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GRANT TITLE:

Bargaining, Fairness and the Labor Allocation Problem

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Bargaining, Fairness and the Labor Allocation Problem

ONR Grant # N00014-01-0917

Paul Pecorino and Mark Van Boening, Principal Investigators

Chapter 1. Overview

A. The Navy Problem

Bilateral bargaining is used extensively by the armed forces for labor allocation. An important example is the assignment of Navy billets. This research is a systematic study of bilateral bargaining in a stylized setting. It is designed to help facilitate a more efficient allocation of resources by investigating the role of fairness in bargaining. Understanding how fairness affects outcomes in this stylized bargaining setting may in turn help yield assignments that are in the interest of the individual sailor and the U.S. Navy.

Assigning approximately 130,000 Sailors a year requires over 200 detailers in the Bureau of Personnel. The vast majority of personnel assignments are negotiated by the detailers and individual Sailors, based on the Navy's needs and the Sailor's preferences. This "enlisted detailing" mechanism is one example of bilateral bargaining. In its current form, however, it is often time-consuming and inefficient, i.e., while this process favors the Navy, it contributes to reduced retention rates and vacant billets, particularly in less desirable jobs. The inefficiencies are in part due to informational asymmetries: only the sailor knows his or her ability and preferences regarding various aspects of a specific job, and only the detailer knows what jobs are available and with what priority they are to be filled.

In an effort to increase retention and induce individuals to volunteer for less desirable jobs, the Navy has adopted various incentive systems, such as selected reenlistment bonuses and reduced sea-shore rotation. These incentives are a novel attempts to overcome information asymmetry, as they indirectly entice the sailor to reveal (some portion of) his or her true preferences, and they indirectly reveal the willingness of the Navy to fill particular billets. The results have been mixed; highly skilled individuals continue to abandon their Naval careers in favor of the private sector. Further, the Navy may be losing highly skilled Sailors who might not be offered sufficient compensation to reenlist.

Low retention rates further exacerbate the current distribution and assignment problems faced by the Navy. There are fewer sailors to fill critical sea and shore billets. The results are longer sea duty tours, longer working hours, and a reduced quality of home life. All of these contribute to the falling retention rate: frequent moves, consistent rotations to undesirable jobs or locations, and family constraints (such as a spouses' employment opportunities and school quality) affect a Sailor's decision to leave.

Thus, mechanisms that reduced bargaining failure, or improve the outcome for all parties even when the bargaining agreements are reached, would appear to be of some importance. The objective of this report is to help identify those conditions or mechanisms that could ultimately be used to efficiently allocate manpower resources and reduce inefficient turnover.

B. The Research Problem

A significant body of economic research addresses bilateral bargaining.[1] Bargaining failure is troubling (and interesting) to economists, because it implies that mutually beneficial gains are lost or left unrealized. Thus it is important to identify those negotiation mechanisms that exploit these otherwise lost opportunities, and that yield

[1] Two of the most important papers on bargaining are Nash (1950) and Rubinstein (1982).

efficient allocation of resources. Bargaining failure can cause inefficient job separations, when the employer and employee cannot agree on the terms of employment. In other contexts, bargaining failure results in costly strikes, civil trials or the use of arbitration proceedings. Key issues include how the two parties to an agreement split the joint surplus from the agreement and an understanding of why bargaining failure occurs.

There are several explanations for bargaining failure, and they are not mutually exclusive. If individuals have different beliefs about the outcome of a dispute should it occur, this could lead to bargaining failure.[2] Beliefs might differ because one or both parties involved may misperceive a situation, and there is considerable experimental evidence that individuals do so in a way that is self-serving.[3] If individuals exhibit a sufficient self-serving bias in evaluating, e.g., the facts surrounding a job assignment, then the employee and employer may fail to come to an agreement. The worker and employer also might each exhibit a self-serving bias in evaluating the worker's value to the firm, or the value of the worker's outside opportunities.

An alternative explanation is that individuals do not have access to the same information and that this is what causes differing beliefs about the likely outcome of a dispute.[4] For example, a worker may know more about his outside employment opportunities than his current employer. Thus, the employer may fail to offer a sufficiently high wage to retain the worker, even if it is efficient to do so.

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[2] An example of a model along these lines from the law and economics literature may be found in Shavell (1982).

[3] See the survey of Babcock and Lowenstein (1987).

[4] See Fudenberg and Tirole (1983) and Bebchuk (1984).

A third factor that has received a great deal of attention is fairness. In ultimatum bargaining games, two parties are to split a fixed amount of money (often referred to as "the pie").[5] One party has the power to make a take-it-or-leave-it offer to the other. If the offer is rejected, the entire pie is lost. For example, players *A* and *B* may be asked to split $10, with *B* given the power to make a single offer to *A*. Player *B* can make any offer between $0 and $10, and if *A* rejects it, both receive nothing. Without considering fairness, standard "fully rational" economic theory predicts that *B* will offer *A* $0.01 (leaving $9.99 for himself), and that *A* will accept this, as $0.01 is better than nothing. An extensive literature on ultimatum games shows that empirically, individuals appear to exhibit a taste for fairness: player *B* typically offers player *A* substantially more than $0.01, with an equal split of $5.00 often the modal outcome, and player *A* frequently rejects offers in the $0.01–$3.50 range. Thus, fairness is vitally important in determining how surplus from settlement is divided between two parties, and differing perceptions about what is fair can be an independent cause of disputes.

This report focuses on the way in which fairness affects bargaining outcomes and the incidence of disputes in a stylized bargaining experiment. The setting involves a take-it-or-leave-it bargaining structure with an embedded ultimatum game. But in contrast to the usual ultimatum game, the entire "pie" does not disappear when there is a dispute. Instead, some fraction of the pie is lost when a dispute occurs. Also, as described below, in this setting player *A* is randomly one of two types, one that receives a low payoff and one that receives a high payoff in the event of a dispute. The total surplus

[5] Among others, see Thaler (1988), Slonim and Roth (1998) and Fehr and Schmidt (2000).

from settlement is the same regardless of *A*'s type, so the problem of splitting the surplus would seem to be independent of *A*'s type. But the co-Principal Investigators' previous research suggests that player *B* is more generous in the division of surplus when player *A* is entitled to the low payoff than when *A* is entitled to the high payoff.[6] Thus, perceptions of fairness may depend upon player *A*'s luck in drawing either the high or low type. If the players cannot agree on how a fair offer changes with the high or low outcome, then an increase in dispute rates may result. Our previous research was designed to address other issues; the experiments reported here allow for a clearer analysis of fairness in a bargaining context.

This current project addresses two key but unresolved issues from the bargaining literature. First, when two bargaining parties reach an agreement, how do they split the joint surplus from the mutually beneficial agreement? Second, when two parties do not reach an agreement, what factors contribute to the bargaining failure? The project consists of two experiments, both of which can be interpreted as a stylized labor market setting or employment allocation problem. For example, in the context of the Navy's enlisted detailing, bargaining failure can be likened to the failure of a sailor to reenlist.

C. Bargaining Mechanism with an Embedded Ultimatum Game

Consider a stylized two-person bargaining situation with a player *A* and a player *B*. Player *B* makes an offer to player *A*, which *A* then either accepts or rejects. Player *A* is one of two types, either a "high" type A_H or a "low" type A_L, which she knows prior to

[6] See Pecorino and Van Boening (2000) and (2001).

receiving B's offer (and thus prior to making her accept/reject decision).[7] If player A accepts player B's offer, then agreement (or no dispute) occurs, and the amount of the offer is transferred from B to A. That is, A's payoff equals the amount of B's offer. If A rejects B's offer, then a dispute occurs, and the outcome is determined by A's type. In particular, type A_H has a higher payoff than type A_L. Additionally, when A rejects B's offer, both player A and player B incur a fixed fee that reduces their respective earnings. For simplicity, these fees are referred to as A and B's dispute costs.

The imbedded ultimatum game is defined by the fees that are incurred when A and B fail to reach agreement (i.e., A rejects B's offer). The fees are the "joint surplus from settlement" that is analogous to the "pie" in the standard ultimatum game: the sum of the fees is surplus that evaporates when A rejects B's offer. Thus, the stylized bargaining situation presented here can be thought of as an ultimatum game played over the joint surplus from settlement. Standard economic theory predicts that in the embedded ultimatum game, player B's offer will extract the entire joint surplus from settlement minus \$0.01. This is analogous to the prediction that player B will offer player A \$0.01 in the standard ultimatum game. In the embedded game, a type A_L player will accept any offer that gives her at least the A_L payoff resulting from a dispute, plus \$0.01, and a type A_H player will accept any offer that gives her at least the A_H payoff from a dispute, plus \$0.01. This is analogous to the prediction that player A will accept any offer of \$0.01 or more in the standard ultimatum game.

[7] For simplicity, player A is referred to with female pronouns, and player B is referred to with male pronouns. In the actual experiments, subjects are assigned roles regardless of gender.

From a Navy perspective, player A represents a sailor and player B represents a detailer. In this labor market context, player A's type reflects her outside opportunities, e.g., whether she low skilled or high skilled. The detailer makes a compensation offer to the sailor for accepting a billet assignment. The detailer does not know for certain what the sailor's outside opportunities are, but he will typically have some prior assessment, e.g., he knows the sailor's civilian work and educational history and her service record. When A accepts B's offer, the sailor is assigned to the billet at the proposed compensation. When A rejects B's offer, this is interpreted as an inefficient job separation. Separation is costly to both player A and player B. For example, when the sailor does not reenlist, she must incur the cost of searching for alternative employment, while the Navy must incur the cost of recruiting and training a replacement.

D. Summary of Experiments 1 and 2

In experiment 1, there is asymmetric information between players A and B, as player B does not know A's type when he makes his offer. He knows only the probabilities that A is type A_H or A_L and the payoffs to each type in the event of a dispute. The experimental design varies the distribution of the dispute costs across a baseline and two treatments. In all three cases the sum of the dispute costs is constant. In the baseline, this cost is divided equally between players A and B, i.e., they have equal dispute costs. In one treatment, player B has a higher dispute cost than player A, and in the other treatment, A has the higher dispute cost. The standard model of rationality makes very sharp theoretical prediction on how offers change with the change in the distribution of the costs. The evolution of the fair offer as a function of the distribution of dispute costs is less clear *a priori*. In experiment 1, the standard model fails in terms of its point predictions, but the comparative static predictions of the theory hold up fairly well. In addition, the rational theory predicts that the probability of a dispute is independent of the distribution of the dispute costs. That prediction is generally supported by the data.

