The Shadow of the Future and Bargaining Delay: An Experimental Approach *

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Forthcoming at The Journal of Politics

*I would like to thank Stephen Chaudoin, James Fearon, Kenneth Schultz, Michael Tomz, Nandita Balakrishnan, Jordan Bernhardt, Jonathan Chu, Iris Malone, Kerry Persen, Elisabeth van Lieshout, the editors and reviewers for the *Journal of Politics*, and participants at the 2017 Midwest Political Science Association annual conference for valuable comments and suggestions. I'd also like to give a special thanks to the Center for International Security and Cooperation (CISAC) for providing funding for this project and for the Institute for the Research in Social Science's Research Experience Program (REP) for providing a participant pool and lab space. I am grateful to Alan Tennent for his help creating the online interface used in this experiment. Any errors are my own.

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Abstract

Can the shadow of the future undermine international cooperation? While Fearon (1998) proposed that long time horizons incentivize states to prolong costly negotiations, the results in the empirical literature testing this model have been mixed. Using a laboratory experiment, I estimate the causal effect of the shadow of the future on bargaining delay and examine its welfare consequences. I show that while parties do take longer to reach agreements when the shadow of the future is long, there is no significant welfare lost compared to agreements made under shorter time horizons. These findings suggest an important caveat to policy recommendations that call for the use of finite duration provisions to shorten international negotiations. These provisions are unlikely to resolve the underlying inefficiency of the bargaining period and may inadvertently decrease states' welfare by shrinking the potential gains from cooperation.

Key Words: Time Horizons, Discount Factor, Bargaining, War of Attrition, Experiment

This study was approved by the Research Compliance Office at Stanford University (Stanford IRB-31611). Financial support was provided by the Center for International Security and Cooperation (CISAC) at Stanford University. Supplementary material for this article is available in the appendix in the online edition. Data and supporting materials necessary to reproduce the findings in this article are available in the JOP Data Archive on Dataverse (https://dataverse.harvard.edu/dataverse/jop).

1 Introduction

Why do some international negotiations resolve in a matter of mere months while others drag on for several years or even decades? For instance, why did the SALT I treaty negotiations – which limited the number of ballistic missiles for both the Soviet Union and the United States – last only a year, while the less ambitious UK-USSR agreement on the prevention of accidental nuclear war took over 2.5 times longer to negotiate?[1]

In his seminal work on bargaining and enforcement, Fearon (1998) points to a surprising answer: a long shadow of the future – that is, when states expect that repeated interaction is likely and place a high value on future payoffs.[2] While scholars have long theorized that the shadow of the future promotes cooperation by enabling states to enforce their agreements (Axelrod 1984; Li 2009; Blake 2013), Fearon argued that long time horizons can make distributional conflicts more severe. States face strong incentives to bargain hard up front to lock in a better deal if they expect an agreement to last far into the future. Drawing on this intuition, scholars have recommended policymakers use finite duration provisions to resolve negotiations on issues where distributional conflicts are particularly acute, like in the ultimately failed Doha Round where economists estimate losses of US$177 billion in potential income for each year that negotiations persisted (Bearce et al. 2015; Kinnman and Lodfalk 2007).

Duration provisions may be a useful way to shorten negotiations, but there are two notable shortcomings in the existing literature that need to be addressed. First, there is not clear evidence that long time horizons increase bargaining delay. Existing observational studies have not only produced conflicting findings (Simonelli 2011; Bearce et al. 2015). Their use of duration provisions to measure the shadow of the future creates an important endogeneity problem and limits our ability to make accurate inferences. If Fearon (1998) is right, states may include duration provisions after engaging in long negotiations with little success, but this would bias against finding a positive relationship between the shadow

[1] Both the Interim Agreement and the UK-USSR Agreement were bilateral security treaties seeking to reduce the risk of nuclear war. While the Interim Agreement enforced strict arms reductions, it specified that the agreement would only last five years. The UK-USSR agreement included no such duration provision.

[2] A long shadow of the future is most frequently captured by a high discount factor in repeated games. Scholars also refer to a high discount factor as having long time horizons or being highly patient.

of the future and bargaining delay. But if long time horizons affect negotiations in ways that run counter to Fearon (1998), removing a duration provision could lead states to reach agreements quickly.[3] As a result, existing observational work has not been able to identify the causal effect of the shadow of the future. If we are going to recommend using duration provisions to shorten international negotiations however, this is exactly the type of evidence we need.

Second, even if duration provisions reduce bargaining delay, it is unclear whether including them in agreements would make states better off. A short shadow of the future may decrease the costs of negotiations. However, it also effectively shrinks the size of the "pie" available to states since future cooperation is heavily discounted. So, the overall effect on state's welfare – either in terms of aggregate payments or bargaining efficiency – is not obvious.[4] While Fearon (1998) did not address this trade-off, policymakers are likely keen to these welfare considerations when debating whether to include duration provisions in agreements.

I use a laboratory experiment both to examine whether a long shadow of the future increases bargaining delay and to explore its welfare implications. An experimental approach can contribute to the literature on international negotiations in two ways. First, it enables us to estimate the causal effect of the shadow of the future on bargaining delay, and in doing so, helps us arbitrate between conflicting findings in the literature. Second, while it is nearly impossible to quantify the political and humanitarian costs of delay for many international agreements with observational data, an experiment allows us to measure the amount of welfare lost in bargaining. As a result, we can evaluate the likely welfare consequences of using duration provisions to shorten negotiations. The results of the experiment are surprising: although a longer shadow of the future did increase bargaining delay, participants still benefited more overall from having a longer agreement. These findings suggest that duration provisions are unlikely to resolve the underlying inefficiency of the bargaining process and may inadvertently decrease states' welfare by shrinking the potential gains from cooperation.

[3]Here, results would be biased towards Bearce et al.'s (2015) finding.

[4]Aggregate welfare refers to the net benefits of cooperation minus the costs of bargaining. Efficiency refers to the size of bargaining costs relative to benefits created by the agreement. I address both standards below.

2 Experimental Design

Subjects played a modified version of the war of attrition model used in Fearon (1998).[5] In this experiment, the war of attrition is modeled as a finite, multi-round game, in which two players bargain over how to divide a \$2.00 per-round payment.

Like Fearon (1998), I did not allow subjects to bargain over all possible divisions of the payment.[6] Fearon assumes that only two deals are feasible: a generic deal x that state 1 prefers and a generic deal y that state 2 prefers. I set these deals to be a 75-25 or 25-75 split of the per-round payment. Once the players decided on a division of the per-round payment, they could not renegotiate the terms of their agreement. They received the payments associated with their agreement until the end of the game.

To bid for these deals, players simultaneously placed high or low demands, where a high demand claimed the larger per-round payment. We can think of placing a high demand as "standing firm" and placing a low demand as "conceding" in more typical war of attrition terminology. If both players made high demands, they would not reach an agreement in the current round. Therefore, they would not receive any payment for that round, and they would bargain again in the next round if it was not the last round of the game.

Players made an agreement as long as both did not place high demands. If one player made a low demand while the other made a high demand, the player who made the high demand received the high payoff of \$1.50 for each round until the end of the game. The player who conceded received \$0.50 each round. If both players placed a low demand, they received \$1.00 for each of the remaining rounds of the game. Evenly splitting the payment is

[5] I made three modifications to Fearon's original model to facilitate implementation in the lab: (1) the game is modeled as a finite, multi-round war of attrition instead of an infinite horizon, continuous time model; (2) I allow students to split the per-round payment for conceding at the same time; and (3) I do not include player specific time costs. Each of these changes are discussed below. Importantly, these modifications change neither the predictions about the effect of the shadow of the future on bargaining delay nor the welfare implications of the model. Refer to appendix A and B for the formal analysis of Fearon (1998)'s original model and the model used in the experiment for proof that these core predictions are unchanged.

