FOCAL POINTS AND BARGAINING

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The idea of a focal point is of great practical importance. However, no consensus exists concerning the manner in which focal points become established or survive after their establishment. At one extreme, some authors emphasize rationality considerations above all else. At the other extreme are authors who argue that social norms are so important that strategic issues can be neglected entirely. Even those who emphasize the importance of social norms are left with unresolved questions. In particular, when several distinct social norms compete for attention, how do people decide which social norm should be followed?

Social norms have played a prominent role in discussions of bargaining, and this paper describes the results of a set of experiments that study the establishment and stability of focal points in the context of a bargaining game. These experiments are described in more detail in the paper by Binmore et al. (1993).

The example of bargaining studied in the experiments is Nash's (1950) bargaining problem. In this problem, two players can achieve any point x in a feasible set X provided that they reach an agreement. Otherwise, the result is a fixed disagreement point ξ in the set X. The feasible set used in the experiments is shown in Figure 1.

There are at least two reasons why the Nash bargaining problem provides a good basis for the experimental study of focal points. First, many candidates have been proposed as focal points for Nash's bargaining problem along with a variety of arguments in support of one or another candidate solution. Proposed solutions include the Nash (1950) bargaining solution, the Kalai–Smorodinsky (1975) bargaining solution, the utilitarian solution associated with Harsanyi (1977), and the equal increments solution associated with Rawls (1972).[1] For the feasible set used in the experiments, these four proposed focal points are shown in Figure 1.

A second attractive feature of the Nash bargaining problem is that it has a continuous strategy space. Cooper et al. (1991) and Van Huyck, Battaglio, and Beill (1991) have studied coordination problems in situations involving discrete choices. But in a discrete

[1] The point in X selected by the equal increments solution is the one that would be selected by Rawls' (1972) maximin criterion. It is also a special case of the proportional bargaining solution studied by Raiffa (1953) and others.

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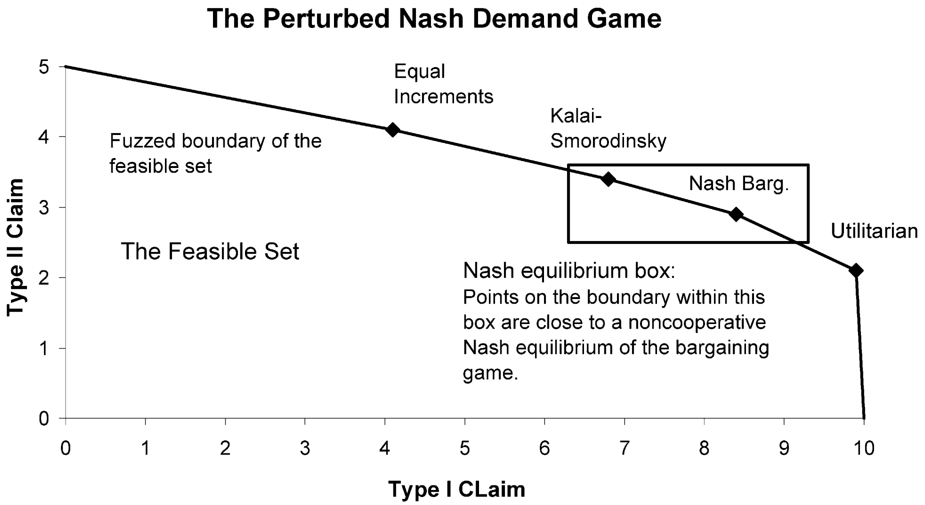


Figure 1. In the Nash demand game, a type I player makes a claim along the horizontal axis of the figure while, simultaneously, a type II player makes a claim along the vertical axis. If the point whose coordinates are determined by this pair of claims falls within the feasible set, then each player receives his claim. If the point falls outside the feasible set, then each player receives the disagreement payoff, which was normalized to 0. The experiments described in this paper involved a perturbed Nash demand game that added a fuzzed boundary to the feasible set. When claims fell on the fuzzed boundary, bargainers received their claims with some probability. In order to control for risk aversion, payoffs were in lottery tickets. After each 10 plays of the game, subjects had the opportunity to win $10 with a probability equal to the number of lottery tickets they had accumulated divided by 100. The horizontal and vertical scales of figures in this paper represent claims to lottery tickets. Focal points that have been proposed to predict the outcome of the Nash demand game include the equal increments solution, the Kalai–Smorodinsky solution, the Nash bargaining solution, and the utilitarian solution. These focal points are all labeled in the figure. The discretized version of the perturbed Nash demand game that was actually played has 12 non-cooperative Nash equilibria which lie along the section of the boundary enclosed by the box shown in the figure.

