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Information, fairness, and reciprocity in the best shot game

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Abstract

Previous best shot experiments document behavior that converges towards the predicted equilibrium despite unequal equilibrium payoffs. Prasnikar and Roth [Quarterly Journal of Economics (1992) 865–888] hypothesize that strategic incentives displace fairness in this game. The current experiment illustrates that providing information differently results in fair outcomes.

Keywords: Fairness; Experiment; Best shot; Information; Reciprocity

JEL classification: D63; H41; C91

1. Introduction

Information is perhaps the most difficult treatment variable to control and analyze in economic experiments. On one hand, it is hard to tell whether participants use information the same way that theoreticians do, and on the other hand, it is not always clear whether the way that information is presented affects results. In this note, we analyze the presentation of information in the best shot game first introduced in Harrison and Hirshleifer (1989), HH.

The best shot game, BSG, is a two person interaction in which player one moves first by announcing a project level, q_1, and then, knowing the project level of the first mover, player two chooses a project level, q_2. The players' choices determine the provision of a public good; in this case the level of the public good is determined by $\max\{q_1, q_2\}$. Hence, the public good is provided collectively by the players 'best shot'.

The monetary incentives of the game are presented in Table 1. Players receive identical payoffs based on the maximum project level chosen, but each player must subtract $0.82 for each unit contributed. Given the sequential nature of the game the perfect equilibrium occurs where player one,

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Table 1
Best shot game payoff table (first ten units only)

Redemption values			Expenditure values	
Project level (units)	Redemption value of specific units	Total redemption values of all units	Number of units you provide	Cost of the units you provide
0	0.00	0.00	0	0.00
1	1.00	1.00	1	0.82
2	0.95	1.95	2	1.64
3	0.90	2.85	3	2.46
4	0.85	3.70	4	3.28
5	0.80	4.50	5	4.10
6	0.75	5.25	6	4.92
7	0.70	5.95	7	5.74
8	0.65	6.60	8	6.56
9	0.60	7.20	9	7.38
10	0.55	7.75	10	8.20

taking advantage of choosing first, announces a contribution of zero, and given this, player two's best response is to choose four units.[1] The equilibrium payoffs are unequal: $3.70 for player one and $0.42 for player two.

Prasnikar and Roth (1992), PR, analyze the BSG in comparison to the ultimatum game, UG.[2] They argue that the BSG is interesting because, while the sequential structure of the game and the unequalness of the equilibrium payoffs are similar to the UG, the off-equilibrium incentives are very different. As is well known (Camerer and Thaler, 1995; or Roth, 1995), proposers in the UG are rewarded by responders for making offers that differ from the perfect prediction. In fact, according to PR, the payoff maximizing demand is for half the pie (Fig. 1, pp. 876). By comparison, PR find that more generous first movers in the BSG are not rewarded by players two. In the BSG, second movers have a strong incentive to reduce q_2 because contributing is costly and any provision less than player one's is redundant. As a result, players one in their experiment maximize earnings by playing the perfect equilibrium strategy. Comparing these two games, the authors conclude that while fairness seems to explain deviations in the UG, strategic incentives dominate in the BSG. That is, fairness is rewarded in the UG, but not in the BSG.

To further account for the behavioral difference between the two games, PR hypothesize that

[1]For a more detailed description of the BSG see Harrison and Hirshleifer (1989); Prasnikar and Roth (1992), or Carpenter (2001).

[2]In the ultimatum game, the proposer, offers a share of an experimental pie and the responder, accepts, in which case the pie is split as proposed, or rejects, in which case both players receive zero. The perfect equilibrium prediction is where the proposer offers the smallest unit of account and the responder accepts.