[6] Fearon argues that many international negotiations take the form of states holding out in hopes that the other side will make a concession first. For instance, in the Doha Round, the United States and the EU refused to make significant reductions to agricultural protectionism while developing countries, lead by Brazil and India, refused to sign an agreement without these reductions.

equivalent in terms of expected utility as Fearon's (1998) fair lottery to handle cases where both states concede at the same time.[7] Including this third division does not change the equilibrium of the game.[8]

It is worth discussing how the opportunity costs of noncooperation are built into the experiment's game compared to Fearon's (1998) original model. In Fearon (1998)'s model, states paid a player-specific per-time unit cost for mutual defection from their own budget. However, in the experiment's model, the costs of mutual defection (both making high demands) are taken from the potential value of the agreement. In other words, participants pay the costs of noncooperation by forgoing the potential payment in rounds where both players stood firm. While modeling the opportunity costs of noncooperation in this way means that the costs are not player-specific, it avoids introducing unmodeled, meta-game effects from having students spend money they already received from leaking into the game.

To manipulate the shadow of the future, I varied the number of rounds a game lasted: games with shorter time horizons lasted five rounds, whereas games with longer time horizons lasted ten. I selected five- versus ten-round games to make it easier for subjects to calculate their expected payments. This manipulation is consistent with Fearon's (1998) conception of the shadow of the future. Varying the number of rounds changes the potential value of an agreement, which is similar to how changing the discount rate manipulates how states overall value a given deal. This method also parallels the use of finite duration provisions to measure the shadow of the future in the empirical literature. While varying the number of rounds does not directly manipulate the duration of the agreements students bargain over, it is functionally equivalent due to the way the costs of negotiations are built into the game. To illustrate, suppose we set the duration of an agreement to be five rounds and included a \$2.00 cost of negotiating each period. The net value of the five-round agreement after two rounds of bargaining would be the same as the value of reaching an agreement in the third round of the five-round version of this game.

I use a within-subject design for causal identification, instead of randomly assigning participants to treatment groups. Under this design, each participant played 20 repetitions of the war of attrition games – 10 games that lasted for five rounds and 10 games that

[7]In appendix D.6, I show that allowing this even split did not create a significant focal point for coordination.
[8]See appendix B.1 for derivation of the experiment games' equilibrium.

lasted for ten rounds. For each repetition, participants were randomly re-matched with a different player in the session, and participants did not know the identity of their opponents. I used counterbalancing to prevent order effects – especially those related to learning and fatigue – from threatening the internal validity of the experiment. For every subject who played the five-round games before the ten-round games, there was a different subject who played the ten-round games first. Counterbalancing in this way means that the treatment is uncorrelated with any order effects that may have otherwise biased the results of this study. I confirmed the validity of the crossover design by showing that subjects who played the five-round games first did not behave any differently than those who played the ten-round games first. Results from this analysis, as well as more systemic investigation of learning and fatigue, can be found in appendix D.5.

I recruited 48 subjects from a pool of local community college students for this experiment. There were four experimental sessions with 10-14 participants each at the laboratory space at a local community college, and these sessions lasted about an hour on average. Students received class credit and payment for their participation. Each session began with a brief instructional period, participants were then quizzed on key elements of the experiment, and students played one practice game to familiarize themselves with the experiment's interface. Further, after playing the 20 repetitions of the experiment's games, I administered a short questionnaire to collect information about participants' age, gender, major, time preferences, altruism levels, and risk attitudes. More details on how the experiment was implemented in the lab, including transcripts of the experiment's instructions, screenshots of the online interface, and survey questions can be found in appendix C.

3 Results

Figure 1 displays the main results about the relationship between the shadow of the future and the length of negotiations. It displays the differences in the cumulative proportion of games between treatment groups that reached an agreement after each of the first five rounds. It also shows the associated confidence intervals.[9] If the shadow of the future did not affect the rate at which participants conceded their preferred agreement, then we would

[9]Wild bootstrapped standard errors are clustered on player 1's and player 2's user ID. Using other specifications for the standard errors do not changes these results.

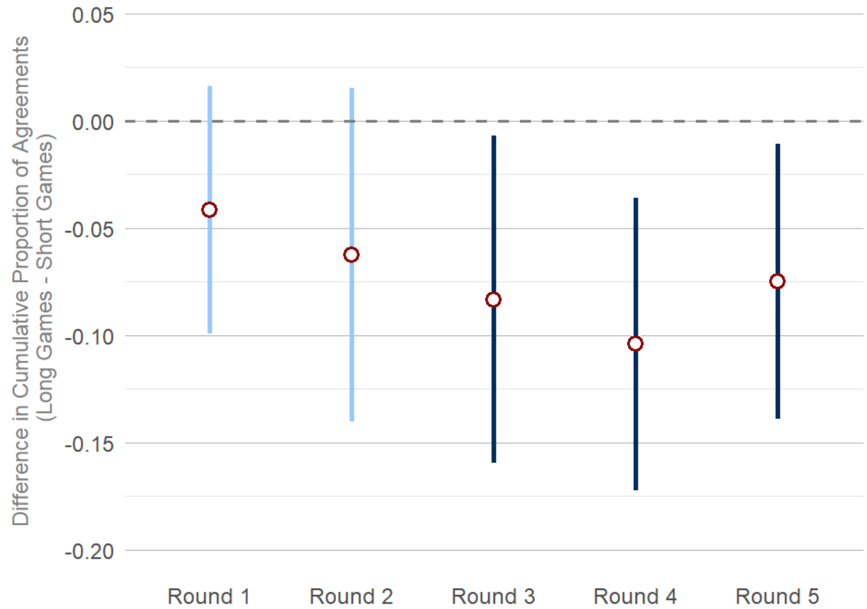

Figure 1: Average Treatment Effect of Long Shadow of the Future. Error bars show 95% confidence intervals, and p values are two-tailed. Results are robust to other specifications. See appendix D.1.

expect there to be no difference in the proportion of games with agreements after each round. But, as Figure 1 illustrates, there is a clear pattern suggesting that it took longer to reach an agreement in the ten-round games. After each of the first five rounds, there was a higher proportion of five-round games with successful agreements than there were ten-round games. The differences in proportions do not reach standard levels of significance until the third round, but the lack of significance in the first two rounds likely result from a lack of power in the tests due to small sample size. Power calculations suggest that – given the observed differences in proportions – there is an 86% chance of incorrectly favoring the null hypothesis after the first round and a 69% chance after the second round. More sophisticated analysis of individual strategies using discrete-time survival models confirm the patterns in the t-tests: individuals were 19.3% less likely to concede when they were playing a ten-round game than when they were playing a five-round game. This analysis can be found in appendix D.4.

Overall then, these results support Fearon's (1998) proposition that the shadow of the future increases bargaining delay and Bearce et al.'s (2015) findings that duration provisions reduce the length of negotiations. But what about the welfare consequences of bargaining delay? Are these provisions a beneficial way for policymakers to shorten negotiations?