In experiment 2, player B knows A's type with certainty. Thus when he makes his offer, he knows A's payoff if she accepts or if she rejects the offer. As in experiment 1, the sum of the dispute costs is constant, but in experiment 2 the players A and B always have equal dispute costs. Somewhat surprisingly, in this embedded ultimatum game setting fairness considerations seem to play a very limited role, with outcomes lying close to the predictions of the standard model of rationality.

Chapter 2. Experiment 1

A. Overview

Experiment 1 consists of a stylized labor bargaining situation with two players, player A and player B. As described in chapter 1, player A can be thought of as a sailor and player B as a detailer. Player A is one of two types, either A_H or A_L (or "high" or "low", respectively), which she knows but player B does not. Player B makes offer O_B to player A, knowing only the probabilities that A is type A_H or A_L. If A accepts O_B, then an agreement (or no dispute) occurs with player B paying player A the amount O_B. If A rejects O_B, then player B's payment and player A's payoff depend on A's type, as described in section B below. Experimentally, a six-sided die is rolled to determine whether A is type A_H or type A_L.[8] For convenience, the result of the die roll is referred to as "outcome H" or "outcome L." Player A knows the outcome of the die roll, and thus her type, before she decides whether or not to accept player B's offer.[9]

If A does not accept B's offer, both players are charged a player-specific fixed fee. For convenience, these fees are referred as "dispute costs" and are denoted as F_A and F_B for players A and B, respectively. Experiment 1 consists of a baseline with symmetric dispute costs $F_A = F_B$ and two treatments with asymmetric dispute costs. In one treatment, $F_A > F_B$, and in the other $F_A < F_B$. However, in all three cases, the sum of the dispute costs is constant at $F_A + F_B =$ \$1.50, so the experimental treatment is the

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[8] A roll of 1, 2, 3 or 4 results in outcome L, a roll of 5 or 6 results in outcome H; see section 2.B below.

[9] As in chapter 1, player A is assigned a female pronoun and player B a male pronoun. In the experiment, subjects are assigned roles independent of gender.

distribution of dispute costs. These costs are avoided if players *A* and *B* can reach an agreement, so they are essentially playing an embedded ultimatum gain over this joint surplus from settlement.

Experiment 1 has two main objectives. The first is to determine how the dispute rate is affected by the distribution of dispute costs. Under the model of strict rationality, changing the distribution of court costs has no effect on the incidence of disputes.[10] But extant theory discounts confounding influences like fairness, and deviating from a symmetric distribution of costs may make it more difficult for players to coordinate on a fair offer. This may, in turn, cause the empirical dispute rate to differ from the theoretical one.

The second objective is to determine how *B*'s offers and *A*'s accept/reject decisions vary with the distribution of dispute costs. The model of rationality makes a very sharp prediction: a self-interested Player *B*'s offer to player *A* decreases one-for-one with an increase in *A*'s dispute cost F_A (and increases one-for-one with a decrease in F_A). By contrast, it is not immediately clear how the "fair" offer changes as a function of the distribution of costs. By varying the distribution of dispute costs across the parties can yield insight as to the determination of a fair offer. One possibility is an offer is that splits the saving from settlement evenly between the two parties, and is the equivalent of offering half the pie in the embedded ultimatum game. Another possibility is an offer that allows each player to retain his or her saved (or avoided) dispute cost. It is an open question as to how the "fair" offer will evolve with the distribution of dispute costs. To date, no research has addressed this question.

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[10] For example, see Bebchuk (1984) or Reinganum and Wilde (1986).

B. Experimental design

Table 2.1 summarizes the experimental design for experiment 1, where the treatment variable is the distribution of dispute costs. There are at total of eight sessions, each consisting of a series of "bargaining rounds" where subjects are randomly and anonymously paired each round. In each session, the distribution of dispute costs is changed once during the course of the session. Dispute costs are symmetric for about half the bargaining rounds with $F_A = F_B = \$0.75$. For the other bargaining rounds, the dispute costs are changed to one of two asymmetric distributions, one favoring player *A* ($F_A = \$0.25$, $F_B = \$1.25$) and one favoring player *B* ($F_A = \$1.25$, $F_B = \$0.25$). Note that the sum of dispute costs always remains constant at $F_A + F_B = \$1.50$.

TABLE 2.1. EXPERIMENTAL DESIGN FOR EXPERIMENT 1

Sessions	Rounds 1 – 7: *A*'s dispute cost F_A	Rounds 1 – 7: *B*'s dispute cost F_B	Rounds 8 – 14[a]: *A*'s dispute cost F_A	Rounds 8 – 14[a]: *B*'s dispute cost F_B	Number of pairs	Location[b]
S1	75	75	25	125	6	Mississippi
S5	75	75	25	125	7	Alabama
S2	25	125	75	75	7	Mississippi
S6	25	125	75	75	7	Alabama
S3	75	75	125	25	5	Alabama
S7	75	75	125	25	7	Mississippi
S4	125	25	75	75	7	Alabama
S8	125	25	75	75	7	Mississippi

Notes: [a] Sessions S2 and S4 lasted 13 rounds.
[b] Sessions conducted at the University of Mississippi, Oxford, MS and the University of Alabama, Tuscaloosa, AL

The order of treatments is randomized both within and across the eight sessions as part of the experimental design. Half the sessions have the asymmetry that favors player *A*, and the other have the asymmetry that favors player *B*. Four sessions (two per treatment) have symmetric dispute costs in the first half the session and asymmetric costs in the second half of the session, and four sessions have asymmetric costs first and the symmetric costs second. The sessions are labeled S1, S2, etc., according to their chronological occurrence. Sessions were held at the University of Mississippi and the University of Alabama, with four sessions at each university in order to balance subject pools.

Subjects were recruited from economics classes at the respective schools. As they arrived to a session, subjects were randomly assigned to one of two rooms, with subjects in one room being player *A* and subjects in the other room player *B*. Subjects maintained the same role throughout the session, and there was no interaction between the *A* and *B* players; the co-PI's transmitted offers and decisions between the two rooms. Each experimental session consisted of a series of rounds where *A* and *B* players were randomly and anonymously paired. Subjects were not informed ahead of time how many rounds there would be. Six of the eight sessions last 14 rounds, and two last 13 rounds. In all rounds of all sessions, $p(A_L) = 2/3$ and $p(A_H) = 1/3$; see step 2 below.

The sequence of events in a round is as follows:

1. Player *A* and player *B* are randomly and anonymously paired.
2. A 6-sided die is rolled for each Player *A*. In the event of a dispute, a roll of 1, 2, 3 or 4 is results in outcome L and a roll of 5 or 6 results in outcome H. Thus $p(A_L) = 2/3$ and $p(A_H) = 1/3$.
3. Player *B* decides on an offer to submit to player A. This offer must be between (and including) \$0.00 and \$5.99.

4. Player B's offer is then communicated to player A, who decides whether or not to accept the offer. Player A's decision is then communicated to player B.

5. If player A accepts player B's offer, then the round is over for that pair.

   Players A's Payoff for the round = Player B's offer

   Player B's Cost for the round = Player B's offer.

6. If player A does not accept B's offer, player A incurs fee F_A and player B incurs fee F_B. A's payoff and B's cost for the round depend on the die roll and the fees.

   Under outcome L: Player A's Payoff for the round = $2.00 – F_A

   Player B's Cost for the round = $2.00 + F_B.

   Under outcome H: Player A's Payoff for the round = $4.00 – F_A

   Player B's Cost for the round = $4.00 + F_B.

In all cases, the total cost of a dispute $F_A + F_B$ = $1.50. Player A's payoff from the experiment is the sum of her payoffs from all rounds. Player B's payoff from the experiment is determined by subtracting the sum of the costs from all rounds from a lump sum which is known in advance only by player B.

The information about the contingent payoffs and dispute costs was public. An overhead was displayed in each room that summarized steps 5 and 6 above (except that dollar amounts were shown simply as 200 and 400, and F_A and F_B were replaced with the relevant numerical figures 75, 25 or 125). The overhead included the information that a roll of a 1, 2, 3 or 4 resulted in outcome L, and a roll of 5 or 6 resulted in outcome H. The overhead also included the statement "The same overhead is displayed in both rooms" to emphasize that this was common information.

C. Predictions

The parameters of experiment 1 were chosen so that the strictly rational, risk neutral model predicts a sorting equilibrium. Table 2.2 summarizes the theoretical predictions of the strictly rational model and two models of fairness discussed in this section. Player *B* makes an offer to player *A* knowing only the probabilities that *A* is type A_L or A_H, while player *A* knows her type with certainty. Thus player *B* makes his offer under asymmetric information. In the sorting equilibrium, a self-interested player *B* makes an offer that is acceptable to A_L but not to A_H because such an offer minimizes his expected costs. Similarly, a self-interested player *A* will never accept an offer that is less than what she receives in the event of a dispute.

Why is a sorting equilibrium predicted with these parameters? Consider the case where $F_A = F_B = \$0.75$. If a dispute occurs between *B* and a type A_L, *B* pays \$2.75 and *A* receives \$1.25. If a dispute occurs between *B* and a type A_H, *B* pays \$4.75 and *A* receives \$3.25. The probabilities of the different player *A* types are $p(A_L) = 2/3$ and $p(A_H) = 1/3$. If *B* offers less than \$1.25, both A_L and A_H will reject the offer, and *B*'s expected cost is (2/3)\$2.25 + (1/3)(\$4.75) = \$3.08. If he offers \$1.25, A_L will accept but A_H will reject, so his expected cost is (2/3)\$1.25 + (1/3)(\$4.75) = \$2.42. Any offer between \$1.25 and \$3.25 will be accepted by A_L and rejected by A_H, but the expected cost will exceed \$2.42. If he offers \$3.25, both A_L and A_H will accept the offer and he pays \$3.25. Any offer above \$3.25 will also be accepted by both A_L and A_H, but will result in costs greater than \$3.25. Thus the expected cost is lowest with the separating offer of \$1.25 than with any other offer, including the pooling offer of \$3.25.

