BELIEFS ABOUT OTHER-REGARDING PREFERENCES IN A SEQUENTIAL PUBLIC GOODS GAME

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Experimental evidence is used to deduce players' beliefs about their opponents' concern for others. The experiment is a sequential public good provision game with a provision point and two different refund rules. A theory is constructed to show how early contributions should change with the refund rule depending on the first mover's beliefs about subsequent players' other-regarding preferences. The evidence rejects the hypothesis that early players believe that their opponents are inequality averse and also rejects the hypothesis that early players are concerned with security. The evidence is consistent with beliefs in spite, reciprocity, or a concern for security. (*JEL* H41, C90, D63, D64)

I. INTRODUCTION

Over the years, experimental evidence has soundly rejected the hypothesis that subjects play the selfish, subgame perfect equilibrium in a large class of sequential games, including the ultimatum game (e.g., Forsythe et al., 1994), the centipede game (e.g., McKelvey and Palfrey, 1992), and the finitely repeated prisoner's dilemma (e.g., Cooper et al., 1996). This failure of selfishness extends to public good provision, as shown by Croson (1998) and Fehr and Gachter (2000). The fact that subjects do not play as if they are selfish raises two issues. One relates to how a subject's concern for others, either negative or positive, impacts their strategy choice. The other relates to how a subject's beliefs about opponents' concern for others impact their play. Although the first issue has received quite a bit of attention, the second has received relatively little.[1] In this article, we present the results of an experiment that can identify players' beliefs about subsequent players' other-regarding attitudes in a sequential public good provision game.

There are several reasons why identifying players' beliefs about their opponents' other-regarding preferences in a public good provision game is important. First, and as already mentioned, because players optimally respond to their beliefs, these beliefs affect play. Second, the sequential public good provision setting is interesting in its own right, because it arises in studies of both fund-raising and team production. How participants believe their opponents feel about them may affect the ability of groups to reach goals successfully. Third, beliefs about other-regarding preferences provide a clue as to what form these preferences take and allow us to distinguish between competing theories.

The game itself is a four-player sequential game with a provision point, such that the public good is provided if the provision point

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1. Harrison and McCabe (1996) explore the effect of beliefs on behavior in an ultimatum game. They focus on how different information treatments affect behavior, rather than concentrating on what beliefs about each other players hold. Levine (1998) uses a parametric specification to obtain a distribution of actual behavior and shows that play in a wide variety of sequential games can be explained if players anticipate that distribution.

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is met.[2] We focus attention on the first mover in the sequential game, because beliefs about subsequent play matter the most at the beginning. We also focus attention on a particular preference pattern, inequality aversion, which captures the notion that players prefer more equitable allocations (see, for example, Fehr and Schmidt, 1999).[3] We are able to determine whether player 1 believes that subsequent players are inequality averse by changing whether contributions are refunded when the provision point is not met.[4] If player 1 believes that subsequent players are inequality averse, they should contribute more in the full-refund setting than in the no-refund setting. The data are inconsistent with this pattern, and we reject the hypothesis that player 1 believes that subsequent players are inequality averse. We also reject the hypothesis that player 1 is concerned with security. Player 1's behavior is consistent with a belief that subsequent players have one of four traits: They are either altruistic, spiteful, engaged in reciprocity, or concerned with security.[5]

These results fit well with existing literature in that they help rule out what other-regarding preferences players attribute to their opponents. It has been well established that proposers make higher offers in the ultimatum game than in the dictator game, presumably because they believe that low offers will be rejected in the ultimatum game. Rejections can arise from either spite, reciprocity, or inequality aversion (but not altruism or a concern for security), so the comparison of offers in the two games yields that the proposer believes that the responder fits one of these three patterns. Our experiment suggests that beliefs in inequality aversion do not drive behavior, leaving beliefs in spite and beliefs in negative reciprocity as the stronger contenders.

The article is organized as follows. Section II describes the setting and the predictions for beliefs in inequality aversion. Section III discusses the experiment, and section IV presents the results. Section V discusses what the results suggest about alternative beliefs in altruism, spite, reciprocity, and security. Section VI determines whether the identified beliefs are justified by the actual behavior of subsequent players. The article concludes in section VII.