coordination problem, it may be hard to destabilize an existing focal point. For example, a population cannot drift gradually from driving on the left to driving on the right.

In order to study the Nash bargaining problem, a bargaining protocol must be specified. One of the simplest bargaining protocols is the Nash (1950) demand game, and this is what was used in the experiments. In each experiment, a group of 12 subjects played the same Nash demand game repeatedly, half the time as player I and half the time as player II. At each play, a subject was matched unpredictably with another subject with whom they were to bargain. Subjects interacted anonymously through a computer display like that shown in Figure 2.

A subject assigned the role of player I in the current play registered a demand x_1 by moving a cursor along the horizontal axis of the feasible set as illustrated in Figure 2. Simultaneously, the subject assigned the role of player II registered a demand x_2 by moving a cursor along the vertical axis of his display. Each player made his demand in

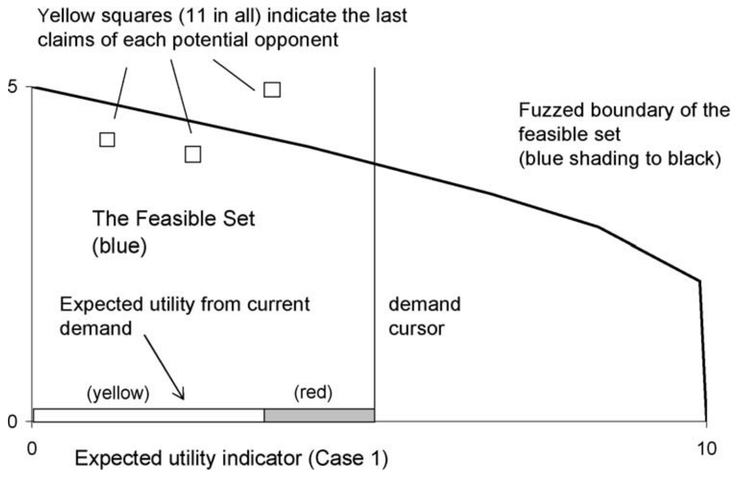


Figure 2. The computer display when a subject is player I.

ignorance of the current demand of the other subject. If the point $x = (x_1, x_2)$ was contained in the feasible set, then each subject received his claim. Otherwise, each player received the disagreement payoff, which was always 0 (i.e., $\xi = 0$).

Risk aversion was controlled using the standard technique of paying the subjects in lottery tickets. Hence, the scales along the vertical and horizontal axes of the figures in this paper represent claims to lottery tickets. After each 10 plays of the game, subjects had the opportunity to win \$10 with a probability equal to the number of lottery tickets they had accumulated divided by 100.

Subjects actually played a perturbed Nash demand game in which the boundary of the feasible set was fuzzed along a narrow strip. Whether subjects would receive a pair of claims that fell within this fuzz was uncertain. For example, if the pair of claims fell on a 60% contour running through the fuzzed strip, then subjects would be granted their claims by the computer only 60 percent of the time.

Following a suggestion of Nash (1950), the fuzzing or smoothing was added to reduce the set of non-cooperative Nash equilibria of the Nash demand game. Any Pareto efficient x in X is a Nash equilibrium of the unperturbed Nash demand game. This includes all four of the proposed focal points illustrated in Figure 1. But it would be a much sharper test of the relevance of strategic considerations versus social norms in determining bargaining outcomes if the proposed focal points were not in fact Nash equilibria. With the fuzzed boundary and a continuous strategy space, all the non-cooperative Nash equilibria are close to the Nash bargaining solution. [See papers 4 and 8 of Binmore and Dasgupta (1987).]

