CHIVALRY AND SOLIDARITY IN ULTIMATUM GAMES

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We report the results of ultimatum game experiments designed to test for differences in the behavior of women and men. Women's proposals are on average more generous than men's, regardless of the sex of the partner, and women respondents are more likely to accept an offer of a given amount. A given offer is more likely to be accepted if it comes from a woman; we term this result chivalry. *Women paired with women almost never fail to reach an agreement; we term this result* solidarity. *Age, earnings, and race also significantly affect proposals and the rates of rejection.* (*JEL* C78, C92, J16)

> Economics has done very badly [explaining] large differences among ethnic groups. This is important . . . also for gender differences. Some of this can be due to individual differences, but some of it clearly must be social.
>
> —Ken Arrow[1]

I. INTRODUCTION

A question that has occupied social psychologists for many years, and one that economists recently have come to address, is whether the decision-making calculus of individuals differs according to their sex. Evidence from social psychology suggests that, whether by nature or nurture, women behave differently from men in many arenas.[2] While economists naturally tend to focus their attention on economic parameters, economic models of behavior potentially could be expanded to incorporate systematic effects of such characteristics as sex or race. If these characteristics are associated (on average) with differences in the decision-making calculus of individuals, then simpler models that abstract from them will describe and predict less accurately.

We consider differences between women and men in bargaining behavior and address two questions: (1) Does the strategy adopted or the offer made or accepted differ systematically by the sex of the decision-maker? (2) Does the sex of the opponent influence a player's strategy choice? In a study of race and gender discrimination in bargaining for a new car, Ayres and Siegelman (1995) address the first question and find significantly different negotiated prices, depending on the gender of the bargainers. They note, "Dealers quoted significantly lower prices to white males than to black or female test buyers using scripted bargaining strategies" (304). Although they find no significant gender-pair effects, in an earlier study Ayres (1991)

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1. Interview with Kenneth J. Arrow, in Swedberg (1990, 147).

2. See, for example, Gill (1986); Moely et al. (1979); Uesugi and Vinacke (1963); and Vinacke (1959).

ABBREVIATIONS

ES: Epps-Singleton
VPI: Virginia Polytechnic Institute and State University
WSU: Wayne State University

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reports that women receive worse deals from women sellers.

Our laboratory study differs from field studies of bargaining behavior in three significant ways. First, the bargaining environment is much simpler: The available bargaining strategies are limited, and the heterogeneity of the bargainers is reduced. This enables us to more clearly observe the strategies chosen by each pair. Second, we can test directly for the effect of gender pairing; a given subject faces all decision environments. Finally, we observe rejection behavior by the bargainers. This allows us to distinguish between payoff-maximizing differences in offers that anticipate rejection rates and costly discrimination.

We study the simplest of bargaining games, the ultimatum game, in which two players split a fixed amount of money according to specific rules[3]. The advantage of the ultimatum game over other simple decision environments, such as a prisoners' dilemma or a public good game, is that the ultimatum game allows us to study gender differences from two perspectives. First, the proposer stage of the game is a strategic environment; subjects' payoffs are interdependent, and an unequal proposal carries the risk of rejection. Second, the second (accept-or-reject) stage of the game is a nonstrategic, riskless environment. Our results indicate differences in the behavior of men and women, but the differences are subtle and complex. Our research also provides some preliminary evidence on the effect of other cultural correlates.

II. BACKGROUND

The conclusion of much psychological research on sex differences is that men tend to be more competitive while women are more cooperative.[4] Gilligan (1982) suggests that women differ considerably from men in moral decision making. Women tend to stress the interests of the group and the avoidance of harm to others—"a morality of responsibility"—and men stress individual rights and justice—"a morality of rights" (22). Economists' interest is in whether this difference holds up in economic decision making, when money is at stake.

Attempts to test this competitive/cooperative hypothesis using social dilemma experiments (e.g., prisoners' dilemma and public goods games) have generated mixed results. In a social dilemma, cooperation means choosing a strategy that contributes to group earnings at the expense of individual earnings; competition is individual earnings maximization. Some studies find greater cooperation by women, as in Aranoff and Tedeschi (1968), Meux (1973), and Ortmann and Tichy (1999). Others find men more cooperative, as in Rapoport and Chammah (1965), Kahn et al. (1971), and Mack et al. (1971). Still others find inconsistent or insignificant differences between the sexes, as in Dawes et al. (1977), Stockard et al. (1988), and Orbell et al. (1994). Among economics experiments, Mason et al. (1991) find no sex difference in a duopoly game. In public goods experiments, Brown-Kruse and Hummels (1993) find men to be more cooperative than women, while Nowell and Tinkler (1994), Seguino et al. (1996), and Cadsby and Maynes (1998) report evidence that women may be more cooperative. Bolton and Katok (1995) find no significant differences between the play of men and women in dictator games; in somewhat different dictator game environments, Selten and Ockenfels (1998) and Eckel and Grossman (1996, 1998) find women to be significantly less selfish than men. In a series of dictator games with different prices of giving, Andreoni and Vesterlund (2001) find that giving by men is more price-elastic. While women are more

3. In the ultimatum game, two players must divide a fixed amount, say $10. The proposer must propose a split, which the respondent then chooses to accept or reject. If accepted, the money is divided as planned; if rejected, both players get $0. There are two subgame perfect equilibria of this game, an offer of $0 or an offer of $ϵ, where $ϵ is the smallest positive nonzero offer possible, to the respondent, with the proposer claiming the remainder. For purposes of discussion, we will assume $ϵ is the only equilibrium.

4. For example, studies of sex-role stereotypes report important differences in the traits valued in men and women. See, for example, Spence et al. (1975). Traits valued in men included competitiveness, aggressiveness, independence, dominance, and objectivity, whereas traits valued in women were an awareness of the feelings of others, a strong need for security, helpfulness to others, and a desire to devote themselves to others. This reflects social stereotypes and may be reflected in people's expectations of behavior. Vinacke (1959, 357) concluded: "A reasonable interpretation of the over-all picture is that females are less concerned with winning, as such, and more concerned with arriving at a fair and friendly solution to the problem. The task for them appears to be to determine a way in which no one suffers at the expense of anyone else."

generous at a 1/1 trade-off, men are more generous when the price of giving to the other person is lower. In a study similar to our own, Solnick (2001) tests for sex differences in an ultimatum game. We return to a discussion of her article, and a comparison with our results in the concluding section. Eckel and Grossman (2001) provide a survey of ultimatum, dictator, and public goods games.