TABLE 2.2. THEORETICAL PREDICTIONS FOR EXPERIMENT 1

Model, category	Formula[a]	Values by Treatment[a] $F_A = 75$ $F_B = 75$	$F_A = 25$ $F_B = 125$	$F_A = 125$ $F_B = 25$
I. Strictly rationality, risk neutral model				
B's sorting offer	$O_B^R = 200 - F_A$	125	175	75
B's comparative static[b]	$\Delta O_B^R = -\Delta F_A$		–50	+50
A_L accepts	$O_B \geq 200 - F_A$	125	175	75
A_H accepts[c]	$O_B \geq 400 - F_A$.	325	375	275
B's expected cost	$(2/3)O_B^R + (1/3)(400 +$	242	292	192
Dispute rate comparative static[b]	A_L 0%, A_H 100%		no change	no change
II. Equal split of 150 surplus				
B's sorting offer	$O_B^F = O_B^R + ½(F_A + F_B)$	200	250	150
B's comparative static[b]	$\Delta O_B^F = -\Delta F_A$		–50	+50
A_L accepts	$O_B \geq 200 - ½(F_A - F_B)$	200	250	150
A_H accepts[c]	$O_B \geq 400 - ½(F_A - F_B)$	400	450	350
B's expected cost	$(2/3)O_B^F + (1/3)(400 +$	292	342	242
Dispute rate comparative static[b]	A_L 0%, A_H 100%		≥0 for A_L	≥0 for A_L
III. Each player saves (or retains) own dispute cost				
B's sorting offer	$O_B^S = O_B^R + F_A$	200	200	200
B's comparative static[b]	$\Delta O_B^S = 0$		0	0
A_L accepts	$O_B \geq 200$	200	200	200
A_H accepts[c]	$O_B \geq 400$	400	400	400
B's expected cost	$(2/3)O_B^S + (1/3)(400 +$	292	308	275
Dispute rate comparative static[b]	A_L 0%, A_H 100%		≥0 for A_L	≥0 for A_L

Notes: [a] All numeric values in \$0.01 increments.

[b] relative to $F_A = F_B$.

[c] equals B's offer and payout in pooling equilibrium

The strictly rational, risk neutral model makes five very sharp predictions: [11]

(i) B*'s* offer O_B will be the strictly "rational" sorting offer $O_B^R = \$2.00 - F_A$.

(ii) Type A_L will reject any $O_B < \$2.00 - F_A$ and accept any $O_B \geq \$2.00 - F_A$.

(iii) Type A_L will reject any $O_B < \$4.00 - F_A$ and accept any $O_B \geq \$4.00 - F_A$.

(iv) Dispute rates will be 0% when A is type A_L and 100% when A is type A_H.

(v) As F_A is varied there should be a one-for-one for change (with an opposite sign) in the offer B makes to A, i.e., the comparative static prediction is $\Delta O_B = -\Delta F_A$.

Note three things about these predictions. First, O_B^R varies with changes in F_A, as does A's minimum acceptable offer. Second, while this model predicts B will offer $O_B^R = \$2.00 - F_A$, any offer in the range $\$2.00 - F_A \leq O_B < \$4.00 - F_A$ will be consistent with a sorting equilibrium, i.e., A_L will accept it while A_H will reject it. Third, recall that based on the die roll, outcome H is expected to apply in 1/3 of all bargaining rounds. So the overall expected dispute rate is 33.3%, with 0% for A_L and 100% for A_H

Empirically, excess disputes are fairly common in an experimental setting such as this.[12] These excess disputes may occur because players cannot agree on what constitutes a fair offer. In rational models the probability of a dispute is a function of the sum of the dispute costs, but not of their distribution.[13] In models with fairness, the distribution of

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[11] For ease of exposition, the theoretical predictions throughout this report fully reflect A's dispute cost and do not add in the extra \$0.01 to ensure settlement (i.e., in the ultimatum game B is predicted to offer A \$0.01).

[12] See Pecorino and Van Boening (2001).

[13] See Bebchuk (1984) or Reinganum and Wilde (1986). Note that the use of conditional cost shifting (e.g., one player pays the dispute costs of both players) may affect the probability of a dispute in rational model.

dispute costs may affect the probability of a dispute.[14] Thus deviations from the strictly rational predictions may be due to considerations of fairness.

The prediction that player B will make a sorting offer that is acceptable to A_L but not to A_H is robust to considerations of fairness, but those considerations play a role in determining the exact amount of the offer. As discussed earlier, it is not clear how a fair offer would evolve as the distribution of dispute costs is varied. Here, two possibilities are considered. Note that as a sorting equilibrium is predicted in both cases, the predicted dispute rates are identical to those predicted by the fully rational theory (0% for A_L, 100% for A_H, 33.3% overall)

The first possibility is that the joint \$1.50 surplus from settlement is split equally; this outcome is closest in spirit to the results that are often observed in the standard the ultimatum game. If player B conforms to this view, his offer equals A_L's dispute payoff (\$2.00 – F_A) plus half of the joint surplus from settlement. This "fair" offer is then $O_B^F = O_B^R + ½(F_A + F_B)$. As the rational offer O_B^R varies one-for-one (in opposite sign) with F_A, so too will the fair offer O_B^F. Similarly, if player A conforms to this view, she will accept nothing less than her dispute payoff plus half of the joint surplus. For type A_L, this can be expressed as $\$2.00 - F_A + ½(F_A + F_B) = \$2.00 - ½(F_A - F_B)$, and for type A_H as $\$4.00 - ½(F_A - F_B)$.

A second possibility is that a fair offer allows players to retain or save their respective dispute cost. Under this scenario, player B offer equals A_L's dispute payoff (\$2.00 – F_A) plus her dispute cost F_A. This "save" offer is $O_B^S = O_B^R + F_A = \$2.00$, regardless of whether F_A = \$0.75, \$0.25 or \$1.25. That is, O_B^S does not vary with

[14] For example, see Farmer and Pecorino (2003).

changes in F_A. Similarly, under this scenario, type A_L will not accept an offer less than \$2.00 – $F_A + F_A$ = \$2.00, and type A_H will not accept any offer less than \$4.00. Finally, note that when players A and B have identical dispute costs, the two views of fairness have the same prediction: when $F_A = F_B$, $O_B^S = O_B^F$.

Why is a sorting equilibrium predicted under both of these fairness scenarios? Suppose fairness required the "save" offer of \$2.00 to induce A_L players to settle, and \$4.00 to induce A_H players to settle. Recall there is a 2/3 probability that player A is a type A_L, in which case the offer O_B^S = \$2.00 is accepted, and a 1/3 probability that player A is a type A_H, in which case the offer O_B^S = \$2.00 is refused and a dispute occurs. So if B makes the offer O_B^S = \$2.00, then he expects to pay (2/3)\$2.00 + (1/3)(\$4.75) = \$2.92. If he offers \$4.00, both A_L and A_H will accept the offer and he pays \$4.00. Thus the expected payment is lower with an offer of \$2.00 than with an offer of \$4.00. Moreover, the difference in expected payoffs under these two strategies differs by \$1.08 per round, which should be sufficient monetary incentive to seek out the optimal solution to this problem. Even under the extreme assumption that fairness requires an offer of \$2.00 to A_L, but only an offer of \$3.25 to A_H (i.e., there is no need to be "fair" to players lucky enough to be type A_H), a separating offer still results in a lower expected cost for player B. A similar analysis holds for the equal-split-of-the-surplus scenario.

Note that as described thus far, each version of the fairness model implies a dispute rate of 0% for A_L players and 100% for A_H players, regardless of the distribution of dispute costs. Under symmetric dispute costs, the "fair" offer to A_L players is \$2.00 under either notion of fairness, and \$2.00 would appear to be a focal point for fair behavior. When the distribution of costs change, it is not clear how perceptions of a fair offer will change. We have presented two different notions of fairness for this game, but there may be others. If the players fail to agree on how fair offers evolve with the distribution of costs, then more disputes may arise between player B and type A_L players. (The dispute rate with A_H is predicted to remain at 100% throughout.)

D. Results

D.1. Dispute rates

The experiment 1 dispute rates are analyzed by following dummy variable (or fixed effects) model:

$$\text{Dispute Rate} = \beta_0 + \beta_1\text{UL25} + \beta_2\text{UL125} + \beta_3\text{EH} + \beta_4\text{UH25} + \beta_5\text{UH125} + \beta_6\text{EF25} + \beta_7\text{EF125} + \epsilon$$

The dispute rate is calculated as four observations per session: one for each of A's type (A_L, A_H) and dispute cost (equal, unequal). Thus there are 2 x 2 x 8 sessions = 32 observations.

The intercept β_0 represents the regression baseline where A is type A_L and dispute costs are equal with $F_A = F_B = 75$. The first five dummy variables capture the treatment effect by player A type:

UL25 = 1 if unequal dispute costs are $F_A = 25$, $F_B = 125$ and A is type A_L
= 0 otherwise

UL125 = 1 if unequal dispute costs are $F_A = 125$, $F_B = 25$ and A is type A_L,
= 0 otherwise

EH = 1 if A is type A_H and equal dispute costs are $F_A = F_B = 75$,
= 0 otherwise

UH25 = 1 if unequal dispute costs are $F_A = 25$, $F_B = 125$ and A is type A_H,
= 0 otherwise

UH125 =1 if unequal dispute costs are $F_A = 125$, $F_B = 25$ and A is type A_H,
= 0 otherwise

The last two dummy variables capture order or sequence effects, as they identify those sessions where the equal dispute costs $F_A = F_B = 75$ occur in the first seven periods:

EF25 = 1 if equal dispute costs $F_A = F_B = 75$ occur in rounds 1-7 of a session and unequal dispute costs $F_A = 25$, $F_B = 125$ occur after round 7,
= 0 otherwise

EF125 = 1 if equal dispute costs $F_A = F_B = 75$ occur in rounds 1-7 of a session and unequal dispute costs $F_A = 125$, $F_B = 25$ occur after round 7,
= 0 otherwise

Table 2.3 shows the results of the estimation. Recall that the strictly rational model predicts a 0% dispute rate for A_L players and 100% for A_H players. The intercept estimate indicates that for type A_L players under the baseline of equal dispute costs, the bargaining disputes occurred 11% of the time on average, and the null hypothesis H_0: $\beta_0 = 0$ is firmly rejected. Thus, there are excess disputes relative to theory, but this is not unusual in experimental bargaining. However, equal-cost dispute rate for A_H players averages 0.11 + 0.86 = 97% (found by summing estimated β_0 and β_3), and the null hypothesis H_0: $\beta_0 + \beta_3 = 1$ cannot be rejected. So the deviations from theory are concentrated in the type A_L players; this is analyzed this further below in section D.3.

If the distribution of dispute costs has no effect on dispute rates for type A_L players, then both β_1 and β_2 should equal zero. As shown in Table 2.3, both of the coefficient estimates of β_1 and β_2 are positive, as our discussion of the fairness models suggested, but the null hypotheses H_0: $\beta_1 = \beta_2 = 0$ is only marginally rejected (p-value = .0908). One interpretation is that for type A_L players, the data provide weak support for the fairness models over the strictly rational model.