II. THEORY AND HYPOTHESES

Four individuals contribute sequentially to a public good, which is provided if contributions meet or exceed a provision point p. When an individual contributes x and the public good is provided, they receive a payoff of $e - x + g$, where e is the individual's initial endowment and g is the individual's share of the public good, with $g > e$. If, instead, contributions do not meet the provision point, the individual's payoff depends on the refund rule. In a full-refund setting, the individual's payoff is simply e, whereas in a no-refund setting, the individual's payoff is $e - x$.

Some additional notation and terminology ease discussion. Throughout the article we refer to a player by their position in the order of play, so that player 1 is the first mover and player 4 is the last. Let

$$C_k = \sum_{i=1}^{k} x_i$$

denote the cumulative contribution after player k's contribution. The public good is provided if $C_4 \geq p$. If, after k players have contributed, $C_k < p - (4 - k)e$, subsequent players cannot possibly contribute enough to reach the provision point. Let $M_k = p - (4 - k)e$ denote the minimum cumulative contribution by the first k players consistent with eventually reaching the provision point. If $C_{k-1} \geq M_{k-1}$ we say that player k "matters," in that their

2. The experiment is described more fully in Coats and Gronberg (2000), who compare the efficiency of a sequential provision point game with a simultaneous provision point game and find that a sequential game has higher efficiency. Others have analyzed sequential public goods games in experiments. Andreoni et al. (1997) analyze an experimental sequential public goods provision game but not one with a provision point. The best-shot game run by Harrison and Hirshleifer (1989) is similar to a sequential public good game but without a provision point.

3. Inequality aversion is chosen both because of its prominence in the literature and because it generates a unique prediction in the setting we consider, whereas other preference patterns generate identical predictions.

4. Isaac et al. (1989) investigate the impact of changing the refund rule in a simultaneous public good game, with a focus on whether the public good is provided. They find that provision is more likely in the full-refund setting; see also Cadsby and Maynes (1999) and Coats and Gronberg (2000). Cornelli (1996) analyzes a theoretical model of contributions with different refund conditions, but with selfish players in a simultaneous, asymmetric information setting that resembles an auction. She finds that optimal contributions are higher in the full-refund setting than in the no-refund setting.

5. Croson (1998) also finds that players are concerned with reciprocity in a public goods framework.

decision can potentially affect the payoffs of the other players. If k matters but selects x_k so that $C_k < M_k$, player k has decided not to contribute enough to allow the provision point to be reached. In this case we say that player k "folds." If, instead, $C_{k-1} \geq M_{k-1}$ and $C_k \geq M_k$, we say that player k "contributes."

Now consider all four individuals together. The vector of contributions is $x = (x_1, x_2, x_3, x_4)$. If $\sum x_i \geq p$, the public good is provided and the vector of payoffs is

$$\pi^{PG}(x) = (e - x_1 + g, e - x_2 + g, e - x_3 + g, e - x_4 + g).$$

If, instead, $\sum x_i < p$, the public good is not provided and the vector of payoffs is

$$\pi^{FR}(x) = (e, e, e, e)$$

under a full-refund rule and

$$\pi^{NR}(x) = (e - x_1, e - x_2, e - x_3, e - x_4)$$

under a no-refund rule.

Individual k has preferences u_k defined over payoff combinations $\pi = (\pi_1, \pi_2, \pi_3, \pi_4)$. It is assumed that all individuals prefer increases in their own payoffs, all else equal, so that $\partial u_k / \partial \pi_k > 0$. How individuals feel about changes in their opponents' payoffs, and how they ultimately play, depends on their types. If a late player in the full-refund treatment folds, the earlier players all get their endowments, but if a late player in the no-refund treatment folds, the earlier players get different amounts depending on their contributions. Because of the differences between the resulting allocations, other-regarding preferences influence the desirability of folding for late players.

To a player who cares about fairness, the benefit of folding in the full-refund case includes the ability to impose the payoff combination $\pi^{FR}(x) = (e, e, e, e)$, which is completely equitable. On the other hand, folding fails to impose fairness under the no-refund setting in which the payoff combination $\pi^{NR}(x) = (e - x_1, e - x_2, e - x_3, e - x_4)$ is not completely equitable. Consequently, an inequality averse player prefers $\pi^{FR}(x)$ to $\pi^{NR}(x)$. Because of this, an inequality averse player will find it less attractive to fold in the no-refund setting, and we would expect to see folds less frequently in the no-refund setting.

