

Bargaining in the shadow of a commitment problem

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Abstract

This paper reports results from laboratory experiments on how commitment problems affect bargaining choices. Subjects are randomly assigned the conditions that produce a commitment problem in order to estimate the effect the commitment problem condition has on bargaining behavior. The empirical results suggest subjects are consistently responsive to the commitment problem condition. When presented with a commitment problem, most subjects identify the condition and choose the present day lottery over future negotiation. Moreover, subjects not exposed to the commitment problem condition bargain as if they were playing the one-stage ultimatum game. Subjects in both games are responsive to their own costs rather than their opponents, playing as if this complete information game were in an incomplete information setting.

Keywords

bargaining, experiments, commitment problem

A commitment problem exists when an individual would rationally choose a present-day costly lottery, where the lottery outcome is uncertain, over a certain bargained future outcome, because her bargaining leverage significantly decreases in the future. This choice, even under perfect and complete information, can produce costly conflict; it is important to many areas of political science because it illustrates how the inefficient breakdown of bargaining can occur even when all of the actors are fully informed. The purpose of this paper is to answer three questions related to commitment problems. (1) Can subjects identify when commitment problems exist? (2) Do demands in two-stage commitment problem games differ from demands in one-stage ultimatum games? (3) How do win probabilities and costs for the lottery shape subjects' demands and the magnitude to which these demands deviate from equilibrium?

Scholars increasingly recognize that the inability to resist taking advantage of changes in bargaining leverage represents a key impediment to conflict resolution. Powell (2004), for instance, points to cases as diverse as labor strikes, litigation, and civil wars as types of conflict that often fail to reach a settlement because the disputants cannot credibly commit not to take advantage of a rapid change in bargaining leverage (Acemoglu and Robinson, 2000). Weingast (1995) points to one sweeping example in what he calls the “fundamental political dilemma of an economic

system”: that the government powerful enough to protect property is powerful enough to take it and finds it difficult to commit not to do so. In addition, Alesina and Tabellini (1990) argue that political parties overspend because of their inability to commit to future expenditure levels. Some scholars suggest the secret ballot creates a commitment problem where voters cannot credibly commit to vote for particular candidates (Goemans and Fey, 2009). Besley and Coate (1998) find that democratic leaders' and parties' inability to commit to future policies and actions can create inefficiencies. Others suggest a barrier to ending civil wars is that neither rebels nor government can commit to disarm, or commit not to resume fighting once the other side disarms (e.g. Fearon, 2004; Walter, 2002). Likewise, some argue commitment problems lead to costly conflict, even where combatants agree on some bargained solution, and even under complete information (Fearon, 1995; Powell, 2006).

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In recent work, other scholars use experiments to examine rationalist claims in bargaining protocols (Quek, forthcoming; Sieberg et al., 2013) and to examine bargaining choices given expectations regarding future interactions (Kertzer and Rathbun, 2015; Tingley, 2011). The specific commitment problem we examine in this paper unfolds in a bargaining context where two parties disagree over the division of some good. At the outset, the first player decides whether to bargain or to fight. If the latter option is chosen, the parties resort to a costly lottery. If, on the other hand, she decides to bargain, the parties amicably divide some good, or resort to a lottery to divide the good for them. In all cases, each party's chance of winning either the first or second lottery is known, and the cost of playing either lottery is also known. In this setting, a commitment problem exists when the first player's chances of winning the lottery in the second stage decline significantly. We examine this particular two-period game in a laboratory setting aimed at determining whether subjects are responsive to conditions that represent commitment problems, where subjects choose to bargain, and how successfully they identify optimal divisions of the good, given the parameters of the lottery.

Data from the experiments indicate three main findings. First, we find strong evidence that subjects choose the early lottery when commitment problem conditions exist, and choose to bargain otherwise. Second, when subjects choose to bargain, their demands diverge from Nash; this is consistent with other experimental findings in bargaining games. Third, we find those deviations from Nash may arise because subjects are responsive to their own costs for conflict, but do not evaluate their opponents' costs. In doing so, subjects play this complete information game as if it were an incomplete information game. The findings suggest bargaining opponents are responsive to bargaining choices consistent with what models of commitment, like Powell's 2006 model, anticipate.

