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RISK AVERSION AND BARGAINING*

Some Preliminary Results

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1. Introduction

Game-theoretic models of bargaining can be thought of as falling into two broad classes: *axiomatic* and *strategic*.[1] In all of these models the preferences of the bargainers are represented by their von Neumann–Morgenstern utility functions.

A series of recent experiments has shown that these models lack descriptive power in a number of important respects. In particular, very clear 'focal point' effects have been observed, of a kind that will be described in somewhat more detail below, that cannot be accounted for within the framework of these classical game-theoretic models.

At the same time, the success of these classical models in the theoretical economics literature rests on the intuitively appealing *qualitative* predictions that they make in a variety of circumstances. Some of these qualitative predictions may prove to have descriptive power even though other aspects of the same model do not. Since these models are stated in terms of the von Neumann–Morgenstern utilities of the bargainers, their qualitative predictions are inevitably involved with the bargainers' risk postures.

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[1]The most influential single model has undoubtedly been the axiomatic model of Nash (1950). For a survey of the literature on axiomatic models, see Roth (1979). A particularly interesting strategic model has recently been proposed by Rubinstein (1982). An overview of a variety of strategic models can be found in Roth (1985a).

Roth (1979), Kihlstrom, Roth and Schmeidler (1981), Roth and Rothblum (1982), and Roth (1985b) systematically studied the models' predictions for the risk posture of bargainers. Rather surprisingly, a very broad class of different models, including all the standard axiomatic models[2] and the strategic model of Rubinstein[3] (1982), yield a common prediction: risk aversion is disadvantageous in bargaining, except when the bargaining concerns potential agreements that have a positive probability of yielding an outcome that is worse than disagreement. (This will be discussed in more detail below in the context of a specific experimental design.)

The experiment described below was designed to distinguish between the prediction of the axiomatic and strategic models discussed above, and three alternative hypotheses: (1) bargaining ability is a personal attribute uncorrelated with risk aversion; (2) bargaining ability is a personal attribute that is correlated with but distinct from risk aversion (e.g., 'aggressiveness'), thus influencing the outcome of bargaining independently of the location of the disagreement point; and (3) the outcome of bargaining is not influenced by the personal attributes of bargainers, but rather by the structure of the information shared by the bargainers. The last hypothesis is motivated by the focal point effect observed in previous experiments.

2. Binary and ternary lottery games

To experimentally test theories that depend on the von Neumann–Morgenstern utilities of the bargainers, the experiment must permit these utilities to be determined. A class of games that permits this was discussed in Roth (1979) and first used in an experimental setting in Roth and Malouf (1979). In these *binary lottery games*, each agent i can eventually win only one of two monetary prizes, a_i or b_i (with $a_i > b_i$). The players bargain over the distribution of 'lottery tickets' that determine the probability of receiving the larger prize: e.g., an agent i who receives 40% of the lottery tickets has a 40% chance of receiving the amount a_i and a 60% chance of receiving the amount b_i. Players who do not reach agreement in the allotted time each receive b_i. Since the information about preferences conveyed by an expected utility function is meaningfully represented only up to the arbitrary choice of origin and scale, there is no loss of generality in normalizing each agent's utility so that $u_i(a_i) = 1$ and $u_i(b_i) = 0$. The utility of agent i for any agreement is then precisely equal to his probability of receiving the amount a_i, i.e., equal to the percentage of lottery tickets he has received.

[2]Including those of Nash (1950), Kalai and Smorodinsky (1975), and Perles and Maschler (1980).

[3]See Roth (1985c). For a different interpretation see Binmore, Rubinstein and Wolhinky (1986).

Note that the set of feasible utility payoffs to the players of a binary lottery game is thus insensitive to the magnitudes of the amounts a_i and b_i for each agent i. One of the effects clearly observed in earlier experiments[4] but not predicted by the classical game-theoretic models is that these magnitudes nevertheless influence the outcome of bargaining. When bargainers knew the amounts of each other's prizes, agreements tended to cluster around two 'focal points': the 'equal-probability' agreement, that gives each bargainer 50% of the lottery tickets, and the 'equal expected value' agreement, that gives each bargainer the same expected value.[5] When bargainers did not know one another's prizes, or when the bargainers had the same prizes (so that the equal probability and equal expected value focal points coincided) agreements were observed to cluster around the equal-probability agreement, often with extremely low variance.[6]

Note also that the reason that the set of utility payoffs in a binary lottery game is insensitive to the size of the monetary prizes is that, precisely because each agent faces lotteries between only two final payments, his utility is not influenced by his risk posture. Risk aversion is a phenomenon that depends on the ability to make tradeoffs between at least three outcomes.