In our experiments player 1 cannot fold, because the provision point can still be reached even if they contribute nothing. Nevertheless, the contribution is affected by both their own preference for fairness and their beliefs about subsequent players' fairness preferences. If player 1 believes that subsequent players have a preference for more equitable outcomes, they believe that they are more likely to contribute rather than fold in the no-refund setting. Player 1 can take advantage of this propensity of later players to contribute in the no-refund setting by contributing less. Consequently, when player 1 believes that subsequent players are inequality averse, and regardless of whether they are also inequality averse, they should contribute less in the no-refund setting than in the full-refund setting. This leads to our first hypothesis, with the hypothesized behavior driven by beliefs in inequality aversion.

HYPOTHESIS 1. *Player 1's contributions are higher in the full-refund setting than in the no-refund setting.*

There are three main reasons why Hypothesis 1 could fail. First, it could be that subjects do not respond optimally to their beliefs. Our experiment is not designed to determine whether subjects behave optimally, and so, as is typical, it is assumed throughout that subjects respond optimally. The second source of failure is that subjects could believe that subsequent players are something other than inequality averse. The third is that subjects care about security when making their choices. Player 1's payoff is secure in the full-refund setting because they are guaranteed at least their endowment, where in the no-refund setting if the provision point is not reached player 1 loses their contribution. A concern for security would lead player 1 to be more likely to contribute zero in the no-refund setting, because a contribution of zero guarantees that the payoff is at least as high as their endowment.

To determine whether the detected behavior arises from beliefs about other-regarding preferences or a preference for security, we also test a second hypothesis.

HYPOTHESIS 2. *Player 1 contributes zero more often in the no-refund setting than in the full-refund setting.*

It is important to note that the same data can support both hypotheses, because Hypothesis 1 implies that player 1 contributes zero less often in the full-refund setting. It is also possible for the same data to reject both hypotheses. If both are supported, it is impossible to tell if the behavior is driven by a belief in inequality aversion or a preference for security. On the other hand, if both are rejected, it implies that behavior is driven by beliefs in something other than inequality aversion.

III. EXPERIMENTAL PARAMETERS AND PROCEDURES

In each experimental session there were 12 subjects, randomly assigned into 3 groups of 4 subjects each. Subjects had complete information of one another's endowments of five experimental tokens and return from the public good of six tokens. The public good was worth 24 tokens and was provided if the subjects donated an amount equal to or greater than its cost, the "provision point," of either 12 or 14 tokens depending on the treatment. Each token was worth 8.5 cents. On completion of a session, subjects could earn considerably more than minimum wage.

Each round, subjects were randomly regrouped and randomly assigned an order within the group. Each subject knew the amounts that the previous subjects in their group contributed. Two alternative rules for insufficient contributions were applied in separate experimental sessions. Under the full-refund rule, subjects pledged a contribution to the public good that was collected if and only if the public good was provided. Under the no-refund rule, contributions were collected regardless of whether the public good is provided.

The public goods game was communicated to subjects via a graphical user interface in the Texas A&M Economic Science Laboratory. The interface was designed to carefully address several presentation concerns. The first design consideration was the necessity for subjects to be able to easily identify the standard (selfish) subgame perfect equilibrium if they so desired (without being suggested to them by the experimenters in any way). We achieved this goal by separating the experimental interface into two regions. One region allowed subjects to explore all possible different hypothetical choice configurations. The second region showed actual choices of subjects, which did not change with the hypotheticals. Subjects made their choices in the same area of the screen in which the actual choices appeared, again establishing the difference between hypothetical play and actual play. The main screen also recorded the choices in the subject's previous groups and a balance in cash earnings. Subjects completed a questionnaire to demonstrate their understanding of the interface.

Other design considerations included a necessity to approximate the one-shot game that we analyze and to control for subjects' considerations of fairness. These considerations were addressed by a random matching protocol in which subjects were randomly rematched with new groups and randomly assigned an order within their new group each period. Because subjects were randomly reordered each period, they had an equal chance every period of being assigned any order in the sequence of play which always favors the first two movers.

Finally, given concerns for framing or presentation effects, the design was implemented in an abstract form while still capturing the essential theoretical elements of an experimental public goods environment. The presentation expressed the game in neutral terms, without explicit reference to the public goods nature of the environment. Terms such as "group account," "contribution," and "public good" were not used. The hypothetical portion of the screen, however, made clear that payoffs depended not only on individual choices but also on the choices of others in the group, thus making the essential theoretical elements clear to subjects.