There are several possible reasons for the inconsistencies in the results:

- Women may exhibit greater risk-aversion. Studies by Powell and Ansic (1997), Schubert et al. (1999), and Eckel and Grossman (2000), among others, find evidence that women are more risk averse in financial decision making in experimental settings; Jianakoplos and Bornase (1998) present similar findings for investment decisions. In social dilemma or public goods settings, cooperation is a risky strategy, and this may confound differences in cooperation. For example, Brown-Kruse and Hummels (1993) restrict their subjects to contributing all or none of their endowment to a "group account," while Nowell and Tinkler (1994) and Seguino et al. (1996) permit fractional contributions; this restriction makes the former environment more risky and could explain the differences in their results.[5]
- Women may be more sensitive to the possibility of exploitation. Ingram and Berger (1977) report that women, in experiment debriefings, indicate that they chose the competitive strategy for fear of falling into the "sucker" role by choosing cooperation when their opponent defects (504).
- Differences in the experimental design may trigger different psychological mechanisms in subjects. For example, in a meta-analysis of helping behavior, Eagly and Crowley (1986) suggest that men can exhibit either chivalrous or victimizing behavior toward "weaker" partners, depending on the context.
- Gender pairing may also affect the outcome. A number of studies report that women and, less frequently, men play differently depending on the sex of their partners, including Deaux (1976), Mack et al. (1971), Moely et al. (1979), and Nowell and Tinkler (1993). Research in evolutionary psychology also predicts that sex pairing will be an important factor, with each sex exhibiting a preference for the other, as explained in Buss (1999).

Theory does not predict unequivocally what strategy each sex will adopt.[6] Will women play a cooperative strategy as is their "true" nature, or will they play a defensive competitive strategy to avoid the risk of falling into the "sucker" role? Will men play a competitive strategy and "victimize" their female partners, or will they be "chivalrous" and play a cooperative strategy? Will strategies vary according to the gender pairing?

III. HYPOTHESES

In light of the inconsistencies in the results from social dilemma games, we have selected the ultimatum bargaining game to study gender differences.[7] The respondent's decision about whether to accept or reject the proposed split is straightforward and uncomplicated by competing strategies or risk. The respondent may cooperate by accepting the proposed split; if the respondent does not want to cooperate, the proposed split is rejected. The respondent's willingness to cooperate is positively affected by the offer he receives.

In the proposer's decision about what split of the pie to offer the respondent, she faces competing competitive and cooperative strategies in a risky environment. In this context we define a purely cooperative strategy

5. There is considerable evidence in the social psychology literature that women are more risk averse than men. See, for example, Rapoport and Chammah (1965); Ebbesen and Haney (1973); Hudgens and Fatkin (1985); and Ward et al. (1988).

6. Because of these conflicting strategic objectives, Deaux (1976, 97–98) suggests that the prisoners' dilemma (or, more generally, the social dilemma) game is "not the ideal paradigm for observing cooperative and competitive behavior." Although a player has only two choices, "each choice can satisfy a number of possible motives on the part of the player."

7. See Binmore (1992) for a complete discussion of this game. The main result of experimental tests of ultimatum games is that offers persist above the equilibrium; offers that are positive but perceived as "unfair" are rejected. Kahneman et al. (1986) show that this is not due to a misunderstanding of the game. Thaler (1988) and Guth and Tietz (1990) survey the early research in this area and note evidence that considerations of fairness play a major part in the outcomes of these experiments. A more recent survey by Roth (1995) stresses the importance of the strategic environment in determining the role of fairness in the outcome of bargaining games. Finally, Camerer and Thaler (1995) survey some recent ultimatum game experiments.

as an offer to the respondent of 50% of the pie. At the other extreme, a purely competitive strategy calls for an offer of ϵ. Of course, ϵ may not be the payoff-maximizing strategy if respondents reject positive but unequal offers. Given a pattern of rejections, a rational, competitive proposer may adopt a strategy that appears to incorporate some degree of cooperation. Thus, the decision of a proposer is determined by: (1) the proposer's decision to play a competitive versus a cooperative strategy; and (2) the proposer's assessment of the respondent's "rationality" (i.e., the extent to which a respondent cares only for her own payoff).

The ultimatum game is not without its shortcomings as a decision environment; one is that it does not allow us to discriminate among all of the theories proposed by psychologists. As theory does not suggest a clear, dominant hypothesis, we present some competing possibilities, which are summarized below.

Hypotheses for Respondents

1. *Competitive Versus Cooperative.* Women, being more cooperative, are more accepting of (unequal) offers than men. The alternative hypothesis is that women, fearing the sucker role, are more likely to reject an unequal offer from a proposer.
2. *Solidarity.* Respondents feel a sense of *solidarity* with a partner of the same sex: Acceptance of offers is more likely when playing with a partner who is expected to have the same sense of community.
3. *Chivalry.* Men are more accepting of offers when playing with a woman partner.

Hypotheses for Proposers

1. *Competitive Versus Cooperative*. Men offer less equal divisions than women.[8]
2. *Chivalry*. If *chivalrous*, men are more generous in their proposals when matched with a female partner. The alternative hypothesis is that, if the perceived weakness of women elicits *victimizing* behavior on the part of men, just the opposite patterns of offers would be observed.
3. *Solidarity.* Both men and women feel a sense of *solidarity* with a partner of expected similar behavioral traits, and offer more equal splits when playing with a partner of the same sex.

8. Note that the same results could be generated by differences in risk attitudes. Women might offer more equal splits because they have a greater fear of being rejected.

IV. EXPERIMENT DESIGN AND PROCEDURES

A. Experiment Design

Our experiment is a variation of the ultimatum game, in which the proposer and respondent are asked to divide an amount of money in specified increments ($5 in increments of 50¢). The proposer is given a sheet on which to indicate the amount that he proposes to keep, and the amount he proposes to give to the respondent. The sheet is then given to the respondent, who can either accept or reject the proposed split. The sheet is returned to the proposer to communicate the outcome. If the proposal is accepted, the money is split as proposed. If it is rejected, both players receive nothing.