The inattentiveness to others' costs represents a novel experimental finding that helps to explain bargaining failures. An insensitivity to opponents' costs may indicate why decision makers so often make demands in bargaining that their opponents cannot rationally accept, reducing the possibility of peaceful bargains, and increasing the likelihood of bargaining failure and conflict. Further, since our results suggest that individuals play a complete information commitment problem game as if they had incomplete information, our findings provide additional evidence that bargaining situations with complete (or nearly complete) information may not mean that such complete information significantly helps decision makers' avoid bargaining failure and conflict.

Commitment and conflict

Many treatments of the bargaining model in international relations are one-period ultimatum-style games where two

parties must divide some good. The first player proposes a division of the good, and the second either accepts (in which case the game ends, implementing that division) or rejects (in which case the game ends in a costly lottery). Players' choices are made in light of the distribution of win probabilities and the costs for playing the lottery.

Other games, however, consider future bargaining periods, and thereby introduce the question of expected shifts in power over time. In general, such games require bargainers to pay significant attention to those potential shifts in power and how such shifts would affect the present and future values of conflict. Games like this often present problems of commitment where the possibility of an adverse future shift in the win probability increases the relative value of the present-day lottery. Commitment games can be thought of as presenting players with two specific questions that distinguish this game structure from the ultimatum game: what is the value of conflict now versus a bargain in the future; and, if bargaining is more valuable than conflict now, what is the optimal portion of the good to demand from my opponent? Structuring the comparison this way places theoretical emphasis on how facing a costly lottery in the initial stage of the game differs from the proposal that begins the ultimatum game.

The commitment problem may arise for four possible reasons. First, the chances of winning the present day lottery may be high or the costs of the present day lottery may be low; this makes fighting today more appealing than a bargain tomorrow. Second, the future cost of conflict for an individual's opponent may be low, also making fighting today more attractive than bargaining tomorrow. Third, the value of winning the conflict in the future is discounted compared to the value of winning conflict now. Finally, these three features may combine in ways that produce bargaining failure. Powell (2006) expresses this dynamic condition formally. For this condition to hold, the future value of bargaining must be small enough relative to the present value of conflict that the actor growing weaker prefers to fight now, while it is still relatively strong; waiting for the future produces a lower value for a bargained outcome because the individual's bargaining leverage has significantly declined. Using the typical costly lottery payoffs and assuming there is no discounting gives the condition for a commitment problem as

$$p_1 - p_2 > c_1 + c_2 \quad (1)$$

where p_1 represents actor 1's win probability today and p_2 represents actor 1's win probability tomorrow. The costs of conflict today for actor 1 are c_1 and the future costs of conflict are c_2 for actor 2. Therefore, if actor 1 fights today she can expect $p_1 - c_1$, and she compares this to bargaining tomorrow with a certain payoff of $p_2 + c_2$. This equation shows that the commitment problem is caused by the relationship between the expected shift in power (and therefore

the chances of winning) and the sum of the costs of fighting. If actor 1's expected value of fighting today ($p_1 - c_1$) exceeds the value of her equilibrium bargaining demand tomorrow ($p_2 + c_2$) then she should rationally choose to fight now since actor 2 cannot commit not to take advantage of his increased leverage in the future. If the condition does not hold, the actors should bargain and divide the good efficiently without incurring any costs; there is no commitment problem, and a bargained solution presents itself.

This discussion points to the three questions we address in the empirical section of the paper in order to assess the effect of commitment problem dynamics on the bargaining process.

- Given information about win probabilities and costs, can subjects identify when a commitment problem exists and choose the appropriate action (bargain if no commitment problem exists; choose the early lottery if one does)?
- How do the exogenous variables (win probabilities and costs) shape the demands?
- Do demands in the two-stage game differ from demands in the one-stage ultimatum game?

Empirical strategy

To assess the effect of bargaining in the shadow of a commitment problem, we implement a set of bargaining experiments. In those experiments, subjects played either the ultimatum model shown in Figure 1 or the two-stage commitment problem game shown in Figure 2. The subjects were drawn from the population of undergraduate students at the University of Maryland. The experiments were conducted in six sessions over August and September of 2014. Each subject played the game ten times; their actions were recorded using the Z-tree computer program (Fischbacher, 2007). In total, 29 subjects participated in the ultimatum model game, and 30 subjects participated in the commitment problem game. This yielded 290 observations for the ultimatum game and 300 observations for the commitment problem game.