The experimental results reported here were conducted as part of a larger set of sessions for an experiment designed to compare the efficiency of alternative institutions, including both simultaneous and sequential provision mechanisms (see Coats and Gronberg 2000). The entire set of sessions and treatments is reported in Appendix Table A1. Only the experimental treatment in sessions relevant to this article is discussed here and the sessions are numbered according to their order in this

TABLE 1
Experimental Sessions SEQ 1–SEQ 8

Session	Refund Rule	Periods	Fisher Test Probability
SEQ 1	Refund	11–20	0.679
SEQ 2	Refund	31–40	0.231
SEQ 3	Refund	11–20	0.687
SEQ 4	Refund	31–40	0.152
SEQ 5	No refund	11–20	0.193
SEQ 6	No refund	31–40	0.284
SEQ 7	No refund	26–50	0.817
SEQ 8	No refund	1–25	0.756

relevant subset. More detailed information is provided in Table 1.

Important questions regarding the presentation of results are whether subject behavior is stable within the periods being pooled and also across the sessions being pooled. Using Fisher's exact test, we analyze the hypothesis that the corresponding payoffs are behaviorally stable across the periods and sessions being pooled. Table 1 reports Fisher's exact tests for stability of subject choices with respect to time for 10-period intervals within each treatment. Contrasting a five-period interval with the preceding five-period interval, we fail to reject the hypothesis of stable behavior in the final periods of any sessions. Behavior within the first 10 periods is not always consistent with that (stable behavior) of the last 10 periods within both refund rules. Using Fisher's exact test for stability of the outcome with respect to session and treatment, we test whether we can pool the behaviorally stable periods in each session across sessions. We fail to reject the hypothesis of stable behavior across sessions (for the behaviorally stable periods) in the full-refund sessions ($p = 0.455$) and in the no-refund sessions ($p = 0.912$).

The random matching protocol, in which subjects are randomly rematched and randomly assigned a position each period, necessitates some clarification of how the hypotheses must be interpreted. Hypothesis 1 states that player 1 contributes more in the full-refund setting than in the no-refund setting, and is motivated by player 1 believing that subsequent players are inequality-averse. Because of the random matching protocol, different subjects assume the role of player 1 in different periods. Rejection of Hypothesis 1 means that, on average, subjects assigned to the role of player 1 contribute less in the full-refund setting than in the no-refund setting. This finding would contradict the assumption that all subjects believe that all other subjects are inequality averse.

IV. RESULTS FOR PLAYER 1

The hypotheses constructed in Section II concern the contributions of player 1, which are described in Table 2 for two different provision points and for early rounds and late rounds in the repeated game.

Begin with the last 10 rounds of the two provision-point treatments. In both cases player 1 contributed zero more often in the full-refund treatment, contrary to Hypothesis 2 (security). Player 1 also contributed more on average in the no-refund treatment, contributing an average of 1.47 in the no-refund treatment versus 1.03 in the full-refund treatment when the provision point was 12, and

TABLE 2
Contributions by Player 1

Provision Point, Rounds	Refund Rule	Percentage of Contributions[a]					
		0	1	2	3	4	5
12, first 5	Refund	23.3 (28)	20.8 (25)	19.2 (23)	29.2 (35)	5.0 (6)	2.5 (3)
	No refund	26.7 (20)	25.3 (19)	20.0 (15)	21.3 (16)	2.7 (2)	4.0 (3)
12, last 10	Refund	39.6 (95)	33.3 (80)	14.2 (34)	10.8 (26)	2.1 (5)	— (0)
	No refund	20.0 (30)	31.3 (47)	32.7 (49)	14.7 (22)	0.7 (1)	0.7 (1)
14, first 5	Refund	41.7 (25)	18.3 (11)	20.0 (12)	11.7 (7)	6.7 (4)	1.7 (1)
	No refund	21.7 (13)	13.3 (8)	13.3 (8)	26.7 (16)	21.7 (13)	3.3 (2)
14, last 10	Refund	50.0 (60)	25.0 (30)	13.3 (16)	9.2 (11)	1.7 (2)	0.8 (1)
	No refund	16.7 (20)	25.0 (30)	31.7 (38)	22.5 (27)	3.3 (4)	0.8 (1)

[a]Number of cases in parentheses.