Several factors distinguish our design from previous ultimatum games:

a. The simple ultimatum game is repeated eight times, each time with a different partner. The trials are not linked. Each subject plays each role four times, though not in the same order.[9] We chose to repeat the game because repetition permits learning by the subjects, and may result in fewer "mistakes," as recommended by Roth (1995).

b. In each trial, a group of four proposers is seated facing a group of four respondents. Players never know which member of the facing group is their partner. Two trials are conducted with each grouping. The groups alternate roles, so that proposers in trial 1 are respondents in trial 2, though not with the same partner. Every two trials, the grouping is changed. Four of the players leave the room and are replaced by four alternate players. We chose to have players facing each other so they can see that their partners are real and also to convey information about the gender of their partners.

c. Subjects are paired according to gender. In each experiment, three different matchings take place, though not in the same order (see Table 1). Players are matched with partners

9. The ordering was different for each of the 16 players in a round.

TABLE 1
Design and Treatment Ordering

Session	Location	Rounds 1, 2	Rounds 3, 4	Rounds 5, 6	Rounds 7, 8
1	VPI	Same	Opposite	Mixed	Same
2	VPI	Mixed	Same	Opposite	Mixed
3	VPI	Opposite	Mixed	Same	Opposite
4	WSU	Same	Opposite	Mixed	Same
5	WSU	Mixed	Same	Opposite	Mixed
6	WSU	Opposite	Mixed	Same	Opposite

Notes: Same: Subjects are paired with partners of the same gender (men with men, women with women). *Opposite:* Subjects are paired with partners of the other gender (men with women, women with men). *Mixed:* Subjects face a mixed group of partners, and so are unable to identify the gender of the partner.

of their own gender (four men face four men, or four women face four women), partners of the opposite gender (four men face four women), or a mixed group (two women and two men face a similar group). Since players see the group their partners are in, they can either identify the gender (male, female) or will be unsure (mixed) of gender; they will not know the identity of their partner. Two trials are conducted with each grouping. Repetition and rotation give us a variety of gender pairs for each subject.

B. Procedure

All subjects are asked to report to a single room, after which they are separated for the first treatment into two different rooms. In each room, two groups of four players face each other. A portion of the instructions is read, and then subjects are asked to take a quiz. If subjects have difficulty with the quiz, those instructions are read again. When all subjects complete the quiz correctly, we read aloud the rest of the instructions, which describe all procedures. Subjects are told that their partner is a member of the group facing them, and that their partner will change from trial to trial. Instructions are available on request.

We conduct the first set of two trials with the initial treatment grouping, with players alternating roles of proposer and respondent. The pairings are changed for each trial. In the second set of trials, four of each gender are chosen to leave their respective rooms and join the other group. Players are rearranged to make the second treatment grouping. When groups are of opposite gender, in one room women are proposers first, and in the other room men are proposers first. Again, two trials are conducted, with alternating proposer and respondent roles. This procedure is repeated for the third and fourth sets of trials.[10]

In each trial, offer sheets are distributed to proposers. Proposers indicate their offers. The experimenter collects the sheets, and a proctor records proposals.[11] The sheets are then distributed to the appropriate respondents, who indicate decisions whether to accept or reject the offers. The sheets are collected by the experimenter, recorded by the proctor, and redistributed to the appropriate proposers. The experimenter then takes up the sheets. Care is taken to ensure than no subject sees any other sheets. No information is given about any results other than the individual's own actions with one other subject in each trial. Each individual keeps a separate record of his or her own experience and earnings.[12] Subjects are paid the sum of their earnings for all games.

10. In one of the sessions conducted at WSU, we were unable to obtain separate rooms. All trials were conducted in a single large room, with half of the subjects in one side and half in the other. The procedural difference did not affect the results for this session.

11. In the VPI experiments the proposals and responses were taken outside the room to be recorded. We thought this would make it harder for subjects to figure out who their partners were. But during debriefing, one subject claimed she thought we were not truthfully revealing the proposals and were making substitutions outside the room. In the WSU experiments, all recording took place inside the room, but in a way that the subjects could not see what was recorded.

12. We found only one mistake in the recording by one subject of another's proposal or response. The subjects calculated cumulative earnings correctly.

C. Subjects

Experiments were conducted at both Virginia Polytechnic Institute and State University (VPI) and Wayne State University (WSU).[13] Three sessions consisting of eight male and eight female subjects with eight trials were performed at each location. The three sessions differed only in the order of the treatments—same gender, other gender, and mixed group pairings (see Table 1). A fourth session was conducted at WSU to ensure replicability. Subjects were recruited from Principles of Economics classes at the two universities.[14] They were asked to participate in an experiment in economic decision making and were told that they would be earning $10–$20 for a two-hour session. Subject pools differed primarily in their age and racial characteristics. The VPI subjects were primarily freshmen and sophomores, ranging in age from 17 to 22. Eighty-seven percent were Caucasian, 8% were Asian, and 2% each were black and Hispanic. About half were business or economics majors. The WSU subjects were also primarily freshmen and sophomores, but had a broader age distribution, ranging from 18 to 56. Again, about half were business or economics majors. The racial makeup of the subject pool was 44% Caucasian, 52% black, and 2% each Asian and Hispanic.

V. RESULTS

A. Summary Data

The data are reported in Table 2 and Figures 1–3. The mean amount offered is $1.875 (37.5%), while the modal amount offered is $2.00 (40%); the overall rejection rate is 12.8%. Few $2.00 proposals are rejected (1.6%), and proposals are increasingly likely to be rejected as they become less generous. Very few proposals are made at the subgame perfect Nash equilibrium of the game ($0.00 or $0.50), and nearly all are rejected. The distribution of offers and rejections, shown in Figure 1, is consistent with previous ultimatum game studies.

Proposals by men are slightly less generous on average than proposals by women: (36.5% versus 38.5% offered to the respondent; see Figure 2). Women's proposals are more closely clustered around $2.00 (standard deviation of 0.48 versus 0.54). Men offer about $1.83 regardless of whether their partners are other men, women, or of undetermined sex; women are less generous to partners of their own sex, offering $1.99 when their partners are men and $1.89 when their partners are women or of undetermined sex.

The most striking result is the difference in the percentage of proposals that are rejected when broken down by sex pairing. Overall, women's offers are notably less likely than men's to be rejected (17.7% of men's proposals versus 7.8% of women's proposals). The result holds for both men and women respondents. This difference may be partially explained by women's more generous offers ($0.10 on average), but a comparison of Figures 2a and 2b shows that even for a given offer amount, an offer of a given size that comes from a woman is less likely to be rejected than if the same offer is made by a man. In addition, there is evidence that women are more likely to accept a given offer than men. In mixed groups, both men and women reject 14.1% of the offers from partners of undetermined sex, despite the fact that the mean offer received by men is $1.92 and by women, $1.79 (not shown in table).

WSU subjects tend to be more generous in their proposals than VPI subjects ($1.982 versus $1.768, respectively). Furthermore, although both show a $2.00 mode, VPI proposals are skewed to the right, whereas WSU proposals are skewed to the left, and proposals of an equal split are considerably more likely.[15] Although race is not an explicit treatment variable in our design, an examination of differences in offers by race sheds some light on the differences between the schools (due to the concentration of blacks at WSU). The mean offer by blacks is $2.11;

13. A pilot experiment with four players of each gender was first conducted at VPI. No significant problems with the experiment design were discovered. The pilot data are not included in the analysis that follows.

14. On two occasions, we found ourselves short a participant, despite recruiting several alternates. Two players were recruited from the hallway to substitute for the missing recruits. There was no apparent difference in their behavior compared with regular recruits.