The payoffs in these games are identical. The only difference between the two strategic settings is that in the commitment problem game, the first player chooses between a lottery and bargaining with the second player. In the ultimatum game, subjects only decided how to divide US\$10 at the initial node of the game.

For each round in the ultimatum game, subjects are instructed to divide US\$10 with the computer. In each round, subjects learn their chances of winning the lottery, and the costs to each player; these all vary across rounds. Win probabilities are drawn from a uniform distribution, with a lower bound of zero and an upper bound of one, and costs are drawn from independent uniform distributions

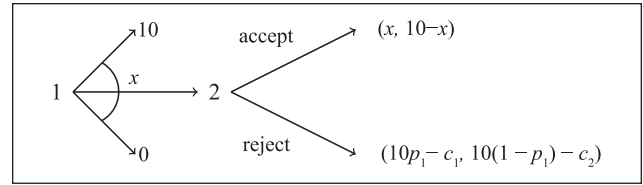


Figure 1. Ultimatum bargaining.

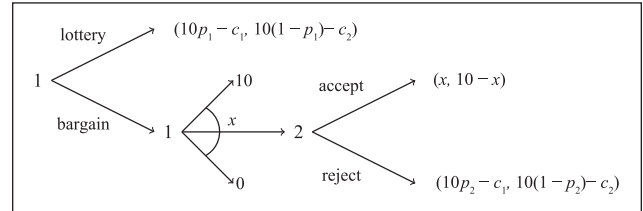


Figure 2. Commitment problem dynamic.

with a lower bound of zero and an upper bound of 0.20.¹ The computer accepts a player's demand if it is less than or equal to the optimal division defined in terms of the Nash equilibrium of the game (i.e. $x^* \leq 10p_1 + c_2$).

The choice to pair subjects with the computer rather than randomly assigning the subjects to pairs was both purposeful and practical. This decision was purposeful because it holds constant the concern that the subjects might have about their opponents' play. It would be difficult to speak directly to the question of "can subjects identify a commitment problem?" if the exogenous variables *and* beliefs about the responders' play constituted the condition. In fact, any number of values for power and costs could create a commitment problem, depending on the subjects' beliefs about the responders' play. This choice to pair subjects with a computer gives us more control over this potentially confounding effect. The choice was practical because it allowed us to obtain more observations from a smaller sample of subjects.

Subjects playing the commitment problem version of the game, depicted in Figure 2, also learn the probability of winning the lottery and the lottery's costs. Because subjects choose between bargaining or playing the lottery at the first node of the game, these subjects were told the probability of winning the lottery at the first node *and* the probability of winning the later lottery during bargaining. The costs of the lottery are held the same in the two stages of this game (though they are drawn anew in each round). As in the ultimatum version of the game, these variables are drawn from the uniform distribution with a lower bound of zero and an upper bound of one for the probability of winning the lottery and with a lower bound of zero and an upper bound of 0.20 for the costs of the lottery. And, just as in the ultimatum game, the computer accepts demands less than or equal to the Nash value.

Both of these games are of complete and perfect information. The solution concept is the subgame perfect Nash

equilibrium, identified by backwards induction. In all cases, subjects know whether the game is one- or two-stage, all win probabilities, and all costs.

In the case of the ultimatum game, at the final node the second player chooses between accepting and rejecting the demand from the first player. The demand is accepted if $10 - x \geq (1 - p_1)10 - c_2$. Otherwise, the second player rejects the demand. Knowing the second player's decision rule, the first player chooses the x^* that maximizes her utility, subject to the constraint that the second player accepts. This optimal demand is

$$\begin{aligned} 10 - x^* &\geq (1 - p_1)10 - c_2 \\ x^* &= 10p_1 + c_2 \end{aligned}$$

This demand is always accepted by player 2 and this combination of actions make up the subgame perfect equilibrium of the game.

