U_1 \geqq u_1$ we have $U_1=u_1=1-s_1$. Similarly we obtain $U_1=u_1=c_2+s_1$ when $c_1>c_2$.

We see that fixed cost bargaining games with zero side values possess the same subgame perfect solutions as corresponding Rubinstein standard games.

[4]The $\max(a,b)$ is denoted by $a \vee b$ and $\min(a,b)$ is denoted by $a \wedge b$.

Appendix 2

Instructions to subjects (quit condition)

Introduction

In the situation that we study two people are given $20.00 if they agree on how to share them. The way they may arrive into an agreement involves bargaining. Either bargainer may quit the negotiation before an agreement is reached.

As in real life the bargaining itself incurs some costs.

If the negotiation ends in an agreement then each bargainer is credited with his/her agreed share minus his/her negotiation costs. If, on the other hand, the negotiation ends without an agreement (if one bargainer quits) then each bargainer gets nothing but still has to pay the negotiation costs.

Let us describe in specific terms the bargaining situations in this experiment.

The bargaining games

A. Who are the bargainers?

In each game of the experiment the computer will randomly assign you to another person, unknown to you, with whom you will bargain over the division of $20.00.

B. What are the costs involved in bargaining?

Each time one of you *rejects* a proposal *both of you* must pay a certain rejection fee. These fees accumulate, of course, until an agreement is reached, or one of you chooses to quit. In no game your rejection fee will be the same as your co-bargainer's.

C. What is your profit/debt in each game?

If agreement is reached, then your outcome equals your agreed share *minus* your rejection fees accumulated for this game (if any). If, on the other hand, the game ends with one of you opting to quit bargaining then you get nothing but still have to pay your rejection fees accumulated for this game (if any).

D. How do you get paid for your participation?

At the end of the experiment, the computer will randomly select two games in which you participated. The amount of money that you will actually get/pay will be your average profit/debt in these games.

Clearly, your best strategy is to bargain well in each game since you do not know which of the games will be selected.

At the end of the experiment you will be paid discretely by the supervisor so no one else will know how much you gained and, of course, you will not know anybody else's gains.

E. What information is available to you and to your co-bargainer?

At the opening of any bargaining game in which you participate, you will know these facts:

(1) Who starts the bargaining, that is who proposes first,
(2) The amount you must pay for every rejection no matter who makes it (your rejection fee),
(3) The amount your co-bargainer must pay for every rejection no matter who makes it (your co-bargainer's rejection fee).

The amount to be divided will be \$20.00 in every game.

The computer will display the same information to both bargainers. Moreover, everybody reads the same instructions you do.

F. How do you bargain?

You take TURNS in proposing how to divide the \$20.00. You make a proposal by simply specifying your share of the proposed agreement. It is understood that the rest of the \$20.00 is proposed to be received by your co-bargainer.

The responding bargainer can do one of three things:

(1) *Accept* the proposed division, thereby terminating the bargaining. Each bargainer's *profit* for this game is his/her agreed share *minus* his/her accumulated rejection fees (if any).
(2) *Reject* the proposed division. This choice signals an intent to continue the bargaining and it is the rejecting bargainer's turn to make a counter proposal. You should understand that a rejection by any party is not free.
(3) *Quit*, thereby terminating the bargaining. Each bargainer's *debt* for this game is his/her accumulated rejection fees (if any).

Remember that any time you or your co-bargainer *rejects* a proposal, your total amount of fees *INCREASES* by your respective rejection fee.

After you make a proposal, the computer will display it back to you, specifying yours and your co-bargainer's profit if this proposal is accepted, considering the fees accumulated during the game (if any). You can revise your proposal after you see this.

G. How to use the computer terminal

We conduct the entire experiment by a computer program. You will use the keyboard to write numbers and to signal agreements, rejections, or quitting. To write the amounts use the digits keys. The decimal point is already marked on the screen, therefore, if a sum is less than $10 enter the digit 0 first. End each entry by pressing the 'Enter' key. If you need to erase a character use the 'Backspace' key.

Summary

You bargain with an unknown co-bargainer on the division of $20.00. The bargaining procedure consists of alternating proposals about how the division is to be done. Both bargainers can quit the bargaining. Any rejection involves a cost to both bargainers no matter who makes it.

If you have questions, press the 'H' key now and wait until the supervisor arrives.

If you understood these instructions, press the 'G' key now. Please wait patiently until all the other participants finish reading the instructions.

Instructions to subjects (no quit condition)

Only sections that are different from the quit condition are included.

Introduction

In the situation that we study two people are given $20.00 if they agree on how to share them. The way they may arrive into an agreement involves bargaining.

As in real life the bargaining itself incurs some costs.

Let us describe in specific terms the bargaining situations in this experiment.

B. What are the costs involved in bargaining?

Each time one of you *rejects* a proposal *both of you* must pay a certain rejection fee. These fees accumulate, of course, until an agreement is reached. In no game your rejection fee will be the same as your co-bargainer's.

C. What is your profit/debt in each game?

Your profit in each game equals your agreed share *minus* your rejection fees accumulated for this game (if any).

F. How do you bargain?

You take TURNS in proposing how to divide the $20.00. You make a proposal by simply specifying your share of the proposed agreement. It is understood that the rest of the $20.00 is proposed to be received by your co-bargainer.

The responding bargainer can do one of two things:

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