For our present purpose, we will therefore consider bargaining between two players in a *ternary lottery game*, in which each player i has three monetary prizes, a_i, b_i, and $c_i[a_i > b_i$ and $a_i > c_i]$. The players bargain over probabilities p_1 and p_2 (with $p_2 = 1 - p_1$) such that player i receives a_i with probability p_i, and receives b_i with probability $1 - p_i$. If the players fail to reach agreement in the allotted time, then players 1 and 2 receive c_1 and c_2, respectively. Letting the utility functions of the players be normalized so that $u_i(a_i) = 1$ and $u_i(b_i) = 0$, the utility of agent i for any agreement is once again equal to his probability p_i of receiving a_i. However each player's utility $u_i(c_i)$ for his disagreement payoff c_i is determined by his risk posture.

To compare the risk aversion of two individuals consider three monetary amounts a, b, and c, with $a > b > c$. Then a measure of an individual's risk aversion on this domain of three possible payoffs is the range of lotteries between a and c that he is willing to accept in preference to having the amount b for certain, i.e., the minimum probability of getting a (rather than c) that makes him like the lottery at least as much as the certain amount b. The individual i who is willing to accept the smaller range of lotteries – i.e., who has the higher minimum probability p_i – is said to be the more risk averse of the two individuals on this domain.

[4]Perhaps most clearly in Roth and Murnighan (1982).

[5]It is this latter agreement, of course, that is sensitive to the magnitudes of each player's monetary prizes. The distribution of agreements in Roth and Murnighan (1982) was observed to be bimodal, with modes at each of these focal points, while the distribution of *outcomes* was trimodal, with the third mode being bargaining sessions that ended in disagreement.

[6]See, e.g., Roth and Malouf (1979).

As mentioned earlier, a broad class of axiomatic models[7] make common predictions about bargaining games. To see the specific predictions make for ternary lottery games, we will consider two cases: first, the case in which $a_i > c_i > b_i$ for both bargainers $i=1$, 2, which will be called the case of *high* disagreement payoffs, and second the case in which $a_i > b_i > c_i$ for $i=1,2$, which will be called the case of *low* disagreement payoffs.

In the case of high disagreement payoffs, the disagreement utilities are given by $u_i(c_i)=p_i$ where p_i is the probability that makes individual i indifferent between the payoff c_i and the lottery that gives him a_i with probability p_i and b_i with probability $1-p_i$. Since under this normalization the disagreement utilities are the only feature of the model that is not symmetric between the two bargainers (in utility space), it is immediate that axiomatic models such as Nash's solution, for example, predict that the resulting agreement will give the higher probability of winning the preferred prize a_i to the player i with the higher disagreement utility $u_i(c_i)=p_i$. That is, these models predict an advantage in bargaining in this situation to the player who is more risk averse.

In the case of low disagreement payoffs, the disagreement utilities are given by $u_i(c_i)=p_i/[p_i-1]$, where p_i is the probability that makes individual i indifferent between the payoff b_i and the lottery that gives him a_i with probability p_i and c_i with probability $1-p_i$. As before, models such as Nash's predict the resulting agreement will give the higher probability of winning the preferred prize a_i to the player i with the higher disagreement utility $u_i(c_i)$, but in this case the disagreement utility $u_i(c_i)$ is a *decreasing* function of p_i. This is, these models predict a *dis*advantage in bargaining in this situation to the player who is more risk averse.

3. The study (reported as study I in Cahier 8536)

The risk aversion of each participant was assessed by having him consider a sequence of lottery choices. Players were asked to choose between receiving \$5 for certain, or participating in a lottery that would give them \$10 with probability p and \$2 with probability $1-p$, with p decreasing as the sequence of choices progressed. They were instructed that, at the end of the experiment, one element of the sequence would be chosen at random, and they would receive what they had chosen, i.e., \$4 or the lottery. Participants were then sorted according to their risk aversion (i.e., by how frequently they chose the sure \$5): individuals in the more risk averse half of the experimental population bargained with individuals in the less risk averse half of the population.

[7]Including all those that are symmetric in the space of individually rational utility payoffs and monotone in a bargainer's disagreement utility.