The analysis is similar for the commitment problem game. Again beginning with player 2's decision at the final node, player 2 accepts the demand if $10 - x \geq (1 - p_2)10 - c_2$. Otherwise, the second player rejects the demand. Knowing the second player's decision rule, the first player chooses the x^* that maximizes her utility, subject to the constraint that the second player accepts. This optimal demand is

$$\begin{aligned} 10 - x^* &\geq (1 - p_2)10 - c_2 \\ x^* &= 10p_2 + c_2 \end{aligned}$$

This combination of actions by player 1 and 2 constitute the subgame perfect equilibrium of the game. This demand is always accepted by player 2. Given that player 1 knows she will receive $x^* = 10p_2 + c_2$ if she bargains, she compares this value for bargaining to the expected value of the present day lottery. If the expected value of the lottery today is greater than the value for bargaining, a commitment problem exists

$$\begin{aligned} 10p_1 - c_1 &> 10p_2 + c_2 \\ 10p_1 - 10p_2 &> c_1 + c_2 \\ 10(p_1 - p_2) - (c_1 + c_2) &> 0 \end{aligned} \quad (2)$$

Note that this is the same condition shown in equation (1), scaled to reflect the fact that the subjects are bargaining over US\$10.

In summary, in both games, player 2 accepts all demands that make him indifferent to his expected value for conflict. Likewise, in both games, player 1 selects the optimal demand that maximizes her value subject to the constraint that player 2 accepts the demand. In the commitment problem game, player 1 compares this optimal demand to the present day lottery and chooses the lottery only if the expected value from the lottery is greater than the value of the optimal demand. This combination of

actions by player 1 and 2 constitute the subgame perfect equilibrium of the game.

Analysis

Subjects playing the commitment problem game were initially faced with a choice between playing a lottery at the first node or bargaining. If there is a commitment problem, subjects are expected to select the lottery. Otherwise, they should bargain.

Can subjects identify commitment problems?

As shown in equation (2), a commitment problem exists if the following condition holds: $10(p_1 - p_2) - (c_1 + c_2) > 0$. In laboratory experiments, subjects consistently responded as if they identified this condition (see Figure 3).

Eighty-three percent of subjects' choices indicate they are responsive to the potentially adverse shift in win probability that indicates a commitment problem. That is, subjects make choices consistent with the subgame perfect equilibrium described above. The sharpness of subject choices may be due to the two-period framing. Figure 4 illustrates subjects' initial choices in the two-stage game between the early lottery and negotiating in the second stage. Whether a commitment problem exists is given by whether $10 \times (p_1 - p_2) - (c_1 + c_2) > 0$. Each black dot represents a subject's correct choice, and each grey dot an incorrect choice; the former outnumber the latter. Seventy-six subjects correctly choose the early lottery (black dots, bottom right), and 174 correctly decide to bargain (black dots, top left); this sums to 250 out of 290 total choices consistent with the commitment problem dynamic. Subjects overwhelmingly respond to anticipated shifts in p as if they recognize commitment problems.

How do subject demands vary?

Though subjects sharply distinguish between games with and without commitment problem conditions, their bargaining demands are substantially less sharp, diverging from Nash in ways consistent with other laboratory analyses of bargaining protocols (Sieberg et al., 2013). Moreover, subject demands are statistically indistinguishable between the two-stage and ultimatum games.

Figure 5 shows the distribution of demands over the probability of winning for both the two-stage commitment problem game (shown on the left panel) and the ultimatum game (shown on the right panel). The dotted line at a 45-degree angle shows the Nash demand as a function of p , the win probability in the respective bargaining stage of each game. The dark-shaded area shows subjects' average demands as a function of p when the proposer's costs are high (at the maximum value), and the light-shaded area shows the demands as a function of p when the proposer's

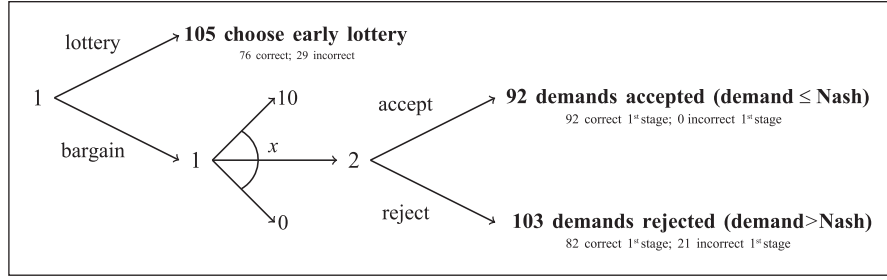


Figure 3. Subject choices in bargaining game with commitment problem.