TABLE 3
C.D.F. of Contributions for Player 1

Provision Point, Rounds	Refund Rule	C.D.F. of Contributions					
		0	1	2	3	4	5
12, first 5	Refund	0.233	0.441	0.633	0.925	0.975	1.000
	No refund	0.267	0.520	0.720	0.933	0.960	1.000
12, last 10	Refund	0.396	0.729	0.871	0.979	1.000	1.000
	No refund	0.200	0.513	0.840	0.987	0.994	1.000
14, first 5	Refund	0.417	0.600	0.800	0.917	0.984	1.000
	No refund	0.217	0.350	0.483	0.750	0.967	1.000
14, last 10	Refund	0.500	0.750	0.883	0.975	0.992	1.000
	No refund	0.167	0.417	0.734	0.959	0.992	1.000

contributing on average 1.73 in the no-refund treatment versus 0.90 in the full-refund treatment when the provision point was 14. These patterns contradict Hypothesis 1 (beliefs in inequality aversion).

The Cramer–von Mises test rejects the hypothesis that the full-refund and no-refund distributions are identical at the $p = 0.0001$ level.[6] A comparison of the resulting cumulative distributions of contributions reveals that in the late rounds for both provision points, the no-refund distribution first-order stochastically dominates the full-refund distribution, as shown in Table 3.[7] Consequently, the hypothesis that the full-refund distribution stochastically dominates the no-refund distribution, as predicted when player 1 believes in inequality aversion, is rejected. Furthermore, a chi-squared test establishes that player 1 contributes zero more often in the full-refund condition (significant at the $p = 0.01$ level), rejecting the hypothesis that zero contributions are more likely in the no-refund setting, as predicted when player 1 cares about security. So, the failure of the belief in inequality aversion is not driven by concerns for security. This provides strong evidence against beliefs in inequality aversion, at least late in the sequential public good provision game.

Now turn attention to the early rounds. The late rounds give subjects an opportunity to respond to what their opponents are actually doing, whereas the early rounds are driven entirely by preconceived beliefs. The results match those of the late rounds when the provision point is 14, but not when the provision point is 12. In particular, there are no statistically significant differences between the two distributions nor in the rate of zero contributions when the provision point is 12, but there are statistically significant differences between the two distributions ($p < 0.0001$) and in the rate of zero contributions ($p = 0.019$) when the provision point is 14. Furthermore, when the provision point is 14 both the hypotheses generated by security and beliefs in inequality aversion are rejected.

V. ALTERNATIVE HYPOTHESES: BELIEFS IN ALTRUISM, SPITE, RECIPROCITY, AND SECURITY

Because it rejects the hypothesis that player 1 prefers security, the evidence of the preceding section suggests that behavior is driven by beliefs about subsequent players' other-regarding preferences. The evidence also rejects the hypothesis that player 1 believes that subsequent players are inequality averse. In this section we briefly discuss alternative other-regarding preferences that player 1 might believe in. All of the beliefs discussed here generate the same prediction: Player 1 believes that folds should be more common in the no-refund setting. In response, player 1 should either contribute more in the no-refund setting or contribute nothing at all in the no-refund setting. The former is the opposite of Hypothesis 1, which was rejected, but the latter coincides with Hypothesis 2, which was also rejected. Still, given the either/or nature of the prediction, the evidence is consistent with all of the beliefs listed here.

6. See Forsythe et al. (1994) for a discussion of nonparametric tests for comparisons between experimental distributions.

7. Letting F^{FR} denote the c.d.f. for the full-refund setting and F^{NR} the c.d.f. for the no-refund setting, F^{NR} first-order stochastically dominates F^{FR} if $F^{NR} \leq F^{FR}$ everywhere.