TABLE 2.3. DISPUTE RATE REGRESSION FOR EXPERIMENT 1

Model: Dispute Rate = $\beta_0 + \beta_1$UL25 + β_2UL125 + β_3EH + β_4UH25 + β_5UH125 + β_6EF25 + β_7EF125 + ϵ

Estimated coefficients (standard error)								Summary statistics	
β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	R^2	F
0.11 (0.03)	0.07 (0.05)	0.10 (0.05)	0.86 (0.04)	0.87 (0.05)	0.84 (0.05)	0.06 (0.04)	0.002 (0.04)	.974 n = 32	128.7 p<.0001

Hypothesis tests

Point Predictions	Strictly Rational, Equal-Split, and Save-Own-Cost Models		
	Player A_L	Player A_H	Both player A types
H_0:	$\beta_0 = 0$	$\beta_0 + \beta_3 = 1$	$\beta_0 = 0, \beta_0 + \beta_3 = 1$
F	11.9	1.20	7.60
(p-value)	(.0021)	(.2838)	(.0028)

Comparative Statics	Strictly Rational, Equal-Split, and Save-Own-Cost Models[b]		
	Player A_L	Player A_H	Both player A types
H_0:	$B_1 = \beta_2 = 0$	$\beta_3 = \beta_4 = \beta_5$	$\beta_1 = \beta_2 = 0, \beta_3 = \beta_4 = \beta_5$
F	2.66	0.08	1.38
(p-value)	(.0908)	(.9275)	(2702)

Experimental Design	Strictly Rational, Equal-Split, and Save-Own-Cost Models	
	No Order Effects	Equal Order Effects
H_0:	$\beta_6 = \beta_7 = 0$	$\beta_6 = \beta_7$
F	1.39	1.58
(p-value)	(.2677)	(.2211)

Notes: [a] The strictly rational model predicts H_0 will not be rejected; the equal-split and save-own-cost models predict H_0 will be rejected.

The distribution of costs has no effect on A_H dispute rates; the dispute rate is predicted to be 100% under all three models. Thus, all models predict $\beta_0 + \beta_3 = 1$, $\beta_0 + \beta_4 = 1$ and $\beta_0 + \beta_5 = 1$, implying $\beta_3 = \beta_4 = \beta_5$. The estimated coefficients are 0.86, 0.87 and 0.84, respectively, and the null hypothesis H_0: $\beta_3 = \beta_4 = \beta_5$ cannot be rejected. Thus for A_H disputes, the data are consistent with all three models.

Collectively, the data seem to support the rational model over the fairness models. The joint hypothesis H_0: $\beta_1 = \beta_2 = 0$, $\beta_0 + \beta_3 = 1$ is rejected, but this is due to the 11% average dispute rate for A_L players. Additionally, the joint hypothesis H_0: $\beta_1 = \beta_2 = 0$, $\beta_3 = \beta_4 = \beta_5$ is not rejected, so the comparative statics support the rational model. Finally, there is no systematic evidence of order effects on the dispute rates, as neither of the null hypotheses H_0: $\beta_6 = \beta_7 = 0$ nor H_0: $\beta_6 = \beta_7$ are rejected.

D.2. *Player B offers*

One of the primary concerns in experiment 1 is the way in which player *B* offers evolve as a function of the distribution of dispute costs. All three of the models in Table 2.4 predict that player *B* will make a separating offer to player *A*, which will be acceptable to A_L players, but not A_H players. Overall, 674 / 728 = 93% of the offers are consistent with at least one of the models. That is, 7% of the offers are inconsistent with all three models: 6% of the offers are theoretically unacceptable to any player *A* and 1% are inconsistent with a separating offer under all three models.[15]

[15] Specifically, 46 of the 728 offers are less than $200 - F_A$, which is the lowest the three "A_L accepts" values shown in Table 2.2, and 8 of the 728 offers equal or exceed the maximum of the three "A_H accepts" values shown in Table 2.2 under a given distribution

In analyzing the role (if any) of fairness in this stylized bargaining framework, the analysis here focuses on the 87% of the offers that are consistent with the separating equilibrium predicted by the strictly rational model, where B makes offers that are acceptable to A_L but not to A_H. These data are again analyzed with a dummy variable regression:

$$O_B = \beta_0 + \beta_1\text{Treat25} + \beta_2\text{Treat125} + \beta_3\text{EF25} + \beta_4\text{EF125} + \varepsilon.$$

The intercept β_0 reflects the offer under the regression baseline of equal costs ($F_A = F_B = 75$). The first two dummy variables capture the treatment effect:

Treat25	= 1 if unequal dispute costs are $F_A = 25$, $F_B = 125$
	= 0 otherwise
Treat125	= 1 if unequal dispute costs are $F_A = 125$, $F_B = 25$
	= 0 otherwise.

The last two dummy variables capture order or sequence effects, as they identify those sessions where the equal dispute costs $F_A = F_B = 75$ occur in the first seven periods:

EF25	= 1 if equal dispute costs $F_A = F_B = 75$ occur in rounds 1-7 of a session and unequal dispute costs $F_A = 25$, $F_B = 125$ occur after round 7,
	= 0 otherwise
EF125	= 1 if equal dispute costs $F_A = F_B = 75$ occur in rounds 1-7 of a session and unequal dispute costs $F_A = 125$, $F_B = 25$ occur after round 7,
	= 0 otherwise

These results are presented in Table 2.4 for the 674 observations consistent with at least one of the three models. The coefficient estimate on β_0 indicates the average offer when $F_A = F_B = 75$ is about 170, which is between the rational and fairness point

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of costs. Analysis of the data does not reveal any systematic deviations due to specific subjects, round number, treatment, etc.

predictions (the estimated β_0 is 45 above the strictly rational point prediction of 125, and 30 below the point prediction of 200 for both the fairness models.) Furthermore, hypotheses based on the point predictions H_0: $\beta_0 = 125$ and H_0: $\beta_0 = 200$ are easily rejected. So the point predictions of the rational and fairness models are equally supported, or equally rejected, depending on one's point of view.

Now consider more generic versions of the fairness models. First, consider an "α-split" version of the equal-split model where player B offers α% of the joint surplus from settlement to player A, e.g., $\alpha = 0.5$ yields the equal-split model shown in Table 2.2. If $\alpha = 0.3$, then the point prediction for β_0 is 170, which essentially equals the estimate of 169.6 in Table 2.4. This "30/70 split" is a combination of the strictly rational and equal-split models: player B is arguably being "fair" by offering player A 30% of the joint surplus, but he is acting in his self-interest by proposing to keep 70% for himself. Alternatively, consider an "α-cost" version of the save-own-cost model where player B offers player A α% of F_A, e.g., $\alpha = 1.0$ yields the save-own-cost model shown in Table 2.2. If $\alpha = 0.6$, then the point prediction for β_0 is again 170. So player B is again being both fair and rational: he's offering A 60% of her dispute cost, but proposing to keep the remaining 40% for himself. Under either scenario, the estimated β_0 suggests that player B is both fair and rational, but more rational than fair.

Although all three models are loosely consistent with the point estimates, the comparative statics rule out the save-own-cost model. That model predicts β_1 and β_2 are both zero, but the estimated coefficients on β_1 and β_2 are roughly two to four times their standard errors, and the null hypothesis H_0: $\beta_1 = \beta_2 = 0$ is easily rejected. Instead, the estimated coefficients have the expected signs and magnitudes consistent with the predictions of the strictly rational and equal-split models, and the null hypothesis H_0: $\beta_1 = -\beta_2 = 50$ cannot be rejected.

TABLE 2.4. PLAYER *B* OFFER REGRESSION FOR EXPERIMENT 1

Model: $O_B = \beta_0 + \beta_1\text{Treat25} + \beta_2\text{Treat125} + \beta_3\text{EqF25} + \beta_4\text{EqF125} + \epsilon$

Estimated coefficient (standard error)					Summary statistics	
β_0	β_1	B_2	β_3	β_4	R^2	F
169.2 (3.8)	45.7 (5.9)	–42.8 (5.7)	26.6 (5.8)	11.4 (5.8)	.280 n = 674	64.9 $p < .0001$

Hypothesis tests

Point predictions	Strictly Rational Model	Equal-Split Model and Save-Own-Cost Model
H_0:	$\beta_0 = 125$	$\beta_0 = 200$
F	132.30	63.91
(*p*-value)	(.0001)	(.0001)
Comparative statics	Strictly Rational Model And Equal-Split Model	Save-Own-Cost Model
H_0:	$\beta_1 = -\beta_2 = 50$	$\beta_1 = \beta_2 = 0$
F	1.27	71.10
(*p*-value)	(.2802)	(.0001)
Experimental design	No Order Effects	Equal Order Effects
H_0:	$\beta_3 = \beta_4 = 0$	$\beta_3 = \beta_4$
F	11.18	4.23
(*p*-value)	(.0001)	(.0401)

The estimated coefficients on β_3 and β_4 and the rejection of the null hypothesis H_0: $\beta_3 = \beta_4 = 0$ indicate that there are statistically significant order effects in experiment 1. When the treatment is $F_A = 25$, offers are approximately 27 higher when the equal cost baseline is run first, and when the treatment is $F_A = 125$, offers are 11 higher when the equal cost treatment is run first. The hypothesis H_0: $\beta_3 = \beta_4$ is rejected, suggesting that the order effects are not symmetric across treatments. None of the theories considered here have a parsimonious explanation of these observed order effects; their origin is left as an area of future research.

The regression and hypothesis tests in Table 2.4 do completely rule out either the strictly rational model or the equal-split model. Table 2.5 categorizes player *B*'s offers according to whether they are consistent with neither model, only one of these two models, or both. Roughly two-thirds of the offers (63.3%) are consistent only with the strictly rational model. While a significant portion of the offers is consistent with the equal-split model, the strictly rational model is the one that is most strongly supported by the data.