As it turned out, the extent to which the set of non-cooperative Nash equilibria could be reduced was limited by technology. The cursor which subjects used to register their claims moved in small but barely perceptible discrete jumps. This changed the strategy space from a continuous set to a set with a large but discrete number of choices. In the discretized version of the perturbed Nash demand game, there were 12 non-trivial Nash equilibria which lie along the section of the boundary enclosed by the box shown in Figure 1.[2] Note that the equal increments solution and the utilitarian solution were not close to Nash equilibria of the discretized, perturbed Nash demand game. However, the Kalai–Smorodinsky solution and, of course, the Nash bargaining solution were close to such equilibria.

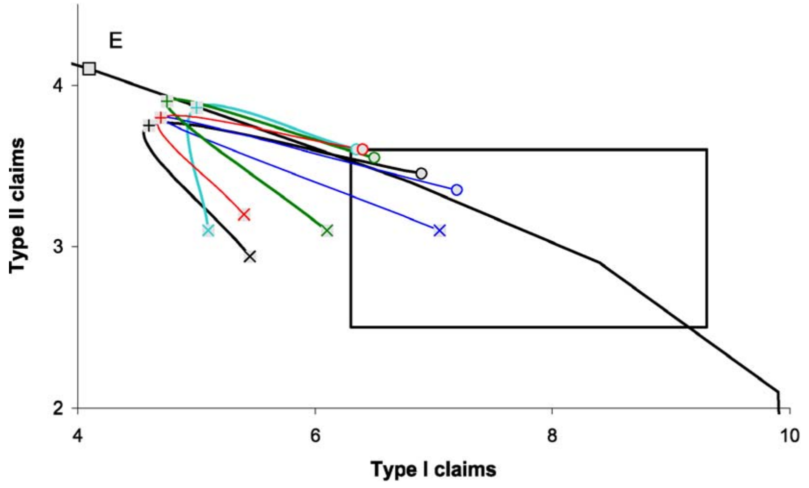
After a hands-on interactive session at the computer to learn the mechanics of the program, subjects first played 10 "practice" games "against the computer" followed by 40 games against "real" opponents. Both when playing the computer and playing against real opponents, subjects sometimes occupied the role of player I and sometimes the role of player II.

In both the real and practice games, subjects were provided with considerable information concerning the past plays of the population of potential opponents. On the computer display, 11 small yellow squares were superimposed on the region representing possible demands. The x-coordinate of the center of a given yellow square indicated the demand made by one potential opponent when that opponent last occupied the role of player I. Similarly, the y-coordinate of the center of the square was the last claim made by that opponent as player II. As a type I subject varied his demand by moving his demand cursor horizontally across the computer screen, the squares changed from yellow to red as the demand represented by the current placing of the subject's cursor became incompatible with the last type II demands made by the subjects represented by their respective squares. The display worked analogously for a subject occupying the role of player II.

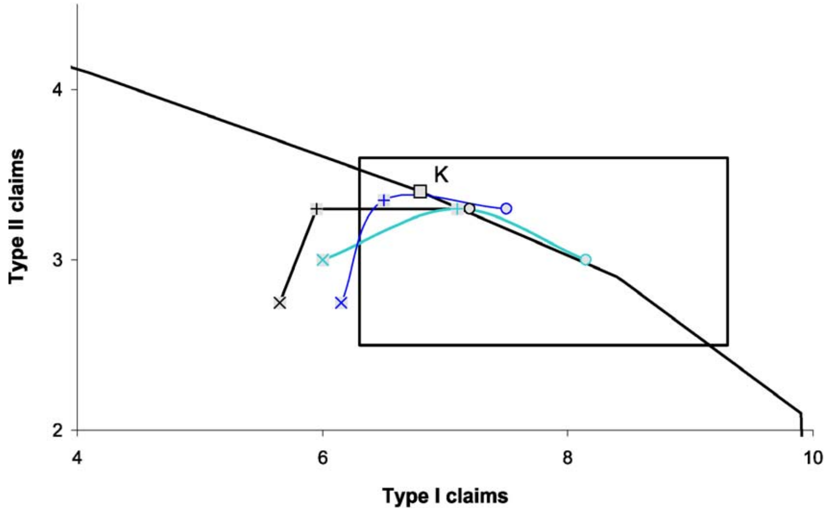
Subjects in Case 2 were offered only this information about the other subjects. Subjects in the main experiment, Case 1, were given more information by the addition of an "expected utility indicator." This took the form of a second cursor that showed the expected number of lottery tickets that the subject would receive if he made the demand indicated by the current placing of the demand cursor and the other subjects made the demands indicated by the current placing of the yellow squares. Figure 2 shows the expected utility indicator and several yellow squares for a subject occupying the role of player I.