15. Four of the 53 proposals by men at $2.50 were by a single WSU subject, a (white) gang member with very strong ideas about fairness. (He also rejected a $3/2 split.) On his comment sheet, he indicated that his proposals and responses were based on fairness and wrote, "I won't be a pushover. No one can be allowed to take advantage of me. Likewise, I will take advantage of no one, ever."

TABLE 2
Summary Data Proposals and Rejection Rates

Proposals By	n	Mean Amount Offered	SD	% Rejected
All subjects	384	1.875	0.514	12.8
Men	192	1.825	0.541	17.7
to men	64	1.828	0.544	18.8
to women	64	1.828	0.579	17.2
to mixed group	64	1.820	0.507	17.2
Women	192	1.924	0.483	7.8
to men	64	1.992	0.567	9.4
to women	64	1.891	0.410	3.1
to mixed group	64	1.891	0.458	10.9
VPI	192	1.768	0.536	14.1
WSU	192	1.982	0.470	11.5
Blacks	100	2.110	0.458	15.0*
Nonblacks	284	1.793	0.508	12.0*

*These figures are rejection rates for offers *to* black and nonblack subjects.

FIGURE 1
Distribution of Offers, All Treatments

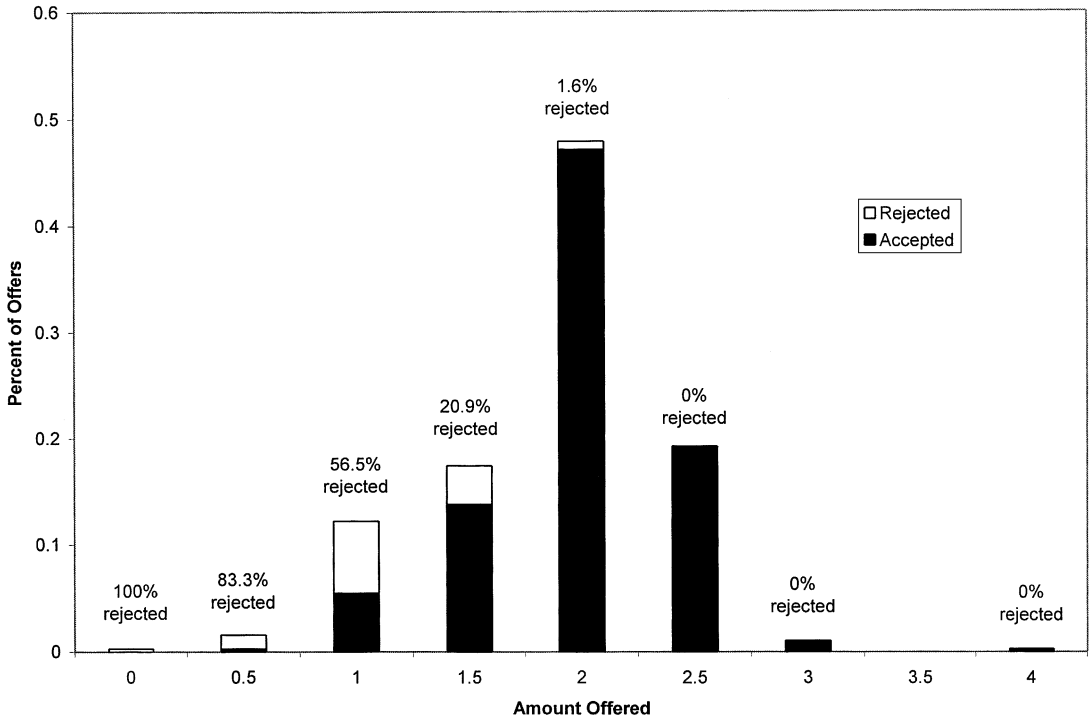
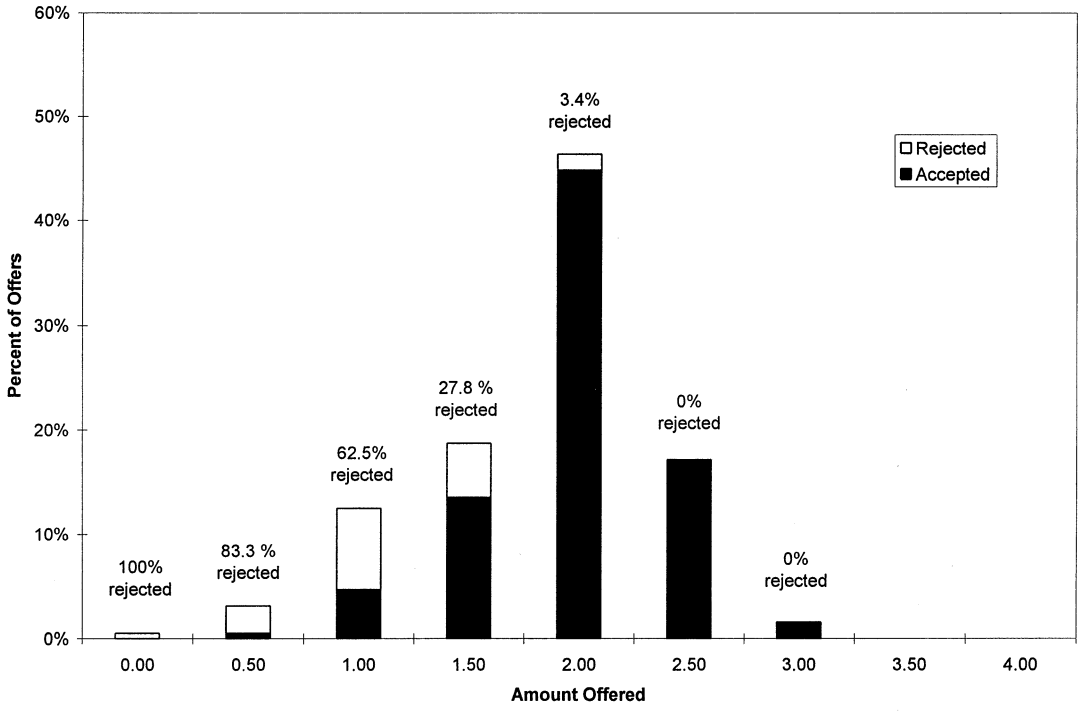
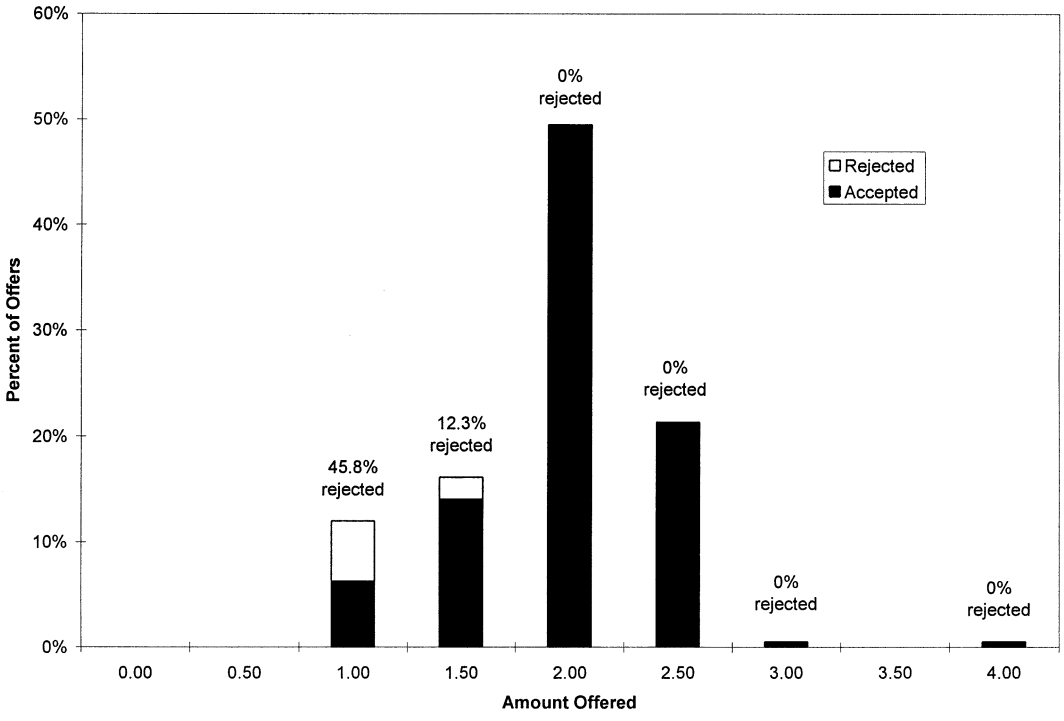