TABLE 4
Percentage of Folds among Players Who Matter[a]

Provision Point, Rounds	Setting	Player 2	*p*-Value	Player 3	*p*-Value	Player 4	*p*-Value
12, first 5	Refund	1.9 (20)	0.001	17.7 (20)	0.009	21.0 (21)	0.465
	No refund	25.6 (25)		34.7 (25)		16.0 (8)	
12, last 10	Refund	4.0 (39)	0.001	16.3 (39)	0.007	16.9 (34)	0.467
	No refund	15.6 (41)		27.7 (41)		13.8 (15)	
14, first 5	Refund	5.5 (19)	0.001	31.7 (19)	0.078	14.6 (6)	0.498
	No refund	31.1 (28)		47.5 (28)		9.4 (3)	
14, last 10	Refund	6.8 (29)	0.014	24.2 (29)	0.152	14.3 (13)	0.894
	No refund	17.4 (39)		32.5 (39)		13.6 (11)	

[a]Numbers of observations in parentheses.

Beliefs in Altruism

A player is altruistic if their utility is increasing in other players' payoffs *ceteris paribus*. Because contributions are secure under the full-refund condition and folding can only decrease all players' payoffs relative to provision, an altruistic player should never fold under the full-refund condition, because contributing puts nothing at risk and altruism means that the player is willing to trade their own payoff for opponents' payoffs. Consequently, an altruistic player is less likely to fold in the full-refund condition than in the no-refund condition.

Beliefs in Spite

An individual is spiteful if their utility is decreasing in others' payoffs ceteris paribus. Because a spiteful player gets higher utility when opponents' payoffs are lower, a spiteful player will find folding more attractive in the no-refund setting, and therefore folds should be more common in the no-refund setting.

Reciprocity

An individual who employs reciprocity desires to reward others' behavior judged as kind, so that $du_k/d\pi_j > 0$ if contributions by $j \neq k$ are judged as adequate, and desires to punish others' behavior judged as unkind, so that $du_k/d\pi_j < 0$ if contributions by $j \neq k$ are judged as inadequate. Punishment behavior is identical to spite, whereas the desire to reward is essentially the same as altruism. As already discussed, the evidence supports beliefs in both spite and altruism. Thus, behavior in the sequential public good provision game we study supports beliefs in reciprocity.

Security

Security is only an issue for players 2 and 3, and then only in the no-refund setting. In the full-refund setting every player is guaranteed at least their endowment. Also, because there is no uncertainty in the game after player 4's move, security is not an issue for them, either. As discussed in section II, a concern for security leads players 2 and 3 to contribute zero more often in the no-refund setting.

VI. ARE BELIEFS JUSTIFIED?

The evidence in section IV suggests that player 1 believes that subsequent players are more likely to fold in the no-refund setting than in the full-refund setting, contrary to the assumption that subsequent players are inequality averse. In this section we explore whether later players do, in fact, fold more often in the no-refund setting.

Table 4 shows the percentages of players who matter and choose to fold in the two refund settings, along with the *p*-values from the chi-squared test used to determine if the probability of folding is independent of the refund treatment. The differences between the probabilities of folding in the full- and no-refund treatments are significant at the 5% level in six cases. The differences are always significant for player 2, and they are significant for player 3 when the provision point is 12. Differences for player 4 are insignificant. In every instance in which the difference is significant, folding is more prevalent in the no-refund setting than in the full-refund setting, in keeping with player 1's revealed beliefs. This pattern is consistent with altruism, spite, reciprocity, and security.

However, player 3 often folds in the full-refund setting, and player 4 often folds in both settings, inconsistent with altruism.

VII. CONCLUSIONS

This article looks specifically at the beliefs players have about subsequent players' concern for others in a sequential public goods provision game. It departs from other studies of fairness, altruism, spite, and reciprocity by looking at how players' actions reflect their beliefs about subsequent players. The data convincingly reject that the first player in the four-player sequential game believes that subsequent players are concerned with fairness. They also reject that the first player is concerned with security. The data are consistent with the first player believing that subsequent players exhibit altruism, spite, reciprocity, or a concern for security.

Coupling these findings with results on the false consensus effect from the psychology literature can help narrow down the remaining patterns. The false consensus effect, first noted by Ross et al. (1977), describes the general tendency for a subject to overestimate their similarity to others on attitudes, behaviors, and personality traits. Because player 1 does not exhibit a concern for security, then the false consensus effect suggests that they will not base their behavior on a belief that subsequent players are concerned with security. If this is the case, player 1's beliefs are narrowed down to altruism, spite, and reciprocity.

Our results shed light on what drives behavior in the ultimatum game as well. Offers tend to be higher in ultimatum games than in dictator games, which is consistent with proposers believing that responders are either spiteful, concerned with fairness, or engaging in negative reciprocity.[8] Because our data rule out beliefs in inequality aversion, our study suggests that proposers in ultimatum games believe that the responders exhibit either spite or negative reciprocity. Further studies can perhaps distinguish between these two remaining belief patterns.