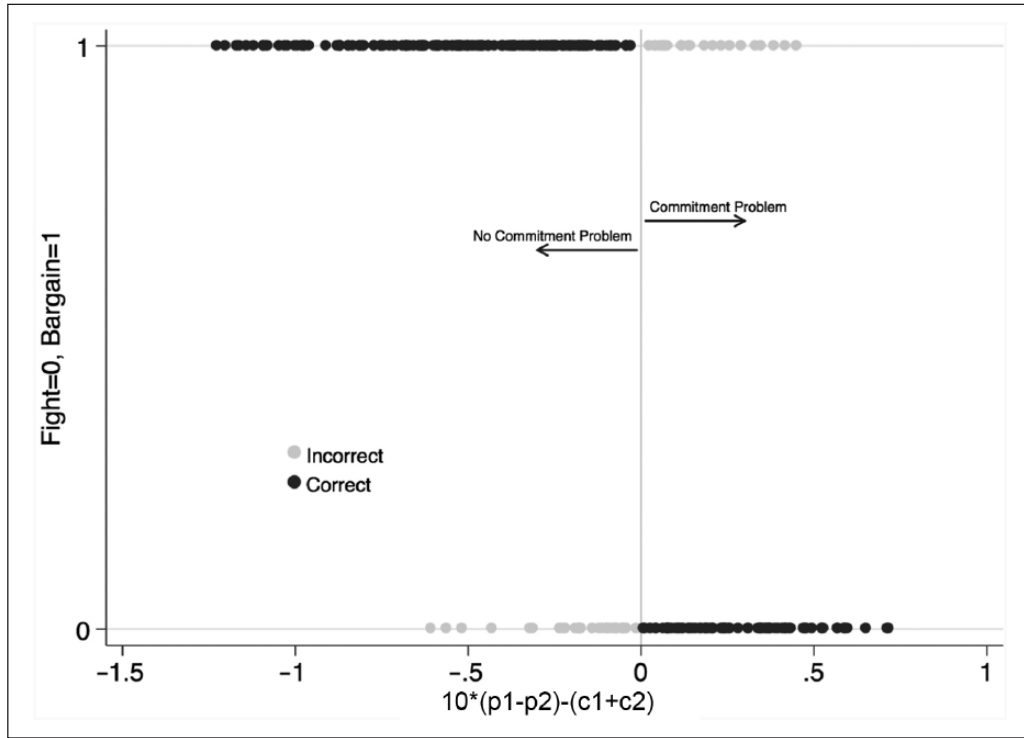


Figure 4. Choices over the distribution of commitment problems.

costs are low (at the minimum value). In both cases, we hold responder costs constant at its mean value.

Demand patterns are statistically the same in the two panels. In both games, subjects tend to make demands that are too large when their bargaining leverage is low, and likewise, make demands that are too small when they have the greatest bargaining advantage in terms of win probability. Over-demanding is especially common when proposer costs for conflict are low (the lighter bands in Figure 5). In both games, low costs to the proposer seem to increase optimism in terms of demand size; the light, low-cost band is statistically higher than the high cost band across all values of p . Facing low lottery costs, proposers make demands statistically higher than when their lottery costs are high, diverging more from the Nash demand. Put differently, the marginal effect of a change in proposer cost from its

minimum (.01) to maximum (.20) is to reduce the average demand, making it closer to the Nash demand.² Responsiveness to proposer costs shifts where subject demands coincide with Nash values. High cost proposers make Nash demands when p is between .5 and .7 (in both panels). Low cost proposers make Nash demands at higher values of p , between .7 and .9.

Statistical analysis

In this section, we examine how playing multiple rounds influences subject choices and how decisions across rounds in the two-stage game might be correlated. Since each subject played ten rounds of the game, we examine trends over rounds. Figure 6 shows how the demands varied as a function of p by period. In this figure, the dark line is the Nash