In the practice games, the information display was used in a (successful) attempt to condition the subjects to begin the games against real opponents close to one of the four focal points under consideration. For example, in the treatment designed to study the equal increments solution as a possible focal point, the yellow squares representing simulated potential opponents were designed to converge slowly over the course of the 10 practice games from a fixed initial configuration to a cluster close to the equal increments solution. The convergence was deliberately not total. After being conditioned

[2] There were also a large number of trivial Nash equilibria where both players make a claim outside the feasible set and both players receive 0.



(a)

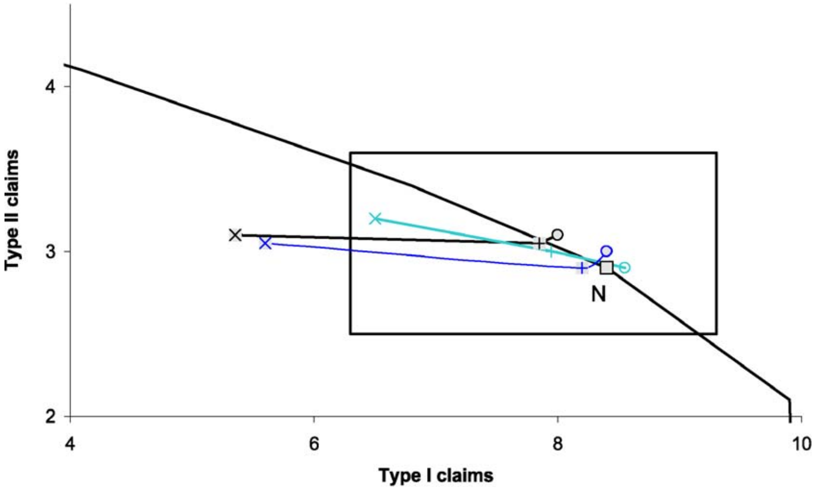


(b)

Figure 3. (a) Case 1E. (b) Case 1K. (c) Case 1N. (d) Case 1U.

to begin by making demands close to the equal increments solution, the question was whether subjects would continue to use this focal point once play against real opponents began.

The four panels, 3a through 3d, that comprise Figure 3 illustrate the main results of the experiment. Each of the panels represents a separate treatment used in Case 1. In Case 1E, the yellow squares in the practice games converged toward the equal incre-



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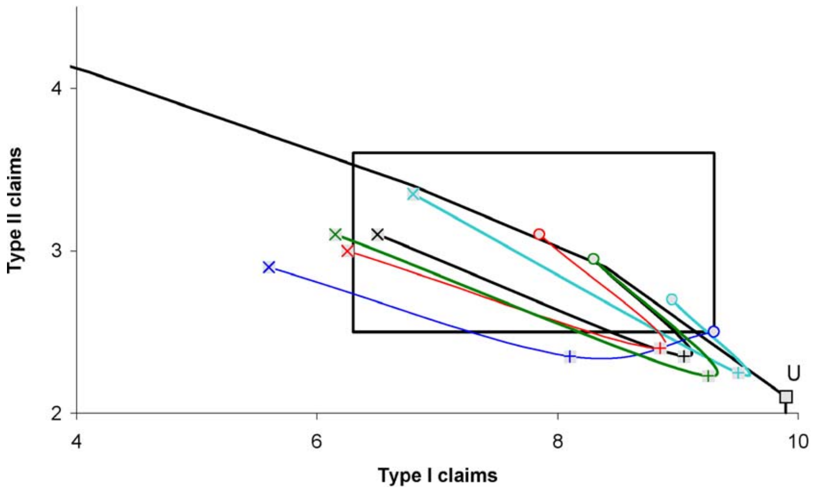

(d)

Figure 3. (*continued.*)

ments solution, E. In Case 1K, the squares converged toward the Kalai–Smorodinsky solution, K. In Case 1N, the yellow squares converged toward the Nash bargaining solution, N, and, in Case 1U, convergence was toward the utilitarian solution, U.