FIGURE 2
Distribution of Offers by Sex of Proposer



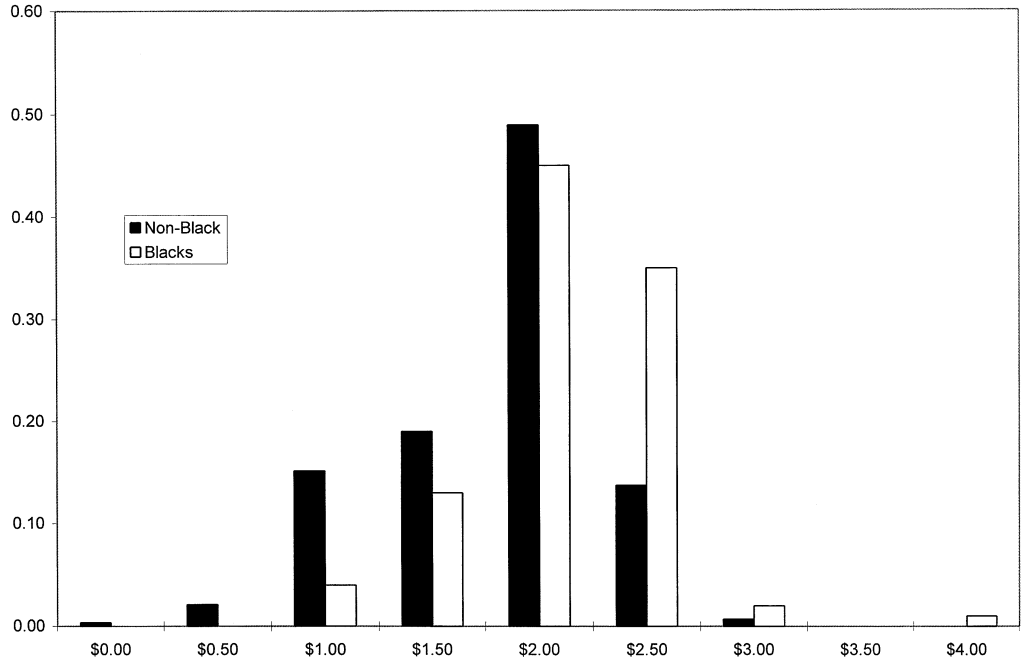
(a) Proposals by men.



(b) Proposals by women.

FIGURE 3

Distribution of Offers Made by Black and Nonblack Subjects



for nonblack subjects, the mean is \$1.793. Figure 3 shows the distribution of proposals by black and nonblack subjects. Black subjects are clearly more egalitarian in their proposals. In addition, blacks are more likely to reject an offer of a given size: Overall rejection rates are 15% for black subjects and 12% for nonblack subjects. However, black subjects rejected 71% of \$1 offers and 47% of \$1.50 offers, as compared to nonblack rejection rates of 54% for \$1 offers and 13% for \$1.50 offers.

We also analyze the distributions of proposals using the Epps-Singleton (ES) test, developed in Epps and Singleton (1986), a nonparametric test for differences in distributions.[16] We consider three pairings of subgroups of subjects—male subjects versus female subjects, VPI subjects versus WSU subjects, and black subjects versus nonblack subjects. An observation for a subject is the average of the four proposals made by that subject.[17] Although the distributions of proposals made by men and women may appear different, the ES test does not allow us to reject the null hypothesis of no difference ($X^2(4) = 3.15, p = 0.53$). We do find a significant difference in the distributions of offers made by VPI and WSU subjects ($X^2(4) = 11.40, p = 0.02$), probably due to the differences in the subject pool characteristics between the two schools noted above. The ES test indicates a highly significant difference between the distributions of black and nonblack subjects' proposals ($X^2(4) = 15.46, p < 0.004$).

B. Regression Analysis

The relationships among the characteristics of the subjects and their proposals and accept/reject decisions are further explored in regression analysis. We analyze both the proposer and respondent decisions. We therefore

16. Forsythe et. al (1994) evaluate the power of this and four other such tests (Cramer-von Mises, Anderson Darling, Kolmogorov-Smirnov, and Wilcoxon rank sum), and find that the Anderson Darling and ES tests have the most statistical power with ultimatum game data. ES is also appealing because it does not require that the distributions be continuous.

