Economics Letters 36 (1991) 21–24
North-Holland

On the robustness of perfect equilibrium in fixed cost sequential bargaining under an isomorphic transformation

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Received 13 November 1990
Accepted 7 January 1991

Subgame perfect equilibrium realizations in sequential bargaining with fixed cost structures under positive and negative frames are studied. No effects for frame or experience are found. The strong prevalence of PE outcomes is discussed in the context of the fairness constraint found in other studies.

1. Introduction

The background to this experiment in sequential bargaining à la Rubinstein (1982) is the sharp contrast between the failure of subgame perfect equilibrium (SPE) predictions with fixed discount factors in finite [Ochs and Roth (1989)] as well as infinite horizon [Weg, Rapoport and Felsenthal (1990)], and the encouraging results of Rapoport, Weg, and Felsenthal (1990) regarding fixed bargaining cost games in infinite horizon. Here we extend the latter experiment beyond bargaining over a sweet pie to bargaining over a spinach pie. The choice of costs in the two situations ensures that the two bargaining games are isomorphic, thereby comparable.

To show the isomorphism between bargaining over a unit of surplus and a unit of deficit, we shall adopt the following notation. Let the costs for the players be c_1 and c_2. Two preference relations for player i, $\succcurlyeq_i^s$ for surplus games (S-games) and $\succcurlyeq_i^d$ for deficit games (D-games) are defined on the pairs $(x, t) \in [0, 1] \times \{1, 2, 3, 4 \ldots\}$. We set

$$(x, t) \succcurlyeq_i^s (y, r) \quad \text{if} \quad x - c_i t \geq y - c_i r,$$

and

$$(x, t) \succcurlyeq_i^d (y, r) \quad \text{if} \quad x + c_i t \leq y + c_i r.$$

* The research was supported by a grant from the Center for Research in Conflict and Negotiation, College of Business Administration, The Pennsylvania State University.

Now,

$$(x, t) \succsim_i^s (y, r) \Leftrightarrow x - c_i t \geq y - c_i r \Leftrightarrow 1 - x + c_i t \leq 1 - y + c_i r \Leftrightarrow x' + x_i t \leq y' + c_i r$$

$$\Leftrightarrow (x', t) \succsim_i^d (y', r),$$

where $x' = 1 - x$ and $y' = 1 - y$. Our interest in isomorphic D- and S-games lies in assessing the robustness of the SPE in view of the consistent differences shown for human subjects when confronted with losses as opposed to gains, in a variety of individual decision tasks [Tversky and Kahneman (1986)].

The null hypothesis is the 'focal point' split [Roth (1986)] – for if players ignore both individual differences in strategic postures and their differential eagerness to settle an issue, the bargaining game is symmetric, thus forcing any model to prescribe symmetric outcomes. Moreover, recent research proposes that pursuit of fairness will bring subjects to allocate more equitably [Güth (1988) and Kahneman, Knetsch and Thaler (1986)], even when symmetry in structure is not maintained.

2. The experiment

Subjects. Thirty-two student subjects, male and female, in four groups of eight participated in the experiment. They were recruited by advertisements in the Penn State University student paper promising financial gains resulting from participation in a bargaining experiment. A session involved bargaining among members of one group and lasted approximately 100 minutes.

Design. Each of the bargaining games consists of bargaining on a surplus or a deficit of \$15 with unequal costs per period of \$1.25 and \$0.05. Subjects were told that the bargaining will continue until an agreement is reached. In practice, a game is terminated if the negotiations reach the 14th period, which in fact, occurred very infrequently. The experiment has a $2 \times 2 \times 2$ structure of position held by the strong player (player 1 or 2), game type (S- or D-game), and experience (whether the subject playing player 1 holds this role for the first or second time). The last two factors are of the within-subject kind.

A session consists of ten steps (first two for practice), randomly partitioning the group so that four games of one type are played in parallel. Subjects interact in a X-window computer environment in which offers, acceptances, and rejections are transmitted through terminals. Subjects do not know against whom they are playing nor do they see each other's screens. The actual payoff to a subject is the average payoffs of two S-games and two D-games, selected randomly from the non-practice games.