TABLE 2.5. SUMMARY OF PLAYER *B*'S OFFERS RELATIVE TO THE STRICTLY RATIONAL AND EQUAL-SPLIT PREDICTIONS IN EXPERIMENT 1

Category	Treatment			
	$F_A = F_B$	$F_A < F_B$	$F_A > F_B$	Row Total
Inconsistent with both the strictly rational and the equal-split models: $O_B < O_B^R$ or $O_B > O_B^F + 200$	19 (5.3%)	27 (14.3%)	9 (4.9%)	55 (7.6%)
Consistent with the strictly rational model only: $O_B^R \leq O_B < O_B^F$	231 (64.7%)	111 (58.7%)	119 (65.4%)	461 (63.3%)
Consistent with both the strictly rational and the equal-split models: $O_B^F \leq O_B < O_B^R + 200$	87 (24.4%)	38 (20.1%)	45 (24.7%)	170 (23.4%)
Consistent with equal-split model only: $O_B^R + 200 \leq O_B \leq O_B^F + 200$	20 (2.6%)	13 (6.9%)	1 (4.9%)	42 (5.8%)
Column Total	357 (100%)	189 (100%)	182 (100%)	357 (100%)

D.3. Player A decisions

Table 2.6 summarizes player *A*'s accept/reject response to player *B* offers, relative to the predictions of the three models shown in Table 2.2.[16] Clearly the player *A* behavior is most consistent with the strictly rational model. Out of the 728 decisions, 88.3% are consistent with the rational model, compared with 65.1% and 65.0% under the equal-split and save-own-cost fairness models, respectively (see "Totals" rows in Table 2.6). Under all three models, the majority of the inconsistencies are due to type A_L players. But the frequency under the strictly rational model are substantially less than under either of the two fairness models (85% versus 50%). Also note that under the strictly rational model, there are 74 instances where A_L's decision is inconsistent with that model's prediction, and 73 of those are cases where A_L rejects an offer that the model says she should accept; this point is discussed further in the section E below.[17]

Table 2.7 provides further analysis of the 73 offers that the strictly rational model predicts player A_L will accept, but she in fact rejects. The right-hand side dummy variables are identical to those used in Table 2.4 above. This analysis reveals that on average, rejected offers exceed the minimum acceptable offer of 125 (based on strictly rational model) by about 16, and H_0: $\beta_0 = 125$ is easily rejected. The comparative statics are roughly equal to those expected, and H_0: $\beta_1 = -\beta_2 = 50$ is not rejected. Also, there is

[16] Analysis of the data at the session and/or subject level does not reveal any session-specific or subject-specific behavior. Consequently, only aggregate data are shown in Table 2.6.

[17] Notice that under the equal-split and save-own-cost models, the preponderance of inconsistencies is cases where A_L accepts offers that the respective model says she should reject.

no evidence of experimental design effects, as the hypothesis H_0: $\beta_3 = \beta_4 = 0$ is not rejected.

TABLE 2.6. SUMMARY OF PLAYER *A*'S DECISIONS BY PLAYER *A* TYPE FOR EXPERIMENT 1

	Model says reject		Model says accept		Consistent with model	
	A rejects	*A* accepts	*A* rejects	*A* accepts	Fraction	Percent
Strictly rational model						
Type A_L	29	1	73	374	403/ 477	84.5%
Type A_H	221	5	6	19	240 / 251	95.6%
Totals	250	6	79	393	643 / 728	88.3%
Equal-split model						
Type A_L	99	230	3	145	244/ 477	51.2%
Type A_H	227	21	0	3	230 / 251	91.6%
Totals	326	251	3	148	474 / 728	65.1%
Save-own-cost model						
Type A_L	87	219	15	156	243/ 477	50.9%
Type A_H	226	20	1	4	230 / 251	91.6%
Totals	313	239	16	160	473 / 728	65.0%

Analysis of the β_0 point estimate reveals that on average, the typical rejected offer would leave player *A* about 10% of the joint surplus from settlement (the average rejected offer is 16 above the point prediction; 16/150 = 0.11). This suggests that player *B* can push player *A* fairly close to the theoretical minimum offer before rejection becomes a significant concern. At the same time, this also suggests that player *B* cannot extract all of *A*'s dispute cost from her, as the strictly rational model predicts. This provides a partial explanation as to why only 85% of the player A_L decisions shown in Table 2.6 are consistent with the strictly rational model

TABLE 2.7. PLAYER A_L REGRESSION FOR "VIOLATIONS" OF THE STRICTLY RATIONAL MODEL IN EXPERIMENT 1

Model: $O_B = \beta_0 + \beta_1\text{Treat25} + \beta_2\text{Treat125} + \beta_3\text{EF25} + \beta_4\text{EF125} + \epsilon$

Estimated coefficients (standard error)					Summary stats	
β_0	β_1	β_2	β_3	β_4	R^2	F
140.6 (5.37)	54.2 (6.70)	–60.1 (7.38)	8.1 (6.77)	8.5 (7.64)	.822 n = 73	78.51 p<.0001

Hypothesis tests for strictly rational model

	Point Prediction	Comparative Static	Order Effects
H_0:	$\beta_0 = 125$	$\beta_1 = -\beta_2 = 50$	$\beta_3 = \beta_4 = 0$
F	8.43	1.39	1.17
(p-value)	(.0050)	(.2557)	(.3151)

E. Summary

By varying the distribution of the costs of a dispute, some predictions of bargaining theory can be tested, both under the assumption of strict rationality and under the assumption of fairness. One of these predictions is that the probability of a dispute is a function of the sum of dispute costs, but not a function of the distribution of these costs. The experiment 1 data fail to reject the hypothesis that there are no treatment effects on the dispute rate, so the evidence supports this prediction of the fully rational model. In models with fairness (e.g. Farmer and Pecorino, forthcoming) the distribution of court costs may affect the probability of a dispute.

The strictly rational model and fairness models also make very sharp predictions about the offer from player B to player A. This offer should fully reflect player A's dispute costs and therefore should change one-for-one with A's dispute costs. This yields both a point prediction and a comparative static prediction for the fully rational theory. While the data reject the point prediction of the theory, they do not reject the comparative static prediction.

Taken together, the results above suggest that the rational theory has fairly good predictive power in the stylized setting of experiment 1. However, the rational theory does not fully explain the results. Player B offers are consistent with an "α-split" version of the equal-split model where player B is both rational (i.e., self-interested) and fair, but more rational than fair. In addition, player A rejects about 17% of offers that the strictly rational theory predicts she should accept; this is almost exclusively due to A_L players. This explains (in part) the sustained dispute rate of 11% for A_L players when theory predicts it should be 0%. At the same time, the player A decisions (particularly those of type A_L) are much less consistent with either the equal-split or save-own-cost models of fairness. The typical rejected offer would leave A_L with about 10% of the joint surplus from settlement. This suggests that fairness plays a role in the experiment 1 bargaining outcome, but a much smaller role than in a standard ultimatum game. This is significant, as the bargaining framework in experiment 1 contains an embedded ultimatum game. Embedding the ultimatum game in a larger bargaining game seems to move the outcome closer to the predictions of the rational theory.

In real (naturally occurring) world interactions, individuals are likely to encounter ultimatum games that are embedded in larger, more complicated games. This changes the framing of the game, and the experiment 1 results (which must be viewed as part of the larger literature) suggest that this may move these real world games closer to the fully rational outcome.

The goal of experiment 1 is not to dismiss the rather robust finding of fairness exhibited in numerous ultimatum game bargaining experiments. Clearly, this behavior exists in the laboratory and has important counterparts in the real world. Rather, the goal of experiment 1 is to begin the process of identifying the real world interactions where fairness is likely to play a significant role.

Chapter 3. Experiment 2

A. Overview

Experiment 2 is very similar to experiment 1, with three important exceptions. First, prior to his offer to player A, player B is informed whether A is type A_H or A_L.[18] Thus the outcome that applies in the event of a dispute is common knowledge. Second, the dispute costs F_A and F_B are symmetric and constant in all bargaining rounds. Third, there is an equal chance that player A is type A_H or A_L, i.e., $p(A_L) = p(A_H) = 1/2$.

Experiment 2 has three main objectives. The first objective is to examine how the dispute rate differs with when player B is matched with a type A_L player than when he is matched with a type A_H. If players A and B agree on how a fair offer should change with A's type, then dispute rates will be the same regardless if player A is type A_L or A_H. However, if A and B differ on how the fair offer should change, then dispute rates will differ depending on whether A is type A_L or A_H. The second objective is to systematically analyze how or if player B's proposed division of the surplus varies with different distributions. The third objective is to analyze how player A's willingness to accept varies with her type.

A fourth objective emerged in the process of conducting experiments 1 and 2. In experiment 1, deviations from the strictly rational theory could occur because of B's difficulty or confusion in identifying the sorting strategy, or because of fairness considerations, or some combination of both. In experiment 2, B knows A's type when

[18] As in chapters 1 and 2, player A is assigned a female pronoun and player B a male pronoun. In the experiment, subjects are assigned roles independent of gender.

he makes his offer, so he does not have to identify a sorting strategy. Hence if deviations from the strictly rational theory occur in experiment 2, fairness considerations would appear to be the only explanation. Comparison of experiment 1 and experiment 2 will help determine the extent to which fairness emerges as an important factor when the ultimatum game is embedded in a stylized bargaining setting. To date, no research has addressed this question.

B. Experimental design

Table 3.1 summarizes the experimental design for experiment 2. There are at total of four sessions, each consisting of a series of "bargaining rounds" where subjects are randomly and anonymously paired each round. In each session, dispute costs are symmetric in all rounds with $F_A = F_B =$ \$0.75. Note that this is identical to the experiment 1 baseline rounds. The sessions are labeled S9, S10, S11 and S12 according to their chronological occurrence. Sessions were held at the University of Mississippi and the University of Alabama, with two sessions at each university in order to balance subject pools. Also, as one objective of experiment 2 is to examine how fairness considerations are affected by player A's type, the co-PI's determined that it was important that there be approximately equal number of observations where player A is type A_L or A_H. Thus in experiment 2, the chance that player A is type A_H is the same as the chance that she is type A_L, i.e., $p(A_L) = p(A_H) = 1/2$.[19]

[19] Recall that in experiment 1, $p(A_L) = 2/3$ and $p(A_H) = 1/3$. There, the probabilities were chosen so that the strictly rational theory predicted a sorting equilibrium.

TABLE 3.1. EXPERIMENTAL DESIGN FOR EXPERIMENT 2

Sessions	Rounds 1 – 13 A's dispute cost F_A	B's dispute cost F_B	Number of pairs	Location[a]
S9	75	75	7	Alabama
S10	75	75	7	Alabama
S11	75	75	6	Mississippi
S12	75	75	7	Mississippi

Notes: [a] Sessions conducted at the University of Mississippi, Oxford, MS and the University of Alabama, Tuscaloosa, AL

The experimental procedure is virtually identical to that in experiment 1. Subjects were recruited from economics classes at the respective schools. As they arrived to a session, subjects were randomly assigned to one of two rooms, with subjects in one room being player *A* and subjects in the other room player *B*. Subjects maintained the same role throughout the session, and there was no interaction between the *A* and *B* players; the co-PI's transmitted offers and decisions between the two rooms. Each experimental session consisted of a series of rounds where *A* and *B* players were randomly and anonymously paired. Subjects were not informed ahead of time how many rounds there would be. All four sessions last 13 rounds, and in all rounds of all sessions, $p(A_L) = p(A_H) = 1/2$.