There are two useful ways to think about welfare analysis – in terms of aggregate payoffs and in relative efficiency. On the one hand, we might think that policymakers primarily care about aggregate welfare: when deciding between two otherwise equal policy options, the proposal that produces the greatest payments after accounting for incurred costs should be preferred. Because increasing the shadow of the future or an agreements' duration effectively increases the size of the "pie" available to states, policymakers should prefer shorter agreements *all else equal* if the costs associated with more bargaining delay outweigh the benefits gained from having a more lasting agreement. But another element to consider is an agreement's efficiency, i.e. the size of bargaining costs relative to an agreement's gains. Here, if policymakers prioritize efficiency, they should prefer agreements that "destroy" less of the welfare created by cooperating. So, they may prefer agreements with a shorter shadow of the future–even if it produces less aggregate welfare–if the costs of bargaining constitute a smaller percentage of the potential welfare the agreement creates.

Fearon (1998) did not examine the welfare implications of his model, but much of the IR literature has reasonably interpreted his model as suggesting the shadow of the future is "bad" for cooperation (e.g. Rosendorff & Milner 2001, Tingley 2011). After all, if long time horizons did not increase bargaining delay, states would certainly be better off under a long shadow of the future since it increases the value of the stream of cooperative payoffs. But because the costs of bargaining delay also increase, it is not clear whether reaching agreements under long time horizons produces less welfare or is less efficient than reaching agreements under shorter time horizons.

By extending Fearon's original model (see appendix A.2), I bring new clarity to the relationship between the shadow of the future and welfare. Even when one accounts for what is lost in bargaining delay, states still fare better in terms of aggregate welfare under a long shadow of the future. Further, the relative efficiency of bargaining does not depend on the length of the shadow of the future. Both when states' time horizons are long and when they are comparatively short, states are expected to lose the same percentage of their potential welfare in bargaining. Importantly, these results for aggregate welfare and relative

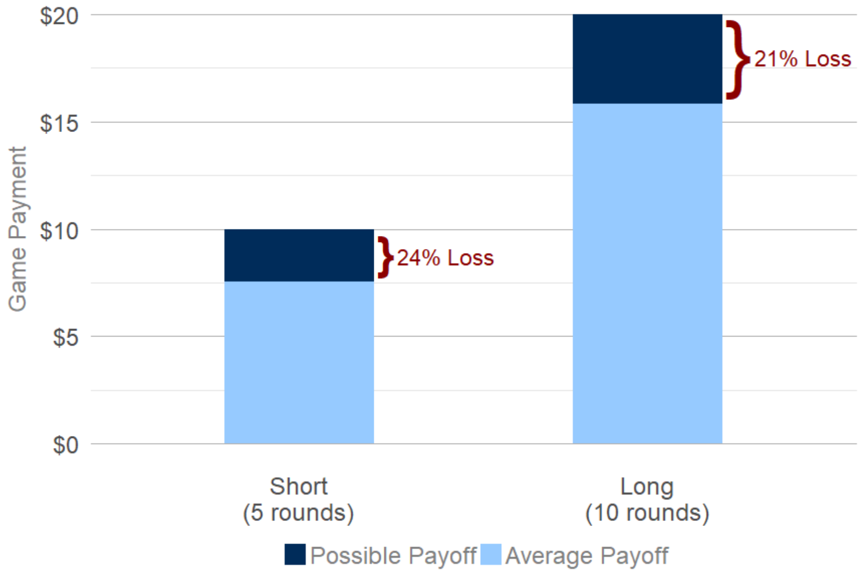

Figure 2: Difference in aggregate welfare and relative efficiency under a short versus long shadow of the future. Difference in % welfare lost not significant. See appendix D.1.

efficiency do not change even when we estimate the model with more flexible assumptions about states' risk preferences.

Do the results of the experiment support these implications? In other words, are these welfare results behaviorally realistic or are they an theoretical artifact of the model? Figure 2 presents the welfare analysis of this game by showing the average per-game payment for five-round and ten-round games as well as the percentage of potential welfare lost in bargaining.

Figure 2 illustrates the relationship between the shadow of the future and welfare. First, participants fared overall better when the shadow of the future was long. The average per-game payment was $7.57, but the average per-game payment was $15.82 in the ten-round version. So, even though students paid higher total bargaining costs in the ten-round games, the gains from from having a more lasting agreement greatly offset the costs of additional bargaining delay. Thus, policymakers should be cognizant that including duration provisions in agreements do come at the cost of effectively shrinking the size of the pie available to states.

Second, Figure 2 also supports the my extension of Fearon's model that illustrates that the degree of inefficiency in bargaining does not depend on the shadow of the future. Players lost about the same percentage of the total pie available to them in the five- and ten-round versions of the games. In five-round games, students lost about 24% of the total possible game payment. In the ten-round games, students lost about 21%. The three-percentage point difference is not statistically significant. These findings suggest a large caveat to Bearce et al.'s (2015) recommendation that policymakers use duration provisions to shorten the bargaining period. Even though these provisions will likely shorten negotiations, they are unlikely to resolve the underlying inefficiency of the bargaining process.

4 Discussion

Pinning down the relationship between the shadow of the future and bargaining delay is both theoretically and normatively important. On the theoretical side, the shadow of the future remains a linchpin of international cooperation theory (Axelrod & Keohane 1985), and scholars continue to use variation in states' time horizons to explain international outcomes ranging from foreign direct investment (Li 2009) to treaty legalization (Blake 2013) and even war (Tingley 2011). Yet, a key insight of Fearon (1998) is that the effect of the shadow of the future depends fundamentally on the underlying structure of the game. While new experimental work has explored some differing effects of long time horizons in other strategic situations (McBride & Skaperdas 2014, Tingley 2011), we still have little evidence about their relationship to bargaining delay. Given that many of the world's most pressing challenges are marked by severe distributional conflicts (e.g. who should bear the costs of climate change cooperation? Are countries benefiting equally from trade liberalization?), getting the story right on the extent to which the shadow of the future hinders negotiations on these issues is crucial for understanding present trends in international cooperation.

This paper used a laboratory experiment to contribute to these ongoing debates and confirms Fearon's (1998) proposition. The shadow of the future does increase costly bargaining delay. Even more, this paper clarifies and tests the welfare implications of Fearon's original model, which has direct policy implications for the use of finite duration provisions in international agreements. Bearce et al. (2015) suggest that duration provisions can be a useful tool for reducing inefficient bargaining delay. However, the results of this experiment suggest otherwise. Even though it takes longer to negotiate agreements expected to last far into the future, states are still better off since these agreements increase the total welfare available. Relative to the total welfare produced, negotiations for shorter agreements will likely be as inefficient as those for longer ones. While there may be valid reasons to include duration provisions in agreements, it is useful to recognize the potential welfare trade-offs their inclusion present.[10]

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[10]For instance, Koremenos (2005) argues states include duration provisions to contract around uncertainty about the distributional gains of an agreement.

Appendices for "The Shadow of the Future & Bargaining Delay: An Experimental Approach"

Contents

A Formal Analysis of Fearon (1998)

A.1 Fearon (1998) Model and Equilibirum

Fearon (1998) argues that classic prisoner dilemma games misrepresent the barriers to international cooperation. By depicting cooperation as only an enforcement problem, these representations ignore an entire class of bargaining problems that plague international negotiations and can lead to inefficient outcomes. He goes on to show that – conditional on an agreement being enforceable – a longer shadow of the future increases costly bargaining delay.[1] When states expect an agreement to last a long time, they face strong incentives to adopt tough bargaining tactics, forgoing cooperation in the present to secure a better deal for the future.