17. Because we use as our observation the individual and not the proposal, we include the two proposals by women that were dropped from the summary data because they violated the rule that proposals had to be in \$0.50 increments.

have the following two-equation model:[18]

$$(1) \qquad y_{1i} = X_1\beta + \mu_i,$$

$$(2) \qquad y^*_{2j} = X_2\Pi + y'_{1i}\gamma - \epsilon_j,$$

where y_{1i} is proposer i's offer, y^*_{2j} is the paired respondent's unobserved continuous accept/reject decision, X_1 and X_2 are matrices of exogenous variables specific to proposer the pairing of proposer I and respondent j, and μ_i and ϵ_i are serially independent error terms. While y^*_{2j} is unobserved, the dichotomous variable y_{2j} is observed.

$$(3) \quad y_{2j} = \begin{cases} 1 \text{ iff } y^*_{2j} \geq 0 \text{ or } X_2\Pi + y'_{1i}\gamma \geq \epsilon_j \\ 0 \text{ iff } y^*_{2j} < 0 \text{ or } X_2\Pi + y'_{1i}\gamma < \epsilon_j \end{cases}$$

We assume that μ_i and ϵ_i are normally distributed.

The dependent variable in equation (1) is *OFFER*, the amount the proposer has offered the respondent. The dependent variable in (3) is *ACCEPT/REJECT*, a (0, 1) dummy variable that takes the value of 1 when the offer has been accepted. Exogenous variables included in X_1 and X_2 include: *ACCUM. EARNINGS, CLASS, MAJOR, BLACK, SCHOOL, ROUND i*, $i = 1, \ldots 8$, and *OFFER REJECTED*. We also include six dummy variables to control for the different proposer/respondent pairings. Variable definitions are given in Table 3.

We initially estimate the recursive model using limited information maximum likelihood and test whether μ_i and ϵ_i are independent. If the error terms are independent (i.e., $\text{cov}(\mu_i, \epsilon_i) = 0$), maximizing the likelihood functions is equivalent to estimating each equation separately, as in Maddala and Lee (1976). We find that the estimated covariance of the error terms is not significantly different from zero and therefore estimate each equation separately.

We first consider learning: Did the fact that subjects played repeated rounds result in systematic changes in their behavior? We applied a number of statistical tests in an attempt to answer this question. First, in additional regressions (not reported) we are unable to reject the hypothesis that learning has no effect on offers made by proposers, that is, that the coefficients on a series of dummy variables for each round, *ROUNDi* = *ROUNDj*, for all $i \neq j$, or that the coefficient on the a variable equal to the log of the period number = 0. Second, applying an 8 (rounds) × 6 (offers) χ^2 contingency table test of the null hypothesis that the offers were independent of the round, we were unable to reject at the 95% level the null ($\chi^2 = 48.23$, 95% critical value for 35 d.f. = 49.52).[19] Further analysis of the data indicates that the principal source of dependence in offers and rounds was in the first two rounds. Summary data suggests that the first two rounds were ones of considerable experimentation and learning on the part of subjects. This observation is supported by the results from a 2 (rounds 1 and 2 combined and rounds 3–8 combined) × 6(offers) χ^2 contingency table test. We were able to reject the null hypothesis of independence ($\chi^2 = 30.24$, 95% critical value for 5 d.f. = 11.07).[20] We reran our regressions excluding data from rounds 1 and 2 but found no appreciable difference in the results. We therefore conclude that learning has not significantly affected the play of subjects.[21]

Our results, reported in Table 4, are consistent with three conclusions. First, in the nonstrategic, riskless environment of the respondent, women are significantly more cooperative—that is, accepting of offers—than men, *ceteris paribus*. Note that the coefficients on the dummy variables for the female respondents in Table 4C (F/F, F/M, F/MX) are uniformly higher than those for male respondents, indicating a higher probability of acceptance. In Table 4D, we see that F/F is significantly higher than all other coefficients in pairwise comparisons. F/M and F/MX are significantly higher than M/M or M/MX.

Second, gender pairing significantly affects the pattern of rejections. For both male and female proposers, the coefficients on the variables for female respondents are highest. In

18. Equations were also estimated as a recursive two-equation system. There are no substantive differences in the estimates or significance levels. We report the separate specification only.

19. Offers were in $0.50 increments. Offers of $0 and $0.50 were combined, as were offers of $3 or more, due to the small number of observations in these categories.

20. A 2 (rounds 1–6 combined and rounds 7 and 8 combined) × 6 (offers) χ^2 contingency table test was unable to reject the null hypothesis of independence ($\chi^2 = 9.02$, 95% critical value for 5 d.f. = 11.07).

21. We also reran our regressions excluding data from round 8 but, again, found no appreciable difference in the results. We conclude that any endgame strategy on the part of subjects did not significantly affect their play.

TABLE 3
Definitions of Variables

Variable	Definition
Amount offered	Amount the proposer offered to the respondent
Accumulated earnings	Sum of earnings from previous rounds (0 in round 1)
F/F	1 if female proposer facing female respondent
F/M	1 if female proposer facing male respondent
F/MX	1 if female proposer facing mixed group of respondents
M/F	1 if male proposer facing female respondent
M/M	1 if male proposer facing male respondent
M/MX	1 if male proposer facing mixed group of respondents
Class	0 if freshman, 1 if sophomore, 2 if junior, and 3 if senior
Major	1 if the subject's major is either business or economics
Black	1 if the subject is black
School	1 if the school is VPI
Offer rejected	Highest offer rejected in prior rounds

Table 4D we see that F/F is significantly higher than F/M or F/MX; in addition M/F is significantly different (at the margin) from M/M or M/MX. This suggests that, as respondents, women display *solidarity* while men behave *chivalrously* toward women.

The difference in the behavior of men and women is illustrated in Figure 4. Here we compare the difference between men and women in the predicted probability of any particular offer being accepted. For example, women are twice as likely to accept an offer of $1.00 when the proposer is another woman (F/F) than when the proposer is a man (M/F) or of unknown sex (MX/F). Likewise, men are twice as likely to accept an offer of $1.00 when the proposer is a woman (F/M) than when the proposer is another man (F/M) or of unknown sex (MX/M).

Third, as the environment in which interactions take place becomes more complex, the behavior of men and women becomes less distinguishable. Within the strategic, risky environment of the proposer, differences between the sexes and the impact of different pairings are less evident. In Table 4A we see that coefficients on the variables when females are proposers exceed those when males are proposers; there is a consistent difference of between $0.03 and $0.14 in the offers made by men and women, *ceteris paribus*. Although these results indicate that women are more generous in their offers than men, this is not a large effect and is not consistently statistically significant. In Table 4B, we see that these differences are significant only for F/M compared with the male-proposer variables (M/M, M/F, M/MX).

One other notable result is the significant difference in the behavior of black and nonblack subjects. Black subjects consistently make offers about $0.25 higher than nonblack subjects. Though more generous, they also expect generosity. Other things equal, black subjects are significantly more likely to reject an offer than nonblack subjects. These results suggest that ethnic, cultural, racial, and class differences may be a productive avenue for further research.