8. Altruistic responders would not reject any offer, so proposers in ultimatum games cannot believe that responders are altruistic. Furthermore, because the responder is the last mover, security is not an issue.

APPENDIX TABLE A1
Full Set of Experimental Sessions

Session	Institution	Refund Rule	Provision Point Periods 1–20	Provision Point Periods 21–40	Provision Point Periods 51–75
1	Sequential	Refund	12	*[a]	
2	Sequential	Refund	12	*	
3	Simultaneous	Refund	12	*	
4	Sequential	Refund	12	*	
5	Sequential	Refund	12	*	
6	Sequential	Refund	14	12	
7	Simultaneous	Refund	14	12	
8	Simultaneous	Refund	12	14	
9	Sequential	Refund	12	14	
10	Sequential	Refund	14	12	
11	Sequential	Refund	12	14	
12	Simultaneous	Refund	14	12	
13	Simultaneous	Refund	12	14	
14	Sequential	No refund	14	12	
15	Simultaneous	No refund	14	12	
16	Sequential	No refund	12	14	
17	Simultaneous	No refund	12	14	
18	Simultaneous	No refund	12	14	12
19	Simultaneous	No refund	14	12	14
20	Sequential	No refund	12	14	12
21	Sequential	No refund	14	12	**

[a]An asterisk indicates that a treatment other than A or B took place.

REFERENCES

Andreoni, J., P. Brown, and L. Vesterlund. "What Makes an Allocation Fair? Some Experimental Evidence." *Games and Economic Behavior*, 40(1), 2002, 1–24.

Cadsby, C. B., and E. Maynes. "Voluntary Provision of Threshold Public Goods with Continuous Contributions: Experimental Evidence." *Journal of Public Economics*, 71(1), 1999, 53–73.

Coats, J., and T. Gronberg. "The Performance of Coordinating Institutions in Public Good Provision: An Experimental Study." Manuscript, St. Louis University, 2002.

Cooper, R., D. V. DeJong, R. Forsythe, and T. W. Ross. "Cooperation without Reputation: Experimental Evidence from Prisoner's Dilemma Games." *Games and Economic Behavior*, 12(2), 1996, 187–218.

Cornelli, F. "Optimal Selling Procedures with Fixed Costs." *Journal of Economic Theory*, 71(1), 1996, 1–30.

Croson, Rachel T. A. "Theories of Altruism and Reciprocity: Evidence from Linear Public Goods Games." Working Paper, Wharton School, University of Pennsylvania, 1998.

Fehr, E., and S. Gachter. "Fairness and Retaliation: The Economics of Reciprocity." *Journal of Economic Pespectives*, 14(3), 2000, 159–81.

Fehr, E., and K. M. Schmidt. "A Theory of Fairness, Competition, and Cooperation." *Quarterly Journal of Economics*, 114(3), 1999, 817–68.

Forsythe, R., J. L. Horowitz, N. E. Savin, and M. Sefton. "Fairness in Simple Bargaining Experiments." *Games and Economic Behavior*, 6(3), 1994, 347–69.

Harrison, G. W., and J. Hirshleifer. "An Experimental Evaluation of Weakest Link/Best Shot Models of Public Goods." *Journal of Political Economy.* 97(1), 1989, 201–25.

Harrison, G. W., and K. A. McCabe. "Expectations and Fairness in a Simple Bargaining Experiment." *International Journal of Game Theory*, 25(3), 1996, 303–27.

Isaac, R. M., D. Schmidtz, and J. M. Walker. "The Assurance Problem in a Laboratory Market." *Public Choice*, 62(3), 1989, 217–36.

Levine, D. K. "Modeling Altruism and Spitefulness in Experiments." *Review of Economic Dynamics*, 1(3), 1998, 593–622.

McKelvey, R. D., and T. R. Palfrey. "An Experimental Study of the Centipede Game." *Econometrica*, 60(4), 1992, 803–36.

Ross, L., D. Greene ,and P. House. "The False Consensus Effect: An Egocentric Bias in Social Perception and Attributional Processes." *Journal of Experimental Psychology*, 13(3), 1977, 279–301.