To model the bargaining process, Fearon uses a war of attrition game in which two states have conflicting preferences over two deals, x and y, to implement, where $x > y$ and these deals are the share of the pie that goes to state 1. He defends the use of a war of attrition model over a bargaining game in which the pie is more continuously divisible by noting that many international negotiations – like the GATT negotiations and many arms control deals – tend to take the form of states holding out in hopes that the other side will make some significant concession first. In the model, both states prefer cooperation on x or y to no agreement at all. Each state incurs a player-specific opportunity cost (c_i) until they reach an agreement, and both states share a common shadow of the future, a discount rate $r > 0$. Lower values of r reflect a longer shadow of the future.[2] In each instant in the continuous time war of attrition game, states choose either to concede their preferred deal or to stand firm. The state that is willing to forgo cooperation the longest receives their preferred deal.

In the equilibrium where there is a positive probability of delay, states choose to concede at any time conditional on having stood firm so far with the following probabilities:

$$\frac{r(1 - x + c_2)}{x - y} dt \text{ for state 1, and}$$

$$\frac{r(y + c_1)}{x - y} dt \text{ for state 2.}$$

These strategies yield the following expected time until an agreement:

$$\bar{t} = \frac{x - y}{r(1 + c_1 + c_2 - (x - y))}$$

We can see from these equations that as r decreases (the shadow of the future increases), states will yield their preferred agreement with lower probability and thus take longer on average to reach an agreement. As Fearon (1998) explains, "the longer states expect today's

[1] Fearon (1998) argues that whether agreement is enforceable creates important selection effects into bargaining. If states anticipate an agreement is not enforceable, they have no incentive to negotiate.

[2] The discount rate can be converted to the standard discount factor, where $\delta = 1/(1 + r)$.

agreement to be relevant in the future, the more reasons they have to delay an agreement by bargaining hard over distributional advantage" (282).

A.2 Welfare Implications

In the original model, Fearon (1998) standardizes the max potential value of cooperation to be 1 util for each period, which means that the total potential value for states is $\frac{1}{r}$ accounting for the discount rate. Because the equilibrium where there is a positive probability of delay is a mixed strategy equilibrium, we know that states are indifferent between standing firm or conceding their preferred agreement at the outset of the game. Therefore, we can calculate each state's *ex ante* expected payoff by examining their payoff for conceding in the first instant of the continuous war of attrition game.

Because the equilibrium probability distributions of conceding is continuous, the probability that both players concede at the same time is 0. Therefore, if State 1 concedes in the first instant of the game, its expected payoff is: $\frac{y}{r}$. If state 2 concedes in the first instant of the game, its expected payoff is: $\frac{1-x}{r}$. Because the shadow of the future increases as r decreases, these *ex ante* payoffs illustrate that aggregate welfare increases with the shadow of the future.

But what about the relative efficiency of bargaining? Given the payoffs above, the *ex ante* expected welfare loss in equilibrium is:

$$\left(\frac{1}{r} - \frac{y}{r} - \frac{1-x}{r}\right) \div \frac{1}{r} = x - y$$

As you can see by this equation, the model predicts the percentage of welfare lost to bargaining does not depend on r, and thus does not depend on the shadow of the future.

This is true, even when we allow for more flexible risk preferences than risk neutrality. Because we are interested in the mixed strategy equilibrium, the utility for conceding and for standing firm in the first instant of the game is the same. Again, the equilibrium probability distributions of conceding is continuous, so the probability that both players concede at the same time is 0. With more flexible risk preferences, state 1's expected utility for conceding in the first instant of the game is: $\frac{u(y)}{r}$. State 2's expected utility for conceding at the outset of the game is: $\frac{u(1-x)}{r}$.

This means that the *ex ante* expected welfare loss in equilibrium is:

$$\left(\frac{u(1)}{r} - \frac{u(y)}{r} - \frac{u(1-x)}{r}\right) \div \frac{u(1)}{r} = \frac{u(1) - u(y) - u(1-x)}{u(1)}$$

Thus, even without the assumption of risk neutrality, the inefficiency of bargaining does not depend on r.

B Formal Analysis of Experiment Game

B.1 Proof of Sub-game Perfect Nash Equilibrium

Following Fearon (1998), I restrict my attention to the sub-game perfect equilibria where there is a positive probability of bargaining delay.

Let σ_k be the probability a player makes a low demand when there are k rounds remaining in a given game. Regardless of the total number of rounds a game last, σ_k will always be the same–that is, in the last round of the 10-round game, players will place a low demand with the same probability that players will place a low demand in the last round of the 5-round game. This features results from the fact that conditional on reaching the last round (or second to last round, etc.) of the game, players have the same payoffs at stake. Again, to use the example from this experiment, if players reach the final round of the 5-round version of the game, their possible total payoffs for the game are \$1.50 (if High-Low combination of demands), \$1.00 (if Low-Low combination), \$0.50 (if Low-High), and \$0 if (High-High). Players in the 10-round version face these same stakes conditional on having not reaching an agreement in an earlier round.

Thus, in the last round of any game, we need to find the probability where a player willing to mix – that is, the player is indifferent between placing a low demand and placing a high demand:

$$EU_0(\text{Low Demand}) = EU_0(\text{High Demand})$$
$$\sigma_0(1) + (1 - \sigma_0)(.5) = \sigma_0(1.5) + (1 - \sigma_0)(0)$$
$$(.5)\sigma_0 + (.5) = 1.5\sigma_0$$
$$\sigma_0 = .5 \text{ or } \frac{1}{2}$$

Thus, in the last round of any game (when there are 0 rounds remaining), each player will place a low demand with 50% probability.

We now need to find the probability that players will place a low demand in the next to last round (when there is 1 round remaining). However, now if both players play a high demand, they will be able to bargain again in the last round of the game. Thus, the payoff for both players placing high demands is equal to the player's expected utility in the last round, which we just derived the probability of placing a low demand for. Thus:

$$EU_1(\text{Low Demand}) = EU_1(\text{High Demand})$$
$$\sigma_1((k + 1) \times 1) + (1 - \sigma_1)((k + 1) \times .5) = \sigma_1((k + 1) \times 1.5) + (1 - \sigma_1)[\sigma_0(1) + \sigma_0(.5)]$$
$$\sigma_1(2) + (1 - \sigma_1)(1) = \sigma_1(3) + (1 - \sigma_1)[1.2]$$
$$\sigma_1 = .2 \text{ or } \frac{1}{5}$$

As we can now see, in the next to last round, each player will place a low demand with (1/5) probability and (1/2) probability in the last round. Following the method used above, we can calculate the probability a player places a low demand for each round, up to the start of the five and ten-round games. Below is the general equation for calculating the probability a player will place a low demand when there are k rounds remaining:

$$EU_k(\text{Low Demand}) = EU_k(\text{High Demand})$$

$$\sigma_k((k+1)\times 1)+(1-\sigma_k)((k+1)\times .5) = \sigma_k((k+1)\times 1.5)+(1-\sigma_k)[\sigma_{k-1}(k)\times(1)+\sigma_{k-1}(k)\times(.5)]$$