VI. DISCUSSION AND CONCLUSIONS

In ultimatum game experiments designed to test the effect of gender and gender pairings, we observe systematic differences in the behavior of men and women. The evidence supports the much hypothesized *compete*/*cooperate* dichotomy. Women's greater cooperation is most evident in the simple environment faced by respondents. The results indicate that women are significantly more cooperative; the probability that a woman will accept a given offer is higher than for a man.

We also find that context is important. The sex of the respondent's partner has a

TABLE 4
Regression Results for Proposer and Responder Models

A. Regression Results: Proposer Regressions

	Coefficient (*t*-Statistic)	
Variable	**OLS**	**LIML**
Accumulated earnings	−0.017	−0.017
	(3.63)	(3.53)
Class	0.078	0.076
	(2.86)	(2.52)
Major	0.023	0.024
	(0.44)	(0.45)
Black	0.262	0.262
	(3.60)	(3.39)
School	−0.057	−0.057
	(0.90)	(0.77)
Offer rejected	−0.064	−0.666
	(1.18)	(1.13)
F/F	1.859	1.859
	(19.19)	(19.38)
F/M	1.965	1.965
	(20.42)	(21.16)
F/MX	1.866	1.867
	(19.51)	(16.39)
M/F	1.831	1.831
	(19.19)	(17.21)
M/M	1.831	1.831
	(19.27)	(17.22)
M/MX	1.824	1.824
	(18.82)	(17.22)
$\mathbf{R}^2$	0.140	
n	384	384

B. *p*-Values: Test of Equal Coefficients Hypotheses (using likelihood ratio tests)

Proposer/Respondent	**F/F**	**F/M**	**F/MX**	**M/F**	**M/M**	**M/MX**
F/F						
F/M	0.11					
F/MX	0.46	0.12				
M/F	0.37	0.06	0.34			
M/M	0.37	0.06	0.34	0.50		
M/MX	0.35	0.05	0.31	0.47	0.47	

continued

TABLE 4 continued

C. Regression Results: Respondent Regression

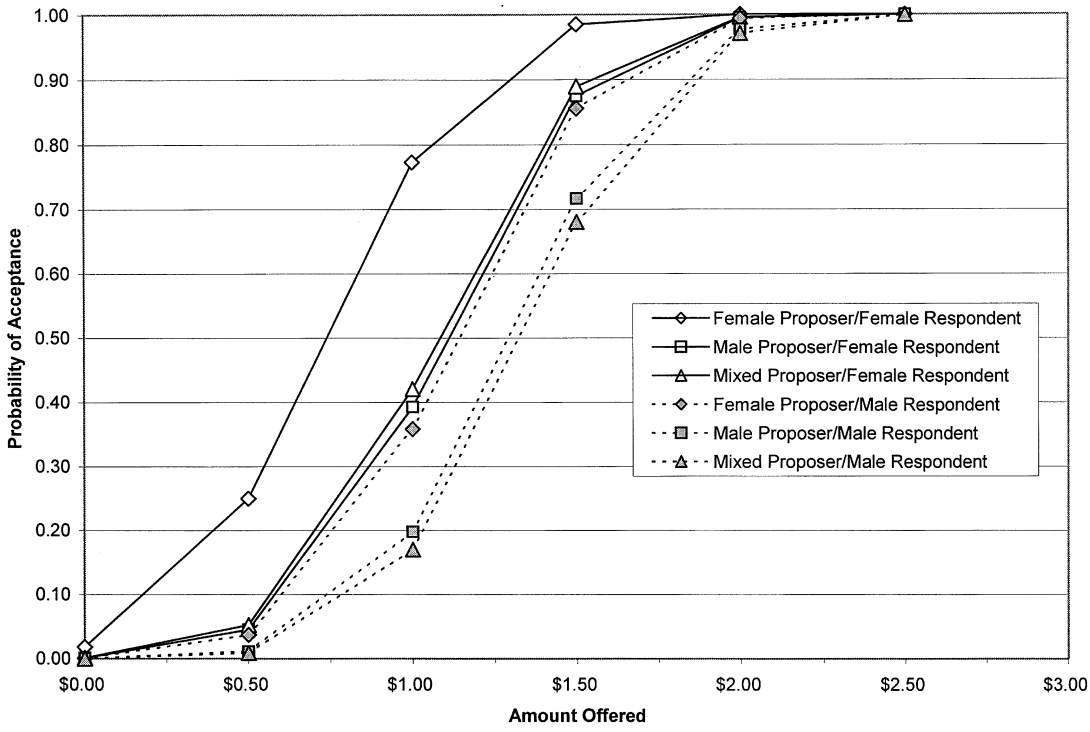
Variable	Probit Coefficient (*t*-Statistic)	LIML (*t*-Statistic)
Amount offered	2.846	3.726
	(7.67)	(2.72)
Accumulated earnings	0.046	0.059
	(1.92)	(1.94)
Class	0.242	0.242
	(1.61)	(1.80)
Major	0.272	0.257
	(1.06)	(1.00)
Black	−1.112	−1.102
	(2.89)	(2.91)
School	0.062	0.252
	(0.19)	(0.58)
F/F	−2.639	−4.505
	(3.33)	(1.55)
F/M	−3.659	−5.538
	(4.81)	(2.00)
F/MX	−3.586	−5.414
	(5.03)	(1.90)
M/F	−3.750	−5.573
	(5.00)	(1.86)
M/M	−4.236	−6.032
	(5.44)	(2.14)
M/MX	−4.340	−6.147
	(5.22)	(2.21)
Log likelihood	−70.192	
n	384	384

D. *p*-Values: Test of Equal Coefficients Hypotheses (using likelihood ratio tests)

Proposer/Respondent	F/F	F/M	F/MX	M/F	M/M	M/MX
F/F						
F/M	0.04					
F/MX	0.04	0.57				
M/F	0.02	0.42	0.34			
M/M	0.002	0.09	0.05	0.10		
M/MX	0.002	0.07	0.04	0.08	0.39	

strong effect on the subject's decision; offers from female opponents are significantly more likely to be accepted. The combination of these two factors—women both reject and are rejected less frequently—produces the appearance of strong *solidarity* between women; cooperative players cooperate more with other cooperative players. When a female proposer and a male respondent face one another, the outcome supports the *chivalry* hypothesis. This finding is consistent with Eagly and Crowley's (1986) arguments that helping behavior can emerge in male-female dyads. We find no evidence of the sucker effect.

FIGURE 4
Probability of an Offer Being Accepted



Finally, though women proposers are consistently more generous than men in the offers they make, this is a statistically weak result. This finding of no difference between men and women in the proposals they make is consistent with results from some social dilemma experiments, such as Dawes et al. (1977) and Brown-Kruse and Hummels (1993), which find no difference in the play of men and women. As with the proposer's role in the ultimatum game, a player in a social dilemma game faces competing strategies in a risky environment.