After the lottery choices, each pair of bargainers played two ternary lottery games, one game with $a_i=\$10$, $b_i=\$5$, and $c_i=\$2$ for both bargainers $i=1,2$, and the other game with $a_i=\$10$, $b_i=\$2$, and $c_i=\$5$ for both bargainers $i=1,2$. (Since bargaining was conducted anonymously via computer terminals, and since this pair of games between the same bargainers was interspersed with games against other opponents, bargainers were unaware that they bargained twice with the same individual.) The prediction of the classical game theoretic model is that the more risk averse of the two bargainers will receive less than 50% of the lottery tickets in the low disagreement payoff game, and more than 50% in the high disagreement payoff game.

Note that this prediction, which implies that the bargainer who does better in one game should do worse in the other, contradicts the prediction of the other two hypotheses about bargaining ability as a personal attribute. If bargaining ability is related to some personal attribute that influences the outcome of bargaining independently of the position of the disagreement payoff, then the relative outcomes of the two players in the two games should be the same; i.e., the 'better bargainer' should do better in both games. If bargaining ability is related to some personal attribute of the bargainers that is uncorrelated with their risk aversion, then which bargainer does better should be independent of the sorting by risk aversion. If bargaining ability is correlated with risk aversion, but unaffected by the position of the disagreement payoff, the more or less risk averse bargainers should obtain consistently better outcomes.

4. Conduct of bargaining

Approximately 30 volunteers were recruited. In the first part of the experiment the participants made their 21 choices between \$5 or a lottery between \$2 and \$10. In the second part of the experiment the eight most risk averse subjects (according to their lottery choices) were paired with the eight least risk averse subjects. Each subject had four bargaining sessions lasting nine minutes each. A more detailed description of a similar bargaining session can be found in Roth and Murnighan (1982).

5. Results

The first question before analyzing the actual bargaining outcomes was whether the assignment of players as more or less risk averse successfully differentiated between them. In other words, were the less risk averse players actually significantly less risk averse on their initial selections from the 21 lottery choices? An analysis of variance using the number of lottery choices as the dependent variable and the assignment to positions of less or more risk averse as independent variables yielded clear results: players identified as less risk averse chose significantly more lottery choices $\bar{X}=11.2$) than players identified as more risk averse ($\bar{X}=4.2$): $F(1.62)=112.3$, $p<0.0001$.

There were 68 games played, 27 disagreements, all of them in the games with a disagreement prize of $5. Among the agreements there were 25 equal 50–50 divisions, 15 divisions where one player received 43 to 49 (and the other obviously from 57 to 51), one 40–60 division and one 35–65 division.

Pairs of bargainers reached two agreements only five times. An additional subset of these data also provides some information to test the prediction. In situations where a disagreement occurred, say in the high disagreement game (the most frequent case), support for the predictions could also be counted if the less risk averse player's final demand when they disagreed was *less* than his agreed upon outcome in the low disagreement game. In such situations, if bargaining had continued until an agreement was reached, the less risk averse player would necessarily have obtained a lower outcome than he received in the low disagreement game unless bad faith bargaining (increasing your demands rather than making concessions) occurred.[8] When these clear cut final demands are taken into consideration there are seven pairs where the more risk averse player does better in the low disagreement condition than in the high disagreement condition and two pairs where he does better in the high disagreement condition. This is in the direction predicted by the theory but it is not statistically significant.

In this study there was a preponderance of 50–50 agreements. This is consistent with data collected from numerous previous experiments which indicate that agreements tend to cluster around 'focal points'. There were also many disagreements in the high disagreement prize condition.

The typical pair of outcomes was a 50–50 agreement in the low disagreement condition and a disagreement in the high disagreement condition. This makes it difficult to discern the effects of risk aversion. To the extent that we could observe this effect, our data supported the theoretical predictions.

More data was needed to permit statistically reliable conclusions. Since only a small fraction of the data using this design permitted the hypothesis to be tested we decided to collect the additional data using a modified design that would decrease the number of disagreements and increase the variance of the agreements. Our previous experiments suggested changes in the prizes that would achieve these objectives and therefore allow us to more easily ascertain the effect of risk aversion. The two additional studies are explained in Murnighan, Roth and Schoumaker (1986) from which this summary is drawn. The additional data obtained from these studies allowed us to observe statistically significant effects of risk aversion in the predicted direction. The reader is referred to the full report for a discussion of these results and their significance.

[8]We never observed any agreements where bargaining in bad faith increased a player's potential outcomes. Instead, this was not frequent, and was usually a cue for disagreements.

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