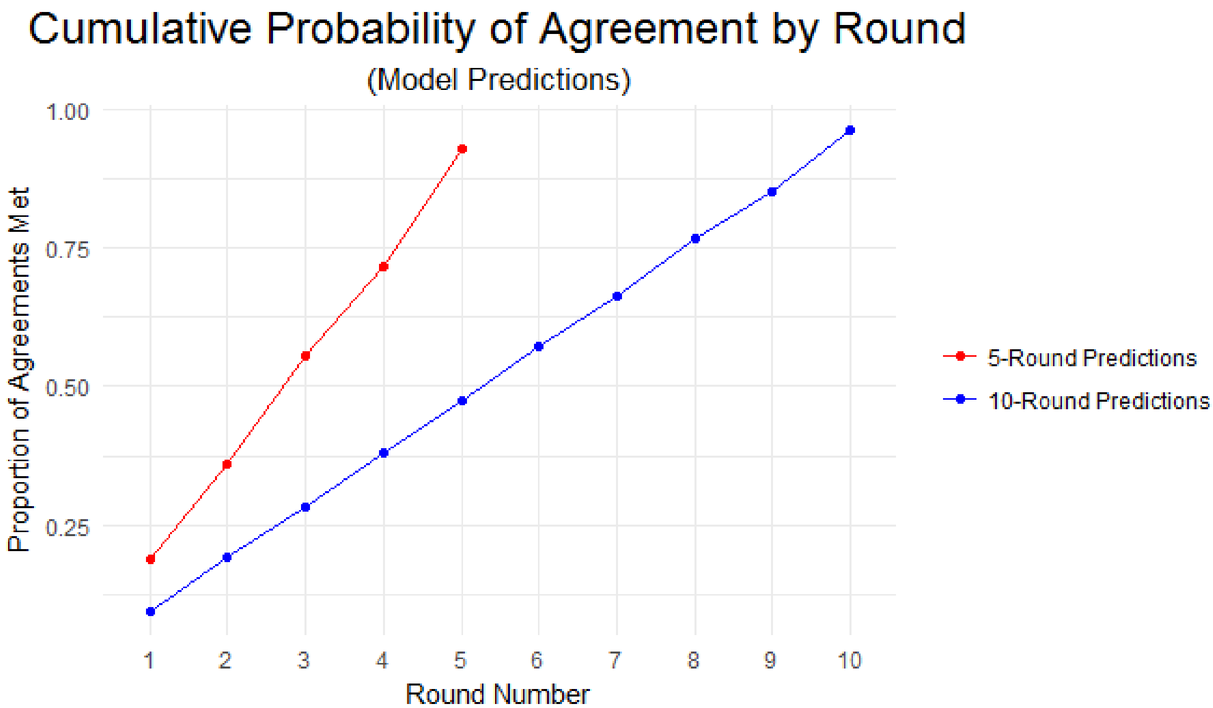
$$\sigma_k = \frac{1-k\sigma_{k-1}}{k+2-k(\sigma_{k-1})}$$

Note that this is a recursive definition, using $\sigma_0 = 0.5$ as the base case. Importantly, the probability a player places a low demand in the 10-round version of the game when there are four rounds remaining is equivalent to the probability a player places a low demand in the first round of the 5-round game. Below is a table showing the values of σ_0 through σ_9, where σ_9 is the probability that a player places a low demand in the first round of the 10-round game.

σ_9	σ_8	σ_7	σ_6	σ_5	σ_4	σ_3	σ_2	σ_1	σ_0
$\frac{1}{21}$	$\frac{1}{18}$	$\frac{1}{17}$	$\frac{1}{14}$	$\frac{1}{13}$	$\frac{1}{10}$	$\frac{1}{9}$	$\frac{1}{6}$	$\frac{1}{5}$	$\frac{1}{2}$

With the individual mixing probabilities calculated, we can use simple probability to determine the probability an agreement is reached by each round. Figure 1 illustrates the cumulative probability that players will reach an agreement by each round in the five- versus ten-round versions of the game. As you can see, the longer the shadow the future, the longer expected time until an agreement.

Figure 1: Predicted Cumulative Proportion of Agreements by Round



B.2 Welfare Analysis

To calculate the expected welfare losses under a long and short shadow of the future, we must first calculate each player's *ex ante* expected payoffs for the equilibrium described above. Because players are playing a mixed strategy, we know that they are indifferent between placing a low demand and a high demand in the first round. We can therefore restrict our attention to player's expected payoff for placing a low demand in the first round.

In equilibrium where both players place a low demand with σ_k^* probability and there are $k+1$ rounds in the game, player's expected payoff is given by:

$$EU_{k+1}(\text{Low Demand}) = \sigma_k^*[\$1 \times (k+1)] + (1-\sigma_k^*)[\$0.50 \times (k+1)]$$

$$EU_{k+1}(\text{Low Demand}) = \frac{1}{2}[\sigma_k^* k + \sigma_k^* + k + 1]$$

Because the game is symmetric, the total *ex ante* expected payoff to both players is:

$$EU_{K+1}(\text{Low Demand}) = \sigma_k^* k + \sigma_k^* + k + 1$$

The total potential welfare for each game is $2(k+1)$. This means that the percentage of total welfare lost in equilibrium is given by:

$$1 - \frac{\sigma_k^* k + \sigma_k^* + k + 1}{2(k+1)}$$

Substituting σ_k^* in and simplifying gives us:

$$\frac{k+1}{2(2+k-k\sigma_{k-1})}$$

C Implementation in the Lab

There were four experimental sessions conducted on February 12th, February 26th, April 13th, and April 27th in 2015 at a local community college. There were 10-14 participants at each of these sessions. These sessions lasted approximately an hour. The instructional period lasted between 15 and 20 minutes. The post-test survey at the end took about five-minutes. The table below shows the dates, number of participants, and duration of game play for each session.

Table 1: Information on Experimental Sessions

Date	Num. Participants	Game Play Duration
2/12	14 participants	40 min
2/26	12 participants	32 min
4/13	12 participants	34 min
4/27	10 participants	36 min

C.1 Outline of Experiment Session

Each session began with a brief instructional period, in which students read through the experiment's instruction on their own before going over them together as a group. To ensure that everyone understood the instructions, I administered a quiz asking about key elements of the experiment. Students also played one practice game so that they could familiarize themselves with the experiment's interface.

Following the instruction's quiz and practice game, I gave participants a questionnaire where they were asked to describe their intended strategy and explain why they planned to adopt this strategy. These questions were included to encourage participants to think through a complete strategy.

Next, subjects played through the 10 repetitions of the five-round or ten-round war of attrition game, depending on which version of the game they were assigned to play first. After each repetition, students were re-matched with a different opponent, and the identity of their opponent was anonymous. After the tenth repetition of the game, students were alerted that the the number of rounds the remaining games would last would change. Then, students played another ten repetitions of the new version of the game.

Participants then completed a post-test survey after the game play portion of the experiment, which collected information on their age, gender, major, time-preferences, altruism levels, and risk attitudes. After completing this survey, participants were paid privately based on their performance in one randomly selected game. Students were also given a handout on the experiment that debriefed them on the subject and what we sought to learn in the experiment. Throughout the experiment, students were not allowed to talk with one another and only allowed to ask clarifying questions to the experiment's administrator.

C.2 Demographic Information on Participants

Table 2: Covariate Summary Statistics

Variable	***Mean***	***Min***	***Max***	***Std. Dev.***
Gender	0.52	0	1	.5
Age	23.54	18	67	9.19
Economics Training	0.15	0	1	0.35
Altruism	29.38	0	100	32.28
Time Preferences	0	-0.91	0.86	0.63
Quiz Score	4.77	1	6	1.36

C.3 Instructions & Instructions Quiz

Experiment Instructions

Thank you for participating in this study. Please turn off all cell phones, and do not talk with one another until the end of the study. Do no open other windows or programs on the computer. If you disobey these rules, we will ask you to leave without payment.

We will begin by going over the instructions. After the instructions, you will take a quiz to test your understanding. You will receive $0.25 for every question you that you answer correctly.

[Screen 1]

In this study, you will play several games. In each game, we will pair you with another person in the room. You will not know which person you are playing with. We will let you know when each game has ended and when a new game begins.

[Screen 2]

In each game, you and the other player will bargain over how to divide some money. Each game will last [5 or 10] rounds, but you will not receive any payment until you and the other player reach an agreement. Once you reach an agreement, you and the other player will receive the agreed upon payoffs each round until the end of the tenth round.