The sequence of events in a round is as follows:

1. Player *A* and player *B* are randomly and anonymously paired.

2. A 6-sided die is rolled for each Player *A*. In the event of a dispute, a roll of 1, 2, or 3 is results in outcome L and a roll of 4, 5 or 6 results in outcome H. Thus $p(A_L) = p(A_H) = 1/2$.
3. Player *B* is then informed as to the outcome of the die roll (H or L).
4. Player *B* decides on an offer to submit to player A. This offer must be between (and including) \$0.00 and \$5.99.
5. Player *B*'s offer is then communicated to player *A*, who decides whether or not to accept the offer. Player *A*'s decision is then communicated to player *B*.
6. If player *A* accepts player *B*'s offer, then the round is over for that pair.

   Players *A*'s Payoff for the round = Player *B*'s offer

   Player *B*'s Cost for the round = Player *B*'s offer.
7. If player *A* does not accept *B*'s offer, player *A* incurs fee F_A and player *B* incurs fee F_B. *A*'s payoff and *B*'s cost for the round depend on the die roll and the fees.

   Under outcome L: Player *A*'s Payoff for the round = \$2.00 – F_A

   Player *B*'s Cost for the round = \$2.00 + F_B.

   Under outcome H: Player *A*'s Payoff for the round = \$4.00 – F_A

   Player *B*'s Cost for the round = \$4.00 + F_B.

In all cases, $F_A = F_B =$ \$0.75, so the total cost of a dispute is constant at \$1.50. Player *A*'s payoff from the experiment is the sum of her payoffs from all rounds. Player *B*'s payoff from the experiment is determined by subtracting the sum of the costs from all rounds from a lump sum which is known in advance only by player *B*.

The information about the contingent payoffs and dispute costs was public. An overhead was displayed in each room that summarized steps 5 and 6 above (except that dollar amounts were shown simply as 200 and 400, and F_A and F_B were replaced with 75). The overhead included the information that a roll of a 1, 2, or 3 resulted in outcome L, and a roll of 4, 5 or 6 resulted in outcome H. The overhead also included the statement "The same overhead is displayed in both rooms" to emphasize that this was common information.

C. Predictions

Table 3.2 summarizes the theoretical predictions of the strictly rational model and two models of fairness. The parameters of experiment 2 were chosen to be analogous with the experiment 1 baseline. The strictly rational theory predicts that a self-interested player B will offer player A the minimum amount necessary to avoid a dispute, and that a self-interested player A will never accept an offer that is less than what she receives in the event of a dispute. As player B knows A's type when he makes his offer, he makes an offer conditional on A's type. In experiment 2, the strictly rational, risk neutral model makes five very sharp predictions:[20]

(i) B's offer O_B to type A_L is the strictly "rational" offer $O_B^{R\text{-}L} = \$2.00 - F_A$.

(ii) B's offer O_B to type A_H is the strictly "rational" offer $O_B^{R\text{-}H} = \$4.00 - F_A$.

(iii) Type A_L rejects any $O_B < \$2.00 - F_A$ and accept any $O_B \geq \$2.00 - F_A$.

(iv) Type A_L rejects any $O_B < \$4.00 - F_A$ and accept any $O_B \geq \$4.00 - F_A$.

(v) Dispute rates are 0% both when A is type A_L and when she is type A_H, as B is predicted to offer both types their respective minimum acceptable amount.

Empirically, excess disputes are fairly common in an experimental setting such as this.[21] These excess disputes may occur because players cannot agree on what constitutes a fair offer; so observed deviations from the strictly rational predictions may be due to considerations of fairness. Here, two possibilities are considered that are analogous to

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[20] As in chapter 2, for ease of exposition the theoretical predictions fully reflect A's dispute cost and do not include the extra $0.01 to ensure settlement.

[21] See Pecorino and Van Boening (2001).

those considered in experiment 1. As with the strictly rational offer, it is predicted that B's offers will vary with A's type because A's type is common knowledge.

TABLE 3.2. THEORETICAL PREDICTIONS FOR EXPERIMENT 2

	Model, category	Formula	Value
I.	Strictly rationality, risk neutral model		
	B's Offer to A_L	$O_B^{R\text{-}L} = 200 - F_A$	125
	B's Offer to A_H	$O_B^{R\text{-}H} = 400 - F_A$	325
	A_L accepts	$O_B \geq 200 - F_A$	125
	A_H accepts	$O_B \geq 400 - F_A$.	325
II.	Equal split of 150 surplus		
	B's Offer to A_L	$O_B^{F\text{-}L} = O_B^{R\text{-}L} + ½(F_A + F_B)$	200
	B's Offer to A_H	$O_B^{F\text{-}H} = O_B^{R\text{-}H} + ½(F_A + F_B)$	400
	A_L accepts	$O_B \geq 200 - ½(F_A - F_B)$	200
	A_H accepts	$O_B \geq 400 - ½(F_A - F_B)$	400
III.	Each player saves (or retains) own dispute cost		
	B's Offer to A_L	$O_B^{S\text{-}L} = O_B^{R\text{-}L} + F_A$	200
	B's Offer to A_H	$O_B^{S\text{-}H} = O_B^{R\text{-}H} + F_A$	400
	A_L accepts	$O_B \geq 200$	200
	A_H accepts	$O_B \geq 400$	400

The first possibility is that the joint \$1.50 surplus from settlement is split equally; this outcome is closest in spirit to the results that are often observed in the standard the ultimatum game. If player B conforms to this view, his offer equals player A's dispute payoff plus half of the joint surplus from settlement. This "fair" offer is $O_B^{F\text{-}L} = O_B^{R\text{-}L}$ +

$\frac{1}{2}(F_A + F_B)$ = \$2.00 to type A_L and $O_B^{F\text{-}H} = O_B^{R\text{-}H} + \frac{1}{2}(F_A + F_B)$ = \$4.00 to type A_H. Similarly, if player A conforms to this equal-split view, she will accept nothing less than her dispute payoff plus half of the joint surplus. For type A_L, this can be expressed as \$2.00 – $F_A + \frac{1}{2}(F_A + F_B)$ = \$2.00 – $\frac{1}{2}(F_A - F_B)$ = \$2.00, and for type A_H as \$4.00 – $\frac{1}{2}(F_A - F_B)$ = \$4.00.

A second possibility is that a fair offer allows players to retain or save their respective dispute cost. Under this scenario, player B offer equals A's dispute payoff plus her dispute cost F_A. This "save" offer is $O_B^{S\text{-}L} = O_B^{S\text{-}L} + F_A$ = \$2.00 to type A_L and $O_B^{F\text{-}H} = O_B^{R\text{-}H} + F_A$ = \$4.00 to type A_H. Note that because of the identical dispute costs $F_A = F_B$, the two views of fairness have the same predictions.

D. Results

D.1. Dispute rates

The experiment 2 dispute rates are analyzed by following dummy variable (or fixed effects) model:

$$\text{Dispute Rate} = \beta_0 + \beta_1\text{H} + \beta_2\text{Round S12} + \beta_3\text{S10} + \beta_4\text{S11} + \beta_5 + \epsilon$$

Dispute rate calculated as two observations (one for each player A type) per round per session, resulting in 2 type x 13 rounds x 4 sessions = 104 observations. In Table 3.3 below, the number of observations is shown as n = 103 because the die rolls in round 4 of session S12 resulted in no type A_L players.

The intercept β_0 represents the regression baseline where player A is type A_L. The first independent variable is a dummy variable for type A_H, the second variable tests for trend effects across rounds, and the last three variables are dummy variables for the different sessions:

H	= 1 if player B's offer is to an A_H player
	= 0 otherwise
Round	= round number 2 thru 13
S10	= 1 if the observation is from session S10
	= 0 otherwise
S11	= 1 if the observation is from session S11
	= 0 otherwise
S12	= 1 if the observation is from session S12
	= 0 otherwise

Table 3.3 shows the results. Recall that the strictly rational model predicts a 0% dispute rate for both A_L players for A_H players. The β_0 estimate indicates that for type A_L players bargaining disputes occur 13.7% of the time on average, and the null hypothesis H_0: $\beta_0 = 0$ is marginally rejected ($p = .0517$). Recall that in the experiment 1 baseline, the bargaining disputes occurred 11% of the time on average. The dispute rate for A_H players averages 0.137 + 0.026 = 16.3% (found by summing estimated β_0 and β_1), and the null hypothesis that H_0: $\beta_0 + \beta_1 = 0$ is rejected. Although the estimated $\beta_1 = 0.026$ suggests that the average dispute rate for A_H is about 3% higher than the average rate for A_L, the hypothesis test H_0: $\beta_1 = 0$ is not rejected. Thus the average dispute rates are similar across player A types. Although both dispute rates are higher than the 0% rate predicted by the strictly rational theory, the excess disputes are in the 10-15% range observed in other experimental bargaining games.

In terms of the first objective of experiment 2, it appears that players A and B agree (or at least do not disagree) on how a fair offer should change with A's type, as the dispute rates are roughly the same regardless if player A is type A_L or A_H. Note that this is somewhat different from the result in experiment 1 with equal dispute costs. There, deviations from the strictly rational dispute rate were concentrated in the type A_L players.

There is no evidence of a round (or trend) effect, as H_0: $\beta_2 = 0$ is not rejected. There is evidence of session effects, as the joint hypothesis H_0: $\beta_3 = \beta_4 = \beta_5 = 0$ is easily rejected. Whatever the origin of this effect, it is roughly constant across sessions, as H_0: $\beta_3 = \beta_4 = \beta_5$ is not rejected. This session effect is analyzed further below.