3. Results

To facilitate the analysis the various offers were transformed in two ways. First, since for and given cost structure the D-games and S-games played are isomorphic, the offers in the D-games are presented in terms of savings. This procedure makes the offers directly comparable. Second, because the cost structure is so extreme the predicted offers to/by the strong player are very similar regardless of who moves first. It follows that if the SPE predictions are correct, there should be no significant differences due to the role played by the strong player when the offers to this player are analyzed.

Table 1 presents the mean first offers, mean final offers [1], their standard deviations and the

[1] When a game was terminated prematurely, the mean of the cell is used. For raw data see, Weg and Zwick (1990).

Table 1
Means and standard deviations of first and final offers to the strong player, and proportions of games ending in the first period by game type, experience and strength of player 1.

		First offer				Final offer			
		D-game		S-game		D-game		S-game	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
$c_1 < c_2$	Mean	12.58	13.48	12.42	13.81	12.62	11.53	11.65	12.02
	Std.	2.85	3.52	2.90	2.14	2.64	4.63	2.91	3.06
Proportion ending in the first period						0.63	0.56	0.38	0.38
$c_1 < c_2$	Mean	6.91	8.50	8.98	6.62	11.11	12.09	11.00	10.64
	Std.	2.87	4.83	2.75	4.55	3.33	3.37	3.46	4.67
Proportion ending in the first period						0.13	0.44	0.25	0.25

proportion of games ending in the first period by game type, experience, and strength of player 1. While the SPE model makes only a small distinction regarding the position occupied by the strong player, table 1 shows that this distinction is overemphasized in the first period and is attenuated as the game continues. Moreover, bargaining frames have no noticeable effects on the offers, no matter whether one considers first offers or final offers. Finally, no discernible experience effects are detected. A testing by multivariate linear model confirms these observations.

Next we consider more direct support for the SPE model. Table 2 presents the distributions of the first and the final offers. Notwithstanding the few absurd outlying offers, it is remarkable that 41% (34%) of all games ended (started) with agreements (offers) exceeding \$13.75. Relatively few outcomes were within the equitable or equal split payoffs. These distributions are not affected by the type of game played. However, the initial offer distributions are affected by the role of the first player, a result consistent with the analysis of the means reported earlier. Twenty games (16% of all games) ended in the first period with the strong player offered \$15. An additional 12 (9%) ended in the second period with offers of \$15 to the strong player. All but one of these last mentioned games were games where the stronger player was player 2.

Table 2
Distributions of first and final offers.

x	$Pr(X < x)$	
	First offers	Final offers
0.00	0.04	0.00
1.25	0.05	0.02
2.50	0.06	0.03
3.75	0.07	0.03
5.00	0.09	0.04
6.25	0.14	0.06
7.50	0.37	0.16
8.75	0.41	0.22
10.00	0.48	0.37
11.25	0.52	0.41
12.50	0.58	0.52
13.75	0.66	0.59
15.00	1.00	1.00

In an experiment testing SPE in discount factor games with a finite horizon, Ochs and Roth (1989) report that among other deviations from the SPE predictions, 81% of all counter-offers were worse in real terms than the rejected offers. Such a phenomenon hardly arose in our experiment. Of the 80 counter-proposals in the second period; only five were of this nature. This ratio is an upper bound over all periods.

4. Discussion

The data provided by this experiment complement the results of Rapoport et al. (1990) and lend additional support to subgame perfect rationality in fixed costs sequential bargaining with infinite horizon: SPE is supported in both surplus and deficit bargaining.

It is of interest to note that ultimatum games share with our games the SPE prediction that one player is allocated essentially nothing. In Güth, Schmittberger, and Schwarze (1982) the first player averaged 65% of the pie. In a related experiment, Kahneman et al. (1986) report that even in dictator games, situations where a player is given the task to divide a pie without any threat of rejection, equal splits are the predominant outcomes. Can one accept these authors' suggestion that players play fair? Why was fairness absent from the results of our experiment?

First, we contend that many of our subjects, naive as they were, knew the 'correct' strategies. Second, playing an infinite game allows the strong player to demand his share without fear of losing his advantage, an argument akin to one made by Binmore, Shaked and Sutton (1985). The first point is shared with the ultimatum and dictator games. The second is not! The immediate termination of the ultimatum games, and the desire not to be seen as greedy while collecting payoff as happened in the dictator experiments, are the probable sources of nonconformity with subgame perfect rationality.

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