[Screen 3]

When you are bargaining, you will choose to make either a high or low demand. The other player will also choose to make either a high or low demand. You will not know what the other player has demanded until you submit your decision.

[Screen 4]

The table below summarizes the four possible outcomes of your and the other player's decisions.

If you demand:	And the other player demands:	Have you reached an agreement?	You will get:	The other player will get:
High	High	No	$0 this round. Choose again next period	$0 this round. Choose again next period.
High	Low	Yes	$3 each round until the end of the game.	$1 each round until the end of the game.
Low	High	Yes	$1 each round until the end of the game.	$3 each round until the end of the game.
Low	Low	Yes	$2 each round until the end of the game.	$2 each round until the end of the game.

As you can see in the highlighted row above, if you and the other player both place a high demand, you will not reach an agreement. Therefore, neither you nor the other player will receive any money for the round. You and the other player will bargain again in the next round. The game will continue in this fashion until you and the other player reach an agreement or the game ends.

[Screen 5]

As shown in the second row, if you make a high demand and the other player makes a low demand, you will receive the high payoff of $1.50 each round until the end of the game. The other player will receive the low payoff of 0.50 each round.

[5-round Example - To illustrate, if you reach this agreement in the first round, you will receive $1.50 for the first round and $1.50 for each of the remaining four rounds, which gives you a total of $7.50. If you reach this agreement in the second round, you will receive $1.50 for the second round and $1.50 for each of the remaining three rounds, giving you a total of $6. If you reach this agreement in the third round, you will receive $1.50 in the third round, another $1.50 in the fourth round, and a final $1.50 in the fifth round, which gives you a total of $4.50. If you reach this agreement in the fourth round, you will receive $3 – $1.50 for the fourth round and another $1.50 for the fifth round. If you reach this agreement in the fifth round, you will receive $1.50 for that round only.]

[10-round Example - To illustrate, if you reach this agreement in the first round, you will receive $1.50 for the first round and $1.50 for each of the remaining nine rounds, which gives you a total of $15.00. If you reach this agreement in the second round, you will receive $1.50 for the second round and $1.50 for each of the remaining 8 rounds, giving you a total of $13.50. If you reach this agreement in the fifth round, you will receive $1.50 for the fifth round and $1.50 for each of the remaining five rounds, giving you a total of $9.00. If you reach this agreement in the eighth round, you will receive $1.50 in the eighth round, another $1.50 in the ninth round, and a final $1.50 in the tenth round, which gives you a total of $4.50. If you reach this agreement in the tenth round, you will receive $1.50 for that round only.]

[Screen 6]

The third row shows that if you make a low demand and the other player makes a high demand, then you will receive the low payoff of 0.50 each round until the end of the game. The other player will receive the high payoff of $1.50 each round.

[Screen 7]

As shown in the fourth row, if you and the other player both make low demands, then you will receive $1 each round until the end of the game. The other player will also receive $1 each round.

[Screen 8]

To recap:

- You will play a series of decision-making games with other people in the room.
- In each game, you will bargain over how to divide some money.
- Each game will last [five or ten] rounds.
- You will not receive any payment until you and the other player reach an agreement.
- You will not reach an agreement if you and the other player both make high demands.
- Once you reach an agreement, the agreement will hold until the end of the game. You cannot renegotiate the agreement.
- You will be paid privately at the end of the experiment based on the amount you earn in one, randomly selected game.

[Screen 9]

You will now take a brief quiz to make sure you understand the rules of the experiment. We will pay you $0.25 for every question that you answer correctly. Remember, you are not allowed to talk with other participants at this time.

[Text after 10 rounds – if switching from 5 to 10 rounds]

For the remainder of the study, each game will last 10 rounds instead of 5. All of the other rules will remain the same. In other words, if you reach an agreement in the first round, you will receive payment for a total of 10 rounds instead of 5. If you reach an agreement in the fifth round, you will receive payment for the fifth round and for each of the remaining five rounds.

[Text after 10 rounds – if switching from 10 rounds to 5 rounds]

For the remainder of the study, each game will last 5 rounds instead of 10. All of the other rules will remain the same. In other words, if you reach an agreement in the first round, you will receive payment for a total of 5 rounds instead of 10. If you reach an agreement in the fifth round, you will receive payment for the fifth round only.

Instructions Quiz

5-round Quiz Version

1. What happens if you and the other player both make high demands?

   a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.

   b. You and the other player will both receive $1.50 each round until the end of the game.

   c. You and the other player will both receive $0.50 each round until the end of the game.

   d. You and the other player will both receive $1 each round until the end of the game.

   Correct Answer: A.
   Explanation: If you and the other player both make high demands, you will not reach an agreement. Without an agreement, you will not receive any payment. As long as it is not the final round, you and the other player will make new demands in the next round.

2. What happens if you and the other player both make low demands?

   a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.

   b. You and the other player will both receive $1.50 each round until the end of the game.

   c. You and the other player will both receive $0.50 each round until the end of the game.

d. You and the other player will both receive $1 each round until the end of the game.

Correct Answer: D.
Explanation: If you and the other player both make low demands, you will reach an agreement. You will receive $1 each round until the game ends. The other player will also receive $1 each round until the end of the game.

3. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 5 rounds.

- Round 1: Alice makes a high demand. Jane makes a high demand.
- Round 2: Alice makes a high demand. Jane makes a low demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. $2

b. $2.50

c. $6

d. $7.50

Correct Answer: C.
Explanation: Alice and Jane do not reach an agreement in the first round because they both made high demands. Therefore, they do not receive any money for the first round.

In the second round, Alice and Jane reach an agreement. Since Alice made a high demand and Jane made a low demand, Alice receives $1.50 each round for the remainder of the game under the agreement. This means that Alice receives $1.50 in the second round, another $1.50 in the third round, $1.50 more in the fourth round, and $1.50 again in the fifth round. $1.50 + $1.50 + $1.50 + $1.50 = $6. Thus, Alice's payment is $6.

4. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 5 rounds.

- Round 1: Alice makes a high demand. Jane makes a low demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. \$2
b. \$2.50
c. \$6
d. \$7.50

Correct Answer: D.
Explanation: Alice and Jane reach an agreement in the first round since they both did not make high demands. Under this agreement, Alice receives \$1.50 each period until the end of the game (since Alice made the high demand). This means that Alice receives \$1.50 in the first round, \$1.50 more in the second round, another \$1.50 in the third round, \$1.50 again in the fourth round, and a final \$1.50 in the fifth round. \$1.50 + \$1.50 + \$1.50 + \$1.50 + \$1.50 = \$15. Therefore, Alice's payoff is \$7.50.

5. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 5 rounds.

- Round 1: Alice makes a low demand. Jane makes a high demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. \$2
b. \$2.50
c. \$6
d. \$7.50

Correct Answer: B.
Explanation: Alice and Jane reach an agreement in the first round since they both did not make high demands. Under this agreement, Alice receives \$0.50 each period until the end of the game (since Alice made the low demand). This means that Alice receives \$0.50 in the first round, \$0.50 more in the second round, another \$0.50 in the third round, \$0.50 again in the fourth round, and a final \$0.50 in the fifth round. \$0.50 + \$0.50 + \$0.50 + \$0.50 + \$0.50 = \$5. Therefore, Alice's payoff is \$2.50.

6. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 5 rounds.

- Round 1: Alice makes a low demand. Jane makes a low demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. $3
b. $4
c. $5
d. $6

Correct Answer: C. Explanation: Alice and Jane reach an agreement in the first round since they both did not make high demands. Under this agreement, Alice receives $1 each period until the end of the game (since both Alice and Jane made low demands). This means that Alice receives $1 in the first round, $1 more in the second round, another $1 in the third round, $1 again in the fourth round, and a final $1 in the fifth round. $1 + $1 + $1 + $1 + $1 = $5. Therefore, Alice's payoff is $5.