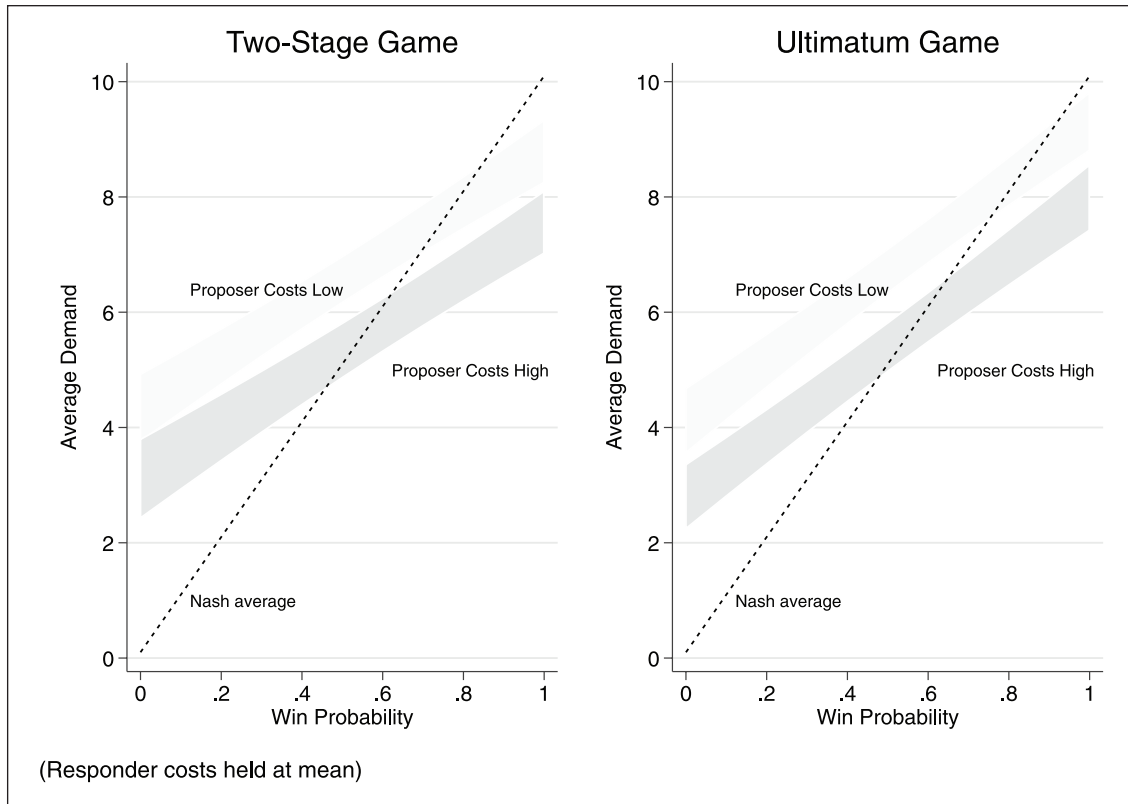


Figure 5. Demands and bargaining leverage.