TABLE 3.3. DISPUTE RATE REGRESSION FOR EXPERIMENT 2

Model: Dispute Rate = $\beta_0 + \beta_1$H + β_2Round + β_3S10 + β_4S11 + β_5S12 + ϵ

Estimated coefficients (standard error)						Summary stats	
β_0	β_1	β_2	β_3	β_4	β_5	R^2	F
0.137 (0.069)	0.026 (0.048)	−0.007 (0.006)	0.146 (0.067)	0.173 (0.067)	0.222 (0.068)	.122 n = 103	2.70 p = .0251

Hypothesis tests

	Point Predictions			Round Effects	Session Effects	
H_0:	A_L $\beta_0 = 0$	A_H $\beta_0 + \beta_1 = 0$	A_H $\beta_1 = 0$	$\beta_2 = 0$	$\beta_3 = \beta_4 = \beta_5 = 0$	$\beta_3 = \beta_4 = \beta_5$
F (p-value)	3.88 (.0517)	5.51 (.0209)	0.29 (.5920)	1.24 (.2677)	3.99 (.0100)	0.63 (.5332)

D.2. <u>*Player B offers*</u>

One of the primary objectives in experiment 2 is how player B's proposed division of the surplus varies with different distributions. Overall, 329 / 351 = 94% of player B's offers are consistent with the prediction of at least one of the models shown in Table 3.2. That is, 6% of the offers are inconsistent with all three models: 5% of the offers are unacceptable to any player A, and 1% are offers to an A_L player that exceed the minimum required of an A_H player.[22]

In analyzing the role (if any) of fairness in this stylized bargaining framework, the analysis here focuses on the 94% of the offers that are not inconsistent with the strictly rational model. Player B's offers O_B are analyzed with a dummy variable (fixed effects) regression:

$$O_B = \beta_0 + \beta_1\text{H} + \beta_2\text{Round} + \beta_3\text{S10} + \beta_4\text{S11} + \beta_5\ \text{S12} + \epsilon$$

The intercept β_0 represents the regression baseline where player A is type A_L. The first independent variable is a dummy variable for type A_H, the second variable tests for trend effects across rounds, and the last three variables are dummy variables for the different sessions:

H	= 1 if player B's offer is to an A_H player
	= 0 otherwise
Round	= round number 2 thru 13
S10	= 1 if the observation is from session S10
	= 0 otherwise
S11	= 1 if the observation is from session S11
	= 0 otherwise
S12	= 1 if the observation is from session S12
	= 0 otherwise

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22 For a given distribution of costs, 10 of the 170 offers to A_L players are less than 200 – F_A, which is the lowest the three "A_L accepts" values shown in Table 3.2, 1 of the 170 offers to A_L players exceeds the highest of the three "A_H accepts" values in Table 3.2, and 11 of the 181 offers to A_H players are less than 400 – F_A, which is the lowest of the three "A_H accepts" values shown in Table 3.2. Analysis of the data does not reveal any systematic deviations due to specific subjects, round number, session, etc.

Table 3.4 shows the results of the estimation. The point estimate on β_0 indicates the average offer to a type A_L player is about 144, which is 19 above the strictly rational point prediction of 125 and 56 below the fair prediction of 200. Although both of the hypotheses H_0: $\beta_0 = 125$ and H_0: $\beta_0 = 200$ are rejected, the estimate on β_0 is much closer to the strictly rational prediction than to the fair prediction. The average offer to a type A_H player about 343 (given by the sum of β_0 and β_1 point estimates), which is 18 above the strictly rational prediction of 325 and 57 below the fairness prediction of 400. Again, although both of the respective hypotheses are rejected (H_0: $\beta_0 + \beta_1 = 325$, H_0: $\beta_0 + \beta_1 = 400$), the point estimate is closer to the strictly rational prediction than to the fair prediction. These results are analogous to those observed in experiment 1: player *B* appears to be both rational and fair, but more rational than fair.

The comparative static prediction is the same in all three models: *B*'s offer to A_H will be 200 above his offer to A_L. The data do not contradict this prediction, as the point estimate on β_1 is about 196, and the hypothesis H_0: $\beta_1 = 200$ is not rejected. Thus, while none of the three models hits its point predictions in the offers, all three predict the difference between *B*'s offers to A_L and his offers to A_H quite well.

As in chapter 2, it is instructive to consider more generic versions of the fairness models. First, consider an "α-split" version of the equal-split model where player *B* offers α% of the joint surplus from settlement to player *A*, e.g., $\alpha = 0.5$ yields the equal-split model shown in Table 3.2. If $\alpha = 0.13$, then the point prediction for β_0 is 144.5, which essentially equals the estimate of 144.2 in Table 3.4, and the point prediction for $\beta_0 + \beta_1 = 344.5$, which is quite close to the 343.4 estimate in Table 3.4 (from summing estimated β_0 and β_1). This "13/87 split" is a combination of the strictly rational and equal-split models: player B is arguably being "fair" by offering player A 13% of the joint surplus, but he is acting in his self-interest by proposing to keep 87% for himself. Recall that in experiment 1, this equal-split α was estimated at 0.30, or B offered A 30% of the joint surplus. So in experiment 2, player B offers substantially less.

TABLE 3.4. PLAYER B OFFER REGRESSION FOR EXPERIMENT 2

Model: $O_B = \beta_0 + \beta_1 H + \beta_2 Round + \beta_3 S10 + \beta_4 S11 + \beta_5 S12 + \epsilon$

Estimated coefficient (standard error)						Summary statistics	
β_0	β_1	β_2	β_3	β_4	β_5	R^2	F
144.2	199.2	−0.2	4.3	7.7	2.2	.950	1219.5
(3.7)	(2.6)	(0.4)	(3.6)	(3.7)	(3.5)	n = 329	$p < .0001$

Hypothesis tests

Point predictions	Strictly Rational Model		Equal-Split Model and Save-Own-Cost Model	
	A_L	A_H	A_L	A_H
H_0:	$\beta_0 = 125$	$\beta_0 + \beta_1 = 325$	$\beta_0 = 200$	$\beta_0 + \beta_1 = 400$
F	26.59	25.24	226.12	241.18
(p-value)	(.0001)	(.0001)	(.0001)	(.0001)

Comparative static	Strictly Rational Model, Equal-Split Model and Save-Own-Cost Model
H_0:	$\beta_1 = 200$
F	0.10
(p-value)	(.7511)

Experimental design	Round Effects	Session Effects
H_0:	$\beta_2 = 0$	$\beta_3 = \beta_4 = \beta_5 = 0$
F	0.37	1.60
(p-value)	(.5441)	(.1902)

Alternatively, consider an "α-cost" version of the save-own-cost model where player B offers player A α% of F_A, e.g., $\alpha = 1.0$ yields the save-own-cost model shown in Table 3.2. If $\alpha = 0.25$, then the point predictions are 143.8 for β_0 and 343.8 for $\beta_0 + \beta_1$. These are essentially the estimates of 144.2 and 343.4, respectively, from Table 3.4. So player B is again being both fair and rational: he's offering A 25% of her dispute cost, but proposing to keep the remaining 75% for himself. Recall that in experiment 1, this save-own-cost α was estimated at 0.60, or B offered A 25% of her cost. Under either scenario, the estimates suggest (a) that player B is both fair and rational, but more rational than fair and (b) player B is substantially less fair in experiment 2 than in experiment 1. Also note that under both "α models" of fairness, player B's inferred α does not vary with player A's type.

There do not appear to be any significant experimental design effects. There is no evidence of round (or trend) effects, as the null hypothesis H_0: $\beta_2 = 0$ is not rejected. Nor do there appear to be any session-specific effects: although there is some variation across the estimated β_3, β_4 and β_5 coefficients, the hypothesis H_0: $\beta_3 = \beta_4 = \beta_5 = 0$ is not rejected.

The regression and hypothesis tests in Table 3.4 do completely rule out either the strictly rational model or the fairness models (recall that both equal-split and save-own-cost models of fairness have the same predictions in experiment 2). Table 3.5 categorizes player B's offers according to whether they are consistent with rationality or fairness, only rationality or only fairness, or both. Approximately 90% of the offers are consistent with the strictly rational model only, i.e., are inconsistent with the fairness models. Collectively, Tables 3.4 and 3.5 indicate that the strictly rational model is the one that is most strongly supported by the data.

TABLE 3.5. SUMMARY OF PLAYER *B*'S OFFERS RELATIVE TO THE STRICTLY RATIONAL AND FAIRNESS PREDICTIONS IN EXPERIMENT 2

Category	Offers to A_L	Offers to A_H	Row Total
Inconsistent with both the strictly rational and the fairness models: $O_B < O_B^R$ or $O_B > O_B^F + 200$	11 (6.5%)	11 (6.1%)	22 (6.3%)
Consistent with the strictly rational model only: $O_B^R \leq O_B < O_B^F$	154 (90.6%)	162 (89.5%)	316 (90.0%)
Consistent with both the strictly rational and the fairness models: $O_B^F \leq O_B < O_B^R + 200$	4 (2.4%)	8 (4.4%)	12 (3.4%)
Consistent with the fairness models only: $O_B^R + 200 \leq O_B \leq O_B^F + 200$	1 (0.6%)	0 (0.0%)	1 (0.3%)
Column Total	170 (100%)	181 (100%)	351 (100%)

D.3. *Player A decisions*

Table 3.6 summarizes player *A*'s accept/reject responses to player *B* offers, relative to the predictions of the three models shown in Table 3.2.[23] Clearly the player *A* behavior is most consistent with the strictly rational model. Out of the 351 decisions, 81.5% are consistent with the rational model, compared with 27.4% under the equal-split and save-own-cost fairness models (see "Totals" rows in Table 3.6). Under both the rational and fairness models, the observed inconsistencies are roughly equal across player *A* types.

[23] Analysis of the data at the session or subject level does not reveal any session-specific or subject-specific behavior, so aggregate data are shown in Table 3.6.

TABLE 3.6. SUMMARY OF PLAYER *A*'S DECISIONS BY PLAYER *A* TYPE FOR EXPERIMENT 2

	Model says reject		Model says accept		Consistent with model	
	A rejects	*A* accepts	*A* rejects	*A* accepts	Fraction	Percent
Strictly rational model						
Type A_L	10	0	27	133	143/ 170	84.1%
Type A_H	9	2	36	134	143 / 181	79.0%
Totals	19	2	63	267	286 / 351	81.5%
Equal-split and save-own-cost models						
Type A_L	37	127	0	6	43 / 170	25.3%
Type A_H	45	128	0	8	53 / 181	29.3%
Totals	82	255	0	14	96 / 351	27.4%

Table 3.6 also shows that under the strictly rational model, there are 65 instances where player *A*'s decision is inconsistent with that model's prediction, and 63 of those are cases where *A* rejects an offer that the model says she should accept. Recall that in experiment 1, this same phenomenon was observed, but it was restricted primarily to A_L players. In experiment 2, it is observed for both player *A* types; further discussion is provided in section E below. Notice in Table 3.6 that under the equal-split and save-own-cost models, the preponderance of inconsistencies is cases where player *A* accepts offers that the fairness models say she should reject.

Table 3.7 provides further analysis of the 63 offers that the strictly rational model predicts player *A* will accept, but she in fact rejects. The right-hand side dummy variables are identical to those used in Table 3.4 above. This analysis reveals that the offers rejected by player A_L are on average 125.2, which very close to the strictly rational prediction of 125 (and H_0: $\beta_0 = 125$ is not rejected), and that offers rejected by player A_H

are on average 324.1 (found by summing estimated β_0 and β_1), which is very close to the strictly rational prediction of 325 (and H_0: $\beta_0 + \beta_1 = 325$ is not rejected). Additionally, comparative static prediction H_0: $\beta_1 = 200$ is not rejected. There is marginal evidence of experimental design effects, as those hypothesis tests have *p*-values less than 0.10.