10-round Quiz Version

1. What happens if you and the other player both make high demands?

   a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.
   b. You and the other player will both receive $1.50 each round until the end of the game.
   c. You and the other player will both receive $0.50 each round until the end of the game.
   d. You and the other player will both receive $1 each round until the end of the game.

   Correct Answer: A.
   Explanation: If you and the other player both make high demands, you will not reach an agreement. Without an agreement, you will not receive any payment. As long as it is not the final round, you and the other player will make new demands in the next round.

2. What happens if you and the other player both make low demands?

   a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.
   b. You and the other player will both receive $1.50 each round until the end of the game.

c. You and the other player will both receive \$0.50 each round until the end of the game.
d. You and the other player will both receive \$1 each round until the end of the game.

Correct Answer: D.
Explanation: If you and the other player both make low demands, you will reach an agreement. You will receive \$1 each round until the game ends. The other player will also receive \$1 each round until the end of the game.

3. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 10 rounds.

- Round 1: Alice makes a high demand. Jane makes a high demand.
- Round 2: Alice makes a high demand. Jane makes a low demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. \$4.50
b. \$10.00
c. \$13.50
d. \$15.00

Correct Answer: C.
Explanation: Alice and Jane do not reach an agreement in the first round because they both made high demands. Therefore, they do not receive any money for the first round.
In the second round, Alice and Jane reach an agreement. Since Alice made a high demand and Jane made a low demand, Alice receives \$1.50 each round for the remainder of the game under the agreement. This means that Alice receives \$1.50 in the second round, and \$1.50 for each of the remaining 8 rounds. \$1.50 + \$1.50 (x8) = \$13.50. Thus, Alice's payment is \$13.50.

4. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 10 rounds.

- Round 1: Alice makes a high demand. Jane makes a low demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. \$4.50
b. \$10.00
c. \$13.50
d. \$15.00

Correct Answer: D.
Explanation: Alice and Jane reach an agreement in the first round since they both did not make high demands. Under this agreement, Alice receives \$1.50 each period until the end of the game (since Alice made the high demand). This means that Alice receives \$1.50 in the first round and \$1.50 for each of the remaining 9 rounds. \$1.50 + 9*(\$1.50)= \$15. Therefore, Alice's payoff is \$15.00.

5. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 10 rounds.

- Round 1: Alice makes a low demand. Jane makes a high demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. \$5.00
b. \$10.00
c. \$13.50
d. \$15.00

Correct Answer: A
Explanation: Alice and Jane reach an agreement in the first round since they both did not make high demands. Under this agreement, Alice receives \$0.50 each period until the end of the game (since Alice made the low demand). This means that Alice receives \$0.50 in the first round and \$0.50 for each of the remaining 9 rounds. \$0.50 + (9* \$0.50) = \$5.00. Therefore, Alice's payoff is \$5.00.

6. Please read the following description and outcomes from a hypothetical game.

Alice and Jane bargain over how to divide some money. Alice and Jane must independently decide to make a low or high demand. The game will end after 10 rounds.

- Round 1: Alice makes a low demand. Jane makes a low demand. Therefore, Alice and Jane reach an agreement and receive the associated payoffs until the end of the game.

What is Alice's total payment for the game?

a. \$4.50
b. \$10.00
c. \$13.50
d. \$15.00

Correct Answer: B.
Explanation: Alice and Jane reach an agreement in the first round since they both did not make high demands. Under this agreement, Alice receives \$1 each period until the end of the game (since both Alice and Jane made low demands). This means that Alice receives \$1 in the first round and \$1 for each of the remaining 9 rounds. \$1 + (9*\$1) = 10. Therefore, Alice's payoff is \$10.

C.4 Pre- & Post- test Survey Text

Pre-Test Survey

Screen 1

1. Please describe your intended strategy for the next game, including your choice for the first turn and what you will do in subsequent turns if an agreement is not reached. Please note that you are not required to play with this strategy in any of the games, and your answer here will not affect your potential earnings in any way.

2. Please explain your strategy choice.

Screen 2

3. Are you willing to share some of the point you ear today with a lower scoring participant? If so, please select the percentage you are willing to share. [5% intervals between 0 and 100%]

Post-Test Survey

Screen 1

1. Are you male or female?

   a. Male
   b. Female

2. What is your intended major?

   a. Political Science

b. Economics

c. International Relations

d. Other:

3. Have you ever received formal training in game theory?

a. Yes

b. No

4. What is your age?

Screen 2

5. For each decision (A-F) below, please choose the amounts you woul dlike to recieve for sure **today** **AND** **in 5 weeks** from now by selecting the corresponding option in each row.

Example: In Decision A, if you wanted $19.00 today and $0 in 5 weeks, you would select the left most option. Remember that you can only select one option per decision!

A	Payment TODAY	$19.00	$15.20	$11.40	$7.60	$3.80	$0
	Payment in 5 WEEKS	$0	$4.00	$8.00	$12.00	$16.00	$20.00
B	Payment TODAY	$18.00	$14.40	$10.80	$7.20	$3.60	$0
	Payment in 5 WEEKS	$0	$4.00	$8.00	$12.00	$16.00	$20.00
C	Payment TODAY	$17.00	$13.60	$10.20	$6.80	$3.40	$0
	Payment in 5 WEEKS	$0	$4.00	$8.00	$12.00	$16.00	$20.00
D	Payment TODAY	$16.00	$12.80	$9.60	$6.40	$3.20	$0
	Payment in 5 WEEKS	$0	$4.00	$8.00	$12.00	$16.00	$20.00
E	Payment TODAY	$14.00	$11.20	$8.40	$5.60	$2.80	$0
	Payment in 5 WEEKS	$0	$4.00	$8.00	$12.00	$16.00	$20.00
F	Payment TODAY	$11.00	$8.80	$6.60	$5.40	$2.20	$0
	Payment in 5 WEEKS	$0	$4.00	$8.00	$12.00	$16.00	$20.00

Screen 3

6. What is the minimum amount of money you would need to be offered to prefer receiving that amount over a 50% chance of winning $100?

7. What was the maximum number of rounds you were willing to make a high demand in order to receive the $1.50 per round payment for the games that lasted 5 rounds?

8. Did the maximum number of rounds you were willing to make a high demand change during the games that lasted 5 rounds? If so, how?

    a. The number increased.

    b. The number decreased.

    c. The number increased and decreased depending on the game.

    d. I did not change the number of rounds I was willing to make high demands.

9. In your own words, please describe why you changed the number of rounds you were willing to make high demands when the game lasted 5 rounds. Please limit your response to 3-5 sentences.

Screen 4

10. What was the maximum number of rounds you were willing to make a high demand in order to receive the $1.50 per round payment for the games that lasted 10 rounds?

11. Did the maximum number of rounds you were willing to make a high demand change during the games that lasted 10 rounds? If so, how?

    a. The number increased.