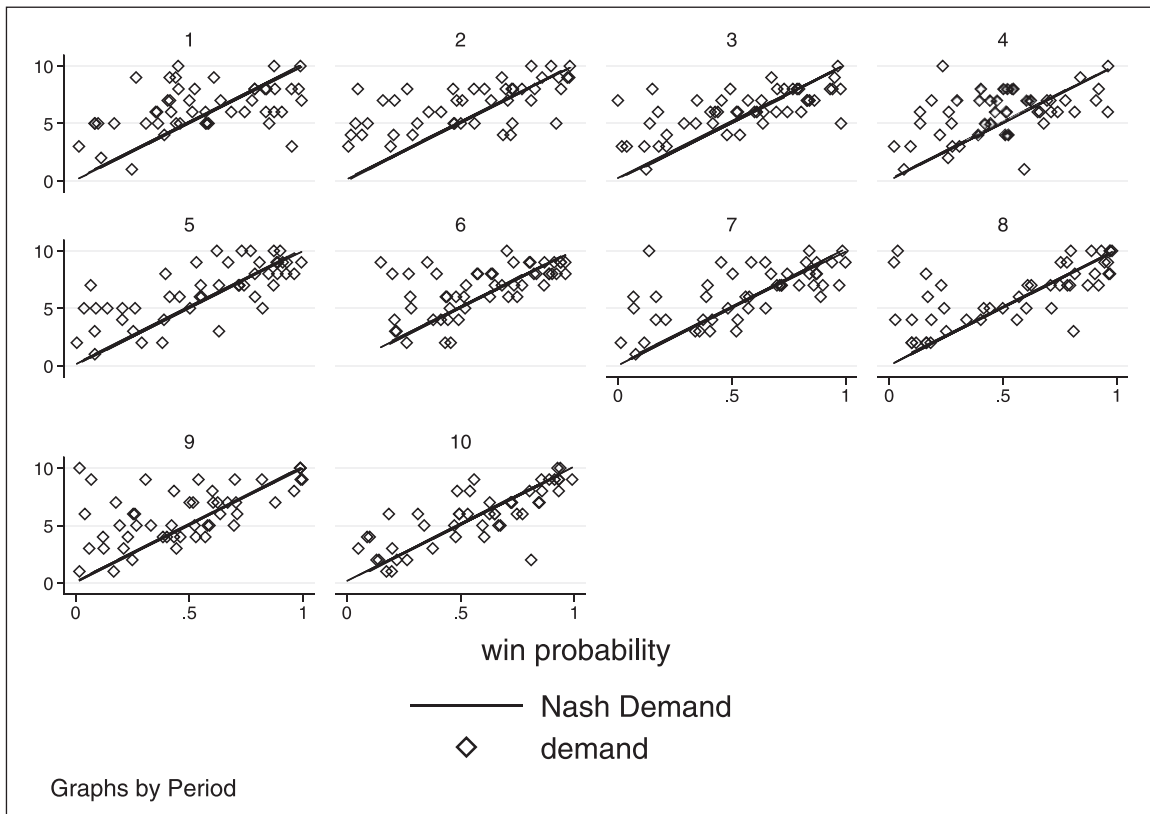


Figure 6. Demands over rounds of play.

Table 1. Demands as a function of win probability and costs.

	Heckman estimates		OLS estimates	
	Demand	Bargain	Demand	
Demand				
Win probability in second stage	4.981*** (0.370)	4.939*** (0.379)		
Cost for conflict to proposer	-6.010*** (1.486)	-6.102*** (1.372)	-6.963 * (2.290)	-6.947* (2.277)
Cost for conflict to responder		-2.132 (1.998)		1.227 (1.908)
Win probability in first stage			5.264*** (0.378)	5.256*** (0.375)
Constant	3.751*** (0.352)	4.016*** (0.467)	4.149*** (0.341)	4.037*** (0.374)
Bargain				
Win probability in first stage	-3.903*** (0.320)	-3.910*** (0.315)		
Win probability in second stage	2.765*** (0.371)	2.771*** (0.374)		
Cost for conflict to proposer	2.651* (1.108)	2.673* (1.121)		
Cost for conflict to responder	1.101 (1.056)	0.732 (0.983)		
Constant	0.846** (0.290)	0.881** (0.282)		
ρ	0.654* (0.318)	0.622* (0.317)		
Observations	300	300	290	290
Adjusted R^2			0.422	0.421

Robust standard errors (clustered by bargaining round) in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. OLS: Ordinary Least Squares.

demand and the diamonds are the observed demands. Overall, the pattern of demands seems to be consistent across rounds with the possible exception that the demands in the last round appear to be closer to Nash.

We also fit regression models to the data collected from the experiments. The regression results are shown in Tables 1 and 2. The independent variables along with the constant appear in the first column of the table. The second and third columns report models that jointly estimate the probability of bargaining and the demand, given the decision to bargain. These models are fit to the data from the subjects who played the two-stage commitment problem game. The last two columns report least squares models fit to the one-stage ultimatum game data.

One common theme across these models is that the subjects appear to be very sensitive to the values of p . However, the effect of the responder's costs is insignificant across all of the models. The effect of p on the decision to bargain in the commitment problem data is also very strong. When subjects draw high values for p in the beginning of the commitment problem game, they are more likely to choose the lottery. When subjects draw low values of p in the beginning of the commitment problem game, they are more

likely to bargain. Finally, the costs of the lottery drawn by subjects playing the commitment problem game do affect the decision to bargain. When the costs of the lottery now are high, the subjects are more likely to bargain. However, consistent with the results from the ultimatum game, subjects do not take into account their opponents' costs in the decision to bargain and the choice of how much to demand. Interestingly, this suggests that the subjects condition their demands based on their belief that there is some risk of rejection. This is an interesting deviation from the combination of actions that form the subgame perfect equilibrium of the game that expects the actions of the proposer to be conditioned on the belief that the responder always accepts the demand.

One conclusion from this is that the demands the subjects are making deviate from Nash because the subjects are not taking into account their opponents' costs for playing the lottery. However, it is interesting to note that their demands coincide rather closely with what the Nash demands would equate to if there were asymmetric information about the computer's costs c_2 . In the asymmetric information version of the model, player 1 conditions her demand on p and her own costs, c_1 . This optimal demand

Table 2. Modeling demands as a function of win probability and costs—models with fixed effect for bargaining round.