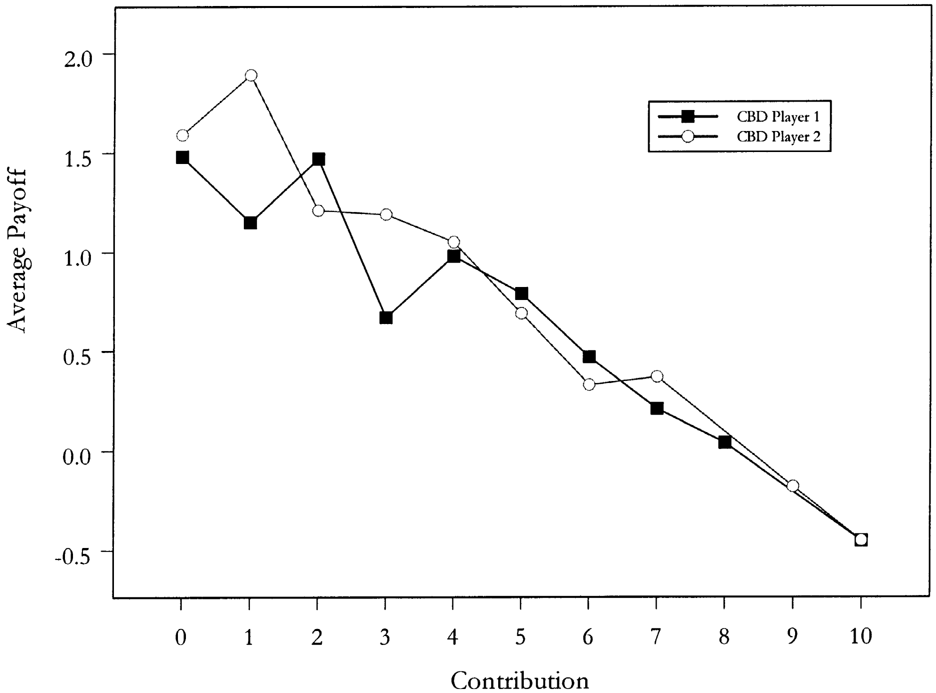

Fig. 1. Average payoffs in the CBD treatment.

information might affect convergence in the BSG. In the UG information is full in the sense that players know each other's payoffs. However, in the original study, HH, did not implement a *full information* best shot experiment because subjects were not sure what payoffs their counterparts received. For fairness to be important, subjects need to compare payoffs.[3]

To evaluate whether payoff information will move behavior towards more fair outcomes, PR compare a partial information game (a replication of HH) with a full information game where subjects know they share a common payoff table and must record their partner's payoff. The results of the two games are similar which the authors interpret as meaning fairness plays a limited role, at best, in the BSG.

In the next section, we will discuss the results of another best shot experiment that presented payoff information differently. In the PR full information game, subjects found out their partner's payoff only after both players had made their decisions. This means that payoffs could be compared only after the fact. In the following experiment, payoff comparisons are made before decisions are binding, which allows second movers to react in the heat of the moment. Specifically, players two were

[3]For example, the early bargaining results of Fouraker and Siegel (1963) show that fairness affects outcomes only when payoff information is shared.

allowed to see the payoffs that would result from any contribution before they submitted their choices. We call this the *compare before deciding*, CBD, treatment. As we will see, this results in fairer outcomes.

2. Another best shot experiment

A total of 26 participants took part in two sessions of the above mentioned, full information version of the BSG, and 20 participants took part in a replication of PR's full information treatment. Both treatments were computerized. Participants were randomly assigned the role of player one or player two and kept this role for all ten periods. As in other best shot experiments, partners were randomly rematched after each period.

Table 2 summarizes behavior in the current experiment as compared with HH and PR.[4] Overall, the original partial information study of HH comes closest to the equilibrium prediction. However, the treatments that are most similar are the HH partial information and the PR full information games, and the PR partial information game and the current results. This illustrates that the information treatment does not generate a predictable effect.

For our purposes, the most interesting comparison is among the full information games. Although the contributions of players one fall, our replication of PR's full information treatment does not move as fully towards the perfect equilibrium prediction as the original. Instead, players one contributions