TABLE 3.7. PLAYER *A* REGRESSION FOR "VIOLATIONS" OF THE STRICTLY RATIONAL MODEL IN EXPERIMENT 2

Model: $O_B = \beta_0 + \beta_1 H + \beta_2 Round + \beta_3 S10 + \beta_4 S11 + \beta_5 S12 + \epsilon$

Estimated coefficient (standard error)						Summary statistics	
β_0	β_1	B_2	β_3	β_4	β_5	R^2	F
125.2	198.9	0.6	6.7	9.8	4.2	.992	1495.2
(3.8)	(2.4)	(0.3)	(4.1)	(4.0)	(3.8)	n = 63	$p < .0001$

Hypothesis tests

Point predictions	Strictly Rational Model		Equal-Split Model and Save-Own-Cost Model	
	A_L	A_H	A_L	A_H
H_0:	$\beta_0 = 125$	$\beta_0 + \beta_1 = 325$	$\beta_0 = 200$	$\beta_0 + \beta_1 = 400$
F	0.00	0.05	384.82	345.10
(*p*-value)	(.9504)	(.8261)	(.0001)	(.0001)

Comparative static	Strictly Rational Model, Equal-Split Model and Save-Own-Cost Model
H_0:	$\beta_1 = 200$
F	0.22
(*p*-value)	(.6392)

Experimental design	Round Effects	Session Effects
H_0:	$\beta_2 = 0$	$\beta_3 = \beta_4 = \beta_5 = 0$
F	3.02	2.39
(*p*-value)	(.0874)	(.0779)

Analysis of the β_0 and $\beta_0 + \beta_1$ point estimates reveal that on average, the typical rejected offer would leaves player A essentially none of the joint surplus from settlement. This suggests that player B can push player A essentially to the theoretical minimum offer before rejection becomes a significant concern. This in contrast to experiment 1, where player B could not, on average, extract all of A's dispute cost from her, as the strictly rational model predicts. In experiment 2, roughly 20% of player A's decisions are inconsistent with the strictly rational model (see Table 3.6), but this is apparently due to player A rejecting offers that are barely above the theoretically acceptable minimum.

E. Summary

Experiment 2 examines the bounds of the experiment 1 baseline results by replicating that bargaining game but without asymmetric information. The strictly rational model and fairness models make very sharp predictions about the offer from player B to player A_L, and from player B to player A_H. These offers should fully reflect player A's dispute costs, regardless of her type. In experiment 2, the observed dispute rate rose to about 14%, relative to the 11% observed in experiment 1.

The results above suggest that the rational theory has fairly good predictive power in the stylized setting of experiment 2, more so than in experiment 1. This suggests that some of the anomalies observed in player B's offers in experiment 1 are do to his confusion about a sorting strategy. In experiment 2, player B knows player A's type, as so he does not have to identify a sorting strategy. The consequence is offers much closer to the strictly rational prediction. As in experiment 1, player B offers are consistent with "α-models" of fairness, where player B is both rational (i.e., self-interested) and fair, but more rational than fair. In experiment 2 player *B*'s estimated α is substantially more in the direction of rationality (at the expense of fairness) than in experiment 1. In addition, player *A* rejects about 20% of offers that the strictly rational theory predicts she should accept, but typically those offers are only a few pennies above the theoretically acceptable minimum. This explains (in part) the sustained dispute rate of 13% when the theory predicts it should be 0%. At the same time, the player *A* decisions are much less consistent with either the equal-split or save-own-cost models of fairness. Overall, the data provide strong support for the strictly rational model over the fairness models.

Chapter 4. Conclusion

A. Project summary

Bilateral bargaining is used extensively by the armed forces for labor allocation. An important example is the assignment of Navy billets. The vast majority of personnel assignments are negotiated by the detailers and individual Sailors, based on the Navy's needs and the Sailor's preferences. In its current form, "enlisted detailing" is often time-consuming and inefficient, i.e., while this process favors the Navy, it contributes to reduced retention rates and vacant billets, particularly in less desirable jobs. The inefficiencies are in part due to informational asymmetries: only the sailor knows his or her ability and preferences regarding various aspects of a specific job, and only the detailer knows what jobs are available and with what priority they are to be filled.

A significant body of economic research addresses bilateral bargaining and the origins and consequences of bargaining failure. Bargaining failure is troubling (and interesting) to economists, because it implies that mutually beneficial gains are lost or left unrealized. Thus it is important to identify those negotiation mechanisms that exploit these otherwise lost opportunities, and that yield efficient allocation of resources. Key issues include how the two parties to an agreement split the joint surplus from the agreement and an understanding of why bargaining failure occurs.

This report focuses on the way in which fairness affects bargaining outcomes and the incidence of disputes in a stylized bargaining experiment. The setting involves a take-it-or-leave-it bargaining structure with an embedded ultimatum game. But in contrast to the usual ultimatum game, the entire "pie" does not disappear when there is a dispute. Two key but unresolved issues from the bargaining literature are addressed here. First, when two bargaining parties reach an agreement, how do they split the joint surplus from the mutually beneficial agreement? Second, when two parties do not reach an agreement, what factors contribute to the bargaining failure? The project consists of two experiments, both of which can be interpreted as a stylized labor market setting or employment allocation problem.

The two experiments involve a player *A* and a player *B*. Player *A* is one of two types, one with a low payoff in the event of a dispute, and one with a high payoff in the event of a dispute. Player *B* makes an offer to player *A* without knowing *A*'s type. Player *A* then either accepts or rejects the offer. If *A* accepts *B*'s offer, then there is a transfer from *B* to *A* equal to the amount of the offer. If *A* rejects *B*'s offer, then the transfer is contingent on *A*'s type, and additionally, both players incur a dispute cost. The sum of the dispute costs can be considered lost surplus or lost gains from exchange due to bargaining failure. In a Navy context, player *A* represents the sailor and player *B* represents the detailer. The lost surplus can be thought of as an unfilled billet: the sailor does not get paid and the Navy has an unassigned billet.

In experiment 1, distribution of the costs of a dispute is systematically varied. Predictions of bargaining theory can be tested, both under the assumption of strict rationality and under the assumption of fairness. One of these predictions is that the probability of a dispute is a function of the sum of dispute costs, but not a function of the distribution of these costs. The experiment 1 data fail to reject the hypothesis that there are no treatment effects on the dispute rate, so the evidence supports this prediction of the fully rational model.

The strictly rational model and fairness models also make very sharp predictions about the offer from player *B* to player *A*. Collectively, the data suggest that the rational theory has the best predictive power of the three models considered in experiment 1. However, the rational theory does not fully explain results. Player *B* offers are consistent with an "α-model" version of the equal-split model where player *B* is both rational (i.e., self-interested) and fair, but more rational than fair. In addition, player *A* rejects about 17% of offers that the strictly rational theory predicts she should accept; this is almost exclusively due to A_L players. This explains (in part) the sustained dispute rate of 11% for A_L players when theory predicts it should be 0%. At the same time, the player *A* decisions (particularly those of type A_L) are much less consistent with either the equal-split or save-own-cost models of fairness. The typical rejected offer would leave A_L with about 10% of the joint surplus from settlement. This suggests that fairness plays a role in the experiment 1 bargaining outcomes, but a much smaller role than in a standard ultimatum game. This is significant, as the bargaining framework in experiment 1 contains an embedded ultimatum game. Embedding the ultimatum game in a larger bargaining game seems to move the outcome closer to the predictions of the rational theory.

Experiment 2 examines the bounds of the experiment 1 baseline results by replicating that bargaining game without the asymmetric informational asymmetry. That is, player *B* knows player *A*'s type before he makes his offer to *A*. The observed dispute rate in experiment 2 is about 14%, as compared to the 11% rate observed in experiment 1. Analysis of player *B* offers and player *A* decisions reveal that the rational model has even better predictive power in the experiment 2 than it has in experiment 1. In experiment 2, player *B* knows player *A*'s type, so he does not have to identify a sorting strategy. The consequence is offers much closer to the strictly rational prediction. This suggests that some of the anomalies observed in player *B*'s offers in experiment 1 are do to his confusion about a sorting strategy. As in experiment 1, player *B* offers in experiment 2 are consistent with "α-models" of fairness, where player *B* is both rational (i.e., self-interested) and fair, but more rational than fair. In experiment 2 player *B*'s estimated α is substantially more in the direction of rationality (at the expense of fairness) than in experiment 1.. In addition, player *A* rejects about 20% of offers that the strictly rational theory predicts she should accept, but typically those offers are only a few pennies above the theoretically acceptable minimum. This explains (in part) the sustained dispute rate of 13% when the theory predicts it should be 0%. At the same time, the player *A* decisions are much less consistent with either the equal-split or save-own-cost models of fairness. Overall, the data provide strong support for the strictly rational model over the fairness models.

B. Implications

Filling billets at the lowest cost (subject to quality requirements) is in the best interest of the Navy. Within the context of the bargaining models analyzed here, the detailer should be able to extract much, but not all, of the available joint surplus from the sailor. Extracting all possible surplus would be analogous to the strictly rational model described in this report. Both experiment 1 and experiment 2 suggest that the detailer might expect fairness considerations to play a relatively small role. This is especially true when the detailer has very reliable information on the sailor's type (e.g., relatively many or few opportunities outside of the Navy), as illustrated by the results from experiment 2. But when negotiating, detailers should not ignore issues of fairness: in both experiments 1 and 2, player A (especially type A_L) often rejects offers that the rational theory says she should accept. Thus if the detailer is determined to extract all or nearly all of the joint gains from agreement, he runs a significant risk of incurring bargaining failure.

The practical implication of this stylized study for the assignment of Navy billets is that while detailers might expect fairness to play a small role when negotiating with sailors, ignoring fairness significantly increases the risk of bargaining failure. In a Naval context, the subsequent misallocation of resources is unfilled billets and low retention rates. While the stylized bargaining setting in this report is much less complex than the naturally occurring bargaining that occurs in Navy detailing, it does provide some insight into how fairness considerations affect bilateral negotiations. Future research includes less stylized environments that are closer to actual Navy detailing, but still experimentally controlled so as to allow systematic study. Additionally, experimental subjects could include real-life sailors and detailers. Collectively, this and other research can useful by helping to yield billet assignments that are in the interest of the individual sailor and the U.S. Navy.

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