	Heckman estimates		OLS estimates	
	Demand	Bargain	Demand	
Demand				
Win probability in second stage	4.951*** (0.359)	4.919*** (0.372)		
Cost for conflict to proposer	-6.326*** (1.713)	-6.405*** (1.613)	-7.084* (2.321)	-7.061* (2.309)
Cost for conflict to responder		-1.905 (2.098)		1.271 (2.059)
Win probability in first stage			5.349*** (0.416)	5.343*** (0.413)
Constant	3.543*** (0.296)	3.753*** (0.401)	4.203*** (0.308)	4.095*** (0.338)
Bargain				
Win probability in first stage	-4.070*** (0.332)	-4.078*** (0.327)		
Win probability in second stage	2.793*** (0.379)	2.796*** (0.383)		
Cost for conflict to proposer	2.300 (1.205)	2.335 (1.223)		
Cost for conflict to responder	1.148 (1.361)	0.776 (1.306)		
Constant	1.005*** (0.171)	1.040*** (0.152)		
ρ	0.706 (0.402)	0.674 (0.401)		
Observations	300	300	290	290
Adjusted R^2			0.418	0.417

Robust standard errors (clustered by bargaining round) in parentheses. All models include fixed effects for bargaining round; not reported.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

with asymmetric information matches very closely to the regression results. While the subjects are not sensitive to their opponents' costs of the lottery, they are responsive to their own costs.

Subjects discount information they have, such that they play all games as if they are asymmetric information. This might help explain the behavioral regularity that bargaining fails even under conditions where all actors are fully informed. It implies that the formal distinction between complete and incomplete information is not nearly so clear in behavioral applications, and that human subjects bargain as if information is asymmetric in either case. One possible extension would be to examine this in the lab, asking subjects to play these games where all parameters are known, and other games where they are not fully known. Our findings here might imply the behavioral choices of complete and incomplete information players would be similar.

Discussion

This manuscript makes several contributions to the empirical literature on bargaining models. First, the results from

the experiments provide striking evidence to suggest that subjects are able to correctly identify commitment problems and bargain accordingly. This result holds for commitment problems that arise from a number of possible combinations of the costs of the lottery and the difference between the probability of winning the lottery at the initial node or after bargaining. Second, for subjects that mistakenly bargained when there was a commitment problem, the demands these subjects made were consistent with misplaced optimism. Subjects that made this mistake always over-demanded and ended the game in a costly lottery in the second stage. Third, in both two-stage and ultimatum games, subjects exhibit sensitivity to the values of p and *their own costs* for the lottery, c_1 . Subjects are sensitive to their own costs when deciding to bargain or play the lottery, and in neither game did subjects take into account their opponents' costs when making a demand.

This suggests that even though these games are of complete and perfect information, the subjects bargain as if they are uncertain about their opponents' reservation values. If subjects were able to identify this reservation value, they should not condition their demands on their own costs

because they would never expect to suffer these costs. However, if subjects believe there is some possibility that their demands will be rejected, it is logical for them to take their own costs into account because they believe that if their demands are indeed rejected, they will end up paying these costs. We believe these are important results that can lead to research on how the costs of conflict affect bargaining, and that our findings will contribute to behaviorally grounded explanations for deviations from the canonical rationalist model of bargaining (Lake, 2011).

Analysts that utilize bargaining and commitment logic to evaluate political interactions should recognize that individuals are quite good at identifying when commitment problems exist. When individuals identify commitment problems, bargaining failure generally occurs and conflict ensues. Thus, individuals will identify most commitment problems and such problems will normally lead to conflict. Furthermore, even when individuals have complete information about their opponents' costs of conflict, this information is unlikely to significantly help these individuals avoid bargaining failure. Future scholarship should bear these findings in mind when modeling all varieties of political interaction via bargaining and commitment frameworks.

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Notes

1. The costs of the lottery were scaled such that there were a sufficient number of cases in which the lottery did not appear prohibitively expensive.
2. Recall that the cost parameter, c_1 , is drawn from a uniform distribution, so its minimum and maximum values occur in the experiments with the same probability as any other values; they are not outliers in the data.

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