Table 2
Average player contributions

Period	Mean player 1 project level (q_1)					Mean player 2 project level (q_2)				
	Partial information		Full information			Partial information		Full information		
	H&H	P&R	P&R	P&R(rep)	CBD	H&H	P&R	P&R	P&R(rep)	CBD
1	–	2.70	1.63	3.60	4.23	–	3.30	2.25	2.90	3.85
2	–	2.90	0.88	2.90	3.85	–	0.50	2.00	1.60	2.46
3	–	3.00	1.13	2.60	3.23	–	1.00	2.00	1.20	3.85
4	–	2.10	0.13	2.10	3.08	–	1.00	2.00	1.60	2.08
5	–	2.70	0.13	2.70	1.77	–	1.30	1.63	1.50	2.77
6	–	1.25	0.13	1.70	2.31	–	1.30	2.25	1.80	1.54
7	–	1.10	0.00	1.10	1.77	–	1.30	2.88	3.00	1.38
8	–	0.80	0.00	1.00	1.92	–	2.30	2.88	0.80	0.92
9	–	0.95	0.00	0.50	1.69	–	1.50	2.88	1.10	1.85
10	–	0.70	0.00	1.30	2.08	–	1.50	3.88	1.60	1.85
Overall	0.63	1.82	0.40	1.95	2.59	3.50	1.50	2.47	1.71	2.26
P&R = P&R(rep)			$t=5.77$, $P=0$					$t=2.40$, $P=0.02$		
P&R(rep) = CBD				$t=1.92$, $P=0.05$					$t=1.74$, $P=0.08$	
N/period	3	10	8	10	13	3	10	8	10	13

H&H: Harrison and Hirshleifer (1989); P&R: Prasnikar and Roth (1992); P&R(rep): replication of Prasnikar and Roth full information treatment; CBD: full information plus participants *compare* payoffs *before deciding* on a project level.

[4] Note, HH only report average contributions pooled across rounds.

dip below one only once and players two contributions rise as high as three only once. In fact, *t*-tests comparing the pooled means for players one and two show we were unable to replicate PR's results (line fifteen of Table 2). The difference between our results and PR's become greater when considering the CBD treatment. Line sixteen of Table 2 reports *t*-tests (of pooled means) indicating that both players one and players two contribute significantly more in the CBD treatment compared to the replication. Rather than converging on the perfect equilibrium, a better description of the behavior in the current experiment is that players one and two converge on contributing the same amount. Testing the difference in q_1 and q_2 in period ten yields $z = 0.63$, $P = 0.53$.

Strategic considerations do not appear to have displaced fairness in the current experiment. Instead, player two appears to consider the fairness of player one's decision before committing to an action. By the end of the experiment the participants have converged on the convention of contributing, on average, the same amount.

Fig. 1 illustrates that, as in the UG, there are payoff advantages to deviating from the perfect equilibrium, especially for players two. We use this as evidence in favor of the evolution of a behavioral equilibrium/convention that differs from the theoretical prediction. According to theory, players one should maximize their payoffs by contributing zero. This is largely true, but notice that players one do just as well by contributing two, on average, and the payoff variance of choosing two is lower (compare 2.81 to 3.47). For players two, the best response to the theoretical behavior of players one is to contribute four, but the behavioral best response (i.e. to the observed distribution of behavior) is to contribute one, and contributing zero, two, or three also result in larger average payoffs. Hence, given players one are not free-riding (contributing zero), players two do better by reducing their contributions. However, players two also do not maximize their expected payoffs by free-riding. Therefore, neither equilibrium in the best shot game predicts behavior, and there is pressure to contribute the same amount.[5]

An obvious question is, why is the expected payoff to free-riding for players one so much lower than the predicted level, 3.70? The most parsimonious answer involves negative reciprocity on the part of players two. Here, egoistic players one are disciplined by reciprocal players two. In 45% of the cases where player one chose zero units, player two reciprocated by choosing zero units. This resulted in both players earning zero for the period.

Lastly, notice that the resulting convention is costly in efficiency terms. Each role playing their component of the perfect equilibrium results in a total of 4.12 in benefits for each pair (3.70 for player one and 0.42 for player two) while playing the convention (call it each contributing two) results in a total payoff of only 0.62. This illustrates that players in the best shot game are willing to sacrifice efficiency for equity.

3. Discussion

The results of the current experiment demonstrate that the presentation and timing of information matters in economic experiments—especially those designed to study fairness. When subjects know how much they and their partner will earn before committing to a strategy, more fair outcomes are observed in the best shot game. Fairness is observed in the fact that players choose identical strategies

[5] Note, there is a second, non-perfect equilibrium in which players one contribute four and players two contribute zero.

resulting in equal payoffs. As in other experiments (Gueth et al., 1982; Gueth and Tietz, 1990; Fehr et al., 1997), negative reciprocity may drive the evolution of fairness in the current best shot game.

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