The curved lines in Figure 3 do not represent trajectories.[3] Each of the 16 sets of lines corresponds to a different group of 12 subjects and summarizes their experience

[3] Trajectories of the median claims made in selected experiments are reproduced in Binmore et al. (1993).

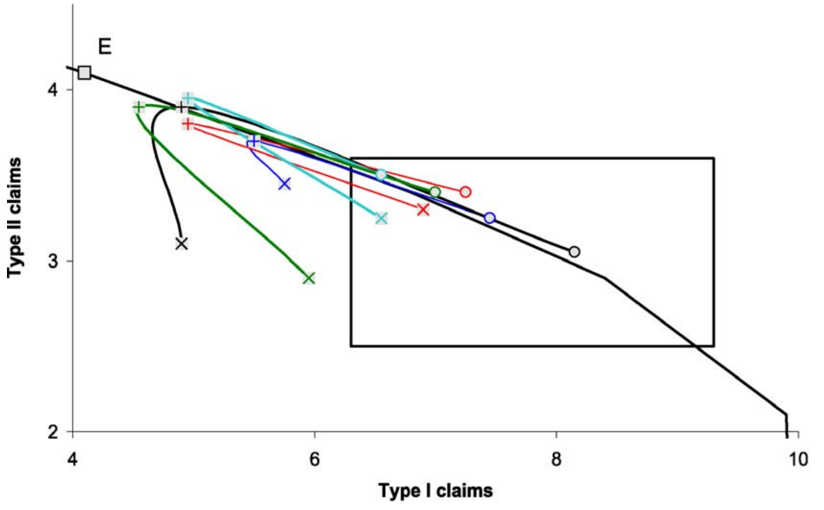

Figure 4. Case 2.

by linking three points. Each point is a pair of median demands. The x-coordinate is the median demand of player I and the y-coordinate is the median demand of the player II. These numbers are plotted for three stages in each experiment. (1) At the very beginning – i.e., in the first and second practice games before any experience had been gained.[4] (2) Immediately after the practice games – i.e., in the 11th and 12th plays that followed the 10 conditioning practice games. (3) At the very end – i.e., in the 49th and 50th plays, after 10 practice games and 40 real games. In Figures 3a through 3d and Figure 4, the points indicating median claims made at the very beginning of each experiment are labeled with an "×." Points indicating the median claims made immediately after the practice games are labeled with a "+." Points indicating the median claims made at the end of each experiment are labeled with a "○."

We draw the following conclusions from the results presented in Figure 3. (1) Whatever social norms the subjects may bring to the experiment are easily displaced. Subjects can be conditioned to begin bargaining against real opponents close to any of the four focal points considered here. (2) The equal increments and utilitarian focal points are not stable. (3) The explanation that groups of subjects converge on an exact Nash equilibrium of the discrete game which they actually played fits the data very well.

One potential criticism of the above experiments is that the graphical display might have made the process of myopic optimization focal. The five experiments in Case 2 were an attempt to investigate the extent to which the results of Case 1 were dependent on the information presented in the computer display. Case 2 was identical to Case 1E

[4] The computer updated the information contained in the yellow squares every second play.

except that the subjects were deprived of the expected utility indicator described earlier. The results are illustrated in Figure 4. Perhaps surprisingly, the subjects' behavior was not very different from that in Case 1E.

The results of these experiments clearly do not support the view that strategic considerations in bargaining situations can be ignored in favor of a study of fairness norms. Indeed, we believe that it is a major error to suppose that social norms are commonly so rigid that they are able to sustain behavior in the long run that is not in equilibrium.

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