Women's greater generosity also is consistent with risk aversion: A more generous offer is less likely to be rejected. It is important to note that this generosity contradicts payoff-maximizing behavior. Using the pattern of rejections faced by men and women proposers, we can calculate the expected payoff for each possible offer. Averaging over all subjects and treatments, the \$3/\$2 split is payoff-maximizing. Making the same calculation for men alone, the optimal offer remains \$3/\$2. However, if women exploited the lower probabilities of rejection that they face, the would offer a payoff-maximizing proposal of a \$3.50/\$1.50 split. Relative to their optimal offers, women are sacrificing even greater earnings by offering more equal splits than their male counterparts. Nevertheless, because women are both less likely to reject and to be rejected, their overall earnings are still on average \$.90 higher than men's.[22]

It is interesting to compare our results with the quite different results of Solnick (2001), who conducts a one-shot game under two treatments. In one treatment, subjects are anonymous; in the second, players are told a gender-revealing first name for their partner. In contrast to our sequential game design, Solnick employs the "strategy method": Players simultaneously propose a division of the pie (if the player is the proposer) and the

22. Average earnings are: men: \$17.69; women: \$18.59; blacks: \$19.18; nonblacks: \$17.78.

TABLE 5
Comparison of Eckel/Grossman and Solnick† Offers Made by Proposers and Rejection Rates by Respondents

	Eckel and Grossman*,a		Solnick*	
Offers Made By	**Mean Offer (% of $5)**	**Rejection Rate (%)**	**Mean Offer (% of $10)**	**Rejection Rate (%)**
All subjects to all subjects	37.5	12.8	46.8	12.4
All subjects to men	38.2		48.9+	
All subjects to women	37.2		43.7+	
Men to all subjects	36.5	17.7	46.7	4.2
Men to men	36.6	18.8	47.3	4.5
Men to women	36.6	17.2	44.3	0.0
Women to all subjects	38.5	7.8	46.8	14.6
Women to men	39.8	9.4	51.3++	6.3
Women to women	37.8	3.1	43.1++	23.1

†This table is from Eckel and Grossman (2001).

*Number of subjects: Eckel and Grossman—96 subjects (each plays four rounds as proposer and four rounds as respondent; 384 proposer/respondent pairings); Solnick—178 subjects (89 proposer/respondent pairings).

[a]Regression analysis results indicate that: (1) female respondents are significantly more likely to accept a given offer, p-value = 0.01; and (2) offers from female proposers are significantly less likely to be rejected than offers from male proposers, p-value = 0.01.

+Means test p-value = 0.08.

++Means test p-value = 0.08.

minimum acceptable division of the pie (if the player is the respondent). Results for the two studies are summarized in Table 5. Although Solnick's subjects make substantially more generous offers overall (46.8% versus 37.5%), neither study finds a significant difference in the overall mean offers made by men and women (46.7% of the pie for men versus 46.8% for women in the Solnick study and 36.5% versus 38.5% here). Both report that offers to women are, on average, lower than those made to men, regardless of the sex of the proposer (43.7% and 48.9% in her study versus 37.2% and 38.2%, respectively). Where the results differ dramatically is in the behavior of the respondents. While the overall rejection rates are similar (12.4% versus 12.8% respectively), Solnick reports higher rejection rates of offers made by women, whereas we report higher rejection rates for offers made by men. One of the most startling differences in the two results is the difference in rejection rates of offers made by women to women. While we report that these offers were least likely to be rejected (3.1%), in the Solnick study these offers were the most likely to be rejected (23.1%).

There are several important design differences between the two studies that might shed some light on the results. One is the one-shot design versus repeated-play design. If subjects come to the experiment with no idea of what constitutes an "acceptable offer (minimum acceptable offer)," first-round results may reflect considerable "noise" as subjects experiment. A second important difference is that she uses the strategy method to collect data on rejections, as compared with the sequential, game method. In general, the strategy method appears to lead to a larger number of rejections, perhaps because subjects fail to understand the simultaneous nature of the decision and attempt to signal a "tough" bargaining position; Camerer (2000) makes this point in a survey of recent bargaining experiments. In these two studies we see very similar overall rejection rates

despite very different offers. In our study, virtually all offers of at least 40% were accepted. In addition, though we do not observe an overall difference in rejection rates across the two studies, it appears that female subjects do reject more offers under the strategy method.

A third difference concerns the proximity of the groups: Our subjects faced each other in groups across a room, whereas Solnick's subjects are seated in different rooms. This could have two effects. Frohlich et al. (2000) have shown that subjects recruited to different rooms may not believe that they are really paired with another subject. This effect may be different for female than for male subjects. In addition, actually facing another subject and knowing that a rejection would lead to a zero payoff for both might have a stronger effect on female players (this point is made by Solnick).

A fourth difference is the nature of the two subject pools. Solnick's subjects are recruited from University of Pennsylvania undergraduates, but ours are from Virginia Polytechnic Institute and State University and Wayne State University. There may be systematic socioeconomic differences in the subject pools that would account for the differences. Notable here is the substantial difference that we observe in the behavior of black subjects. More study is necessary to disentangle these results.

Economists may find it worthwhile to incorporate gender and culture into the study of economic markets if indeed women or minorities respond differently in economic situations, or if both men and women respond differently to women compared to men in economic situations. Consider the Ayres and Seigelman (1995) study of automobile negotiations. Why might men receive better deals than women in this setting? Perhaps car salesmen wisely exploit the greater tendency by women to accept an offer, as shown in our experiments. Our data also support Ayres's earlier finding that women get their worst deals from other women. Think of the proposer as the seller in a car negotiation and the respondent as a buyer. As shown in Table 3, women sellers make relatively unfavorable take-it-or-leave-it offers to other women buyers, yet these women are more likely to accept despite the lower payoff.[23]

Clearly, some puzzles remain. Our evidence suggests that women's basic inclination to cooperate is suppressed when decisions are made in a strategic and risky environment; women behave more like men in mixed-sex settings. Additional research is needed to determine whether and when strategic considerations or risk aversion drive the outcome. It is likely that particular environments may cue competitive or cooperative behavior by men and women. Environmental cues are likely to have stronger effects when the tasks are gender-related in some way; the purchase of an automobile may still be largely associated with men, although this is clearly changing over time. Systematic experimentation may provide a useful basis for more accurate modeling of markets in which women and blacks increasingly participate.

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23. Unfortunately, our design does not permit us to test for similar effects for race. We know that blacks make more generous offers, but not whether subjects make higher or lower offers to blacks, since race was not a treatment variable in our design.

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