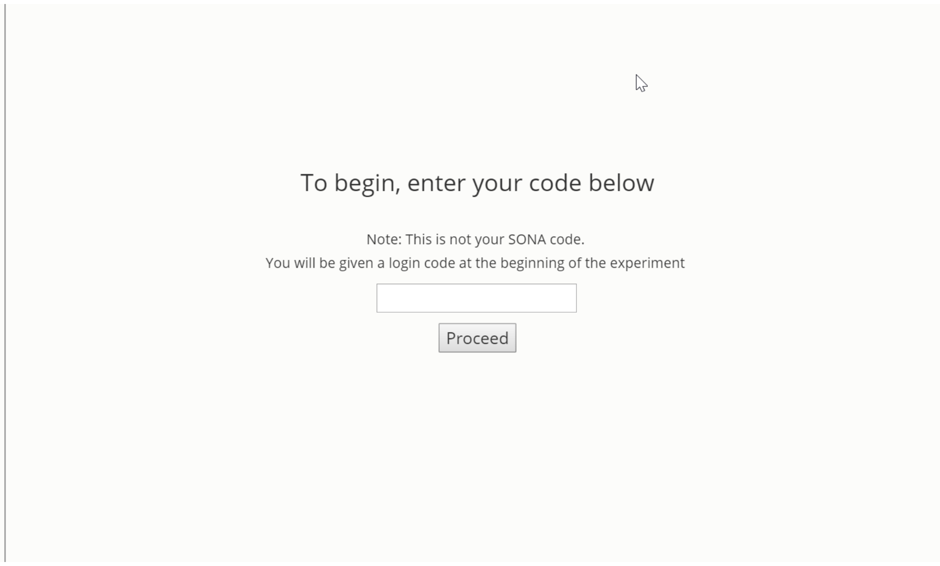
    b. The number decreased.

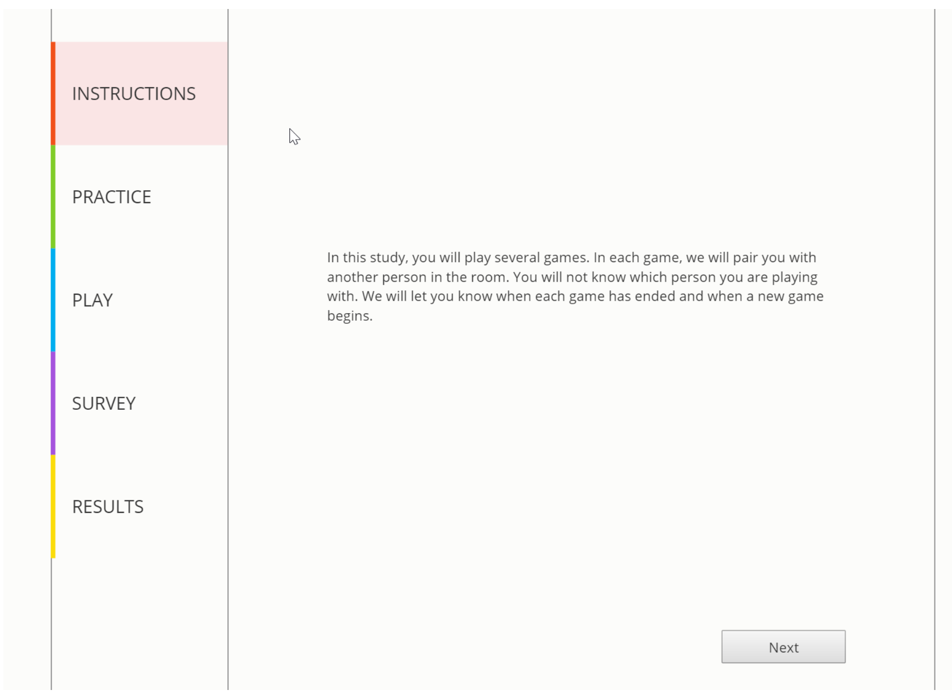
    c. The number increased and decreased, depending on the game.

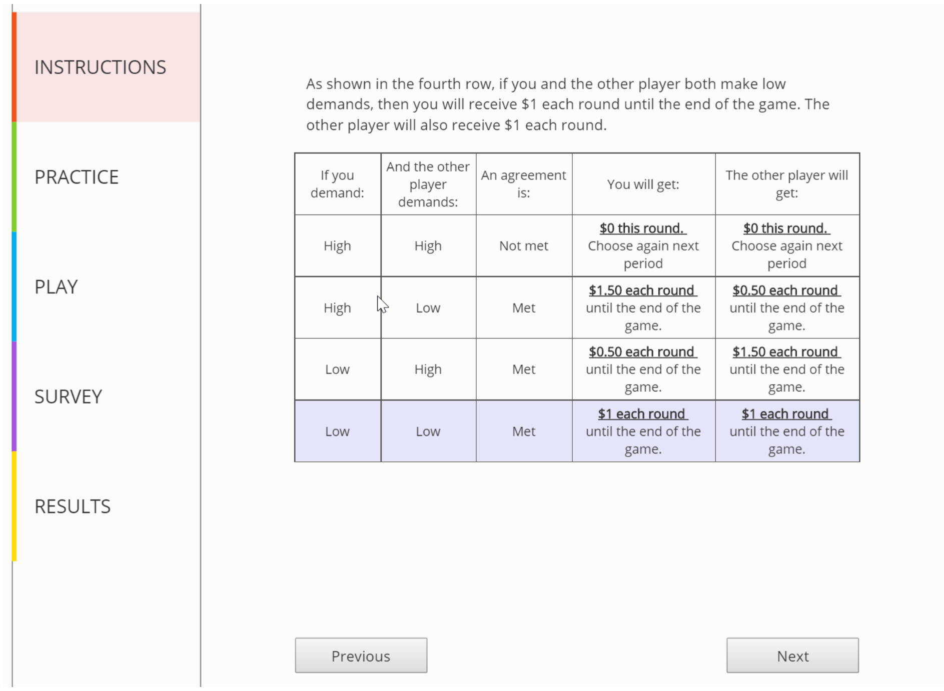
    d. I did not change the number of rounds I was willing to make high demands.

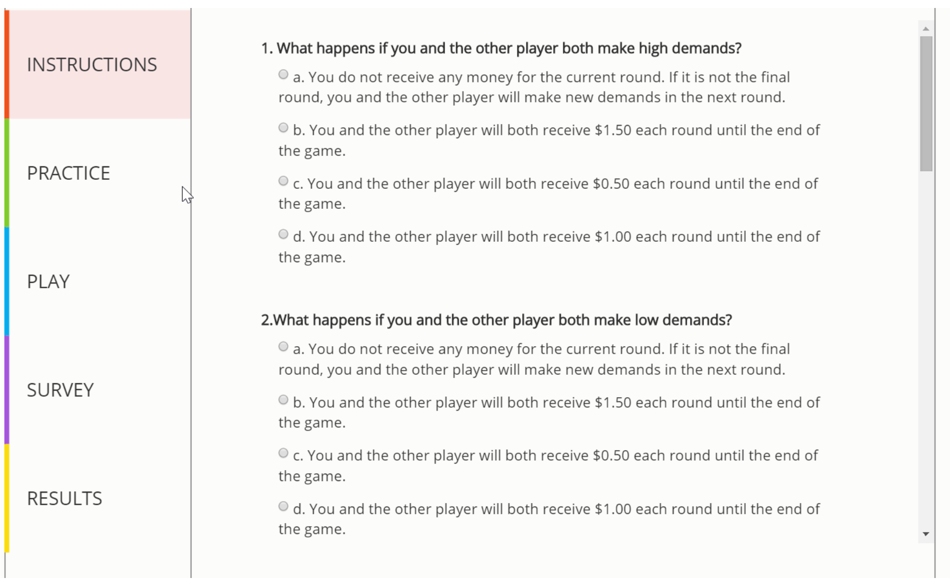
12. In your own words, please describe why you changed the number of rounds you were willing to make a high demand for the games that lasted 10 rounds. Please limit your response to 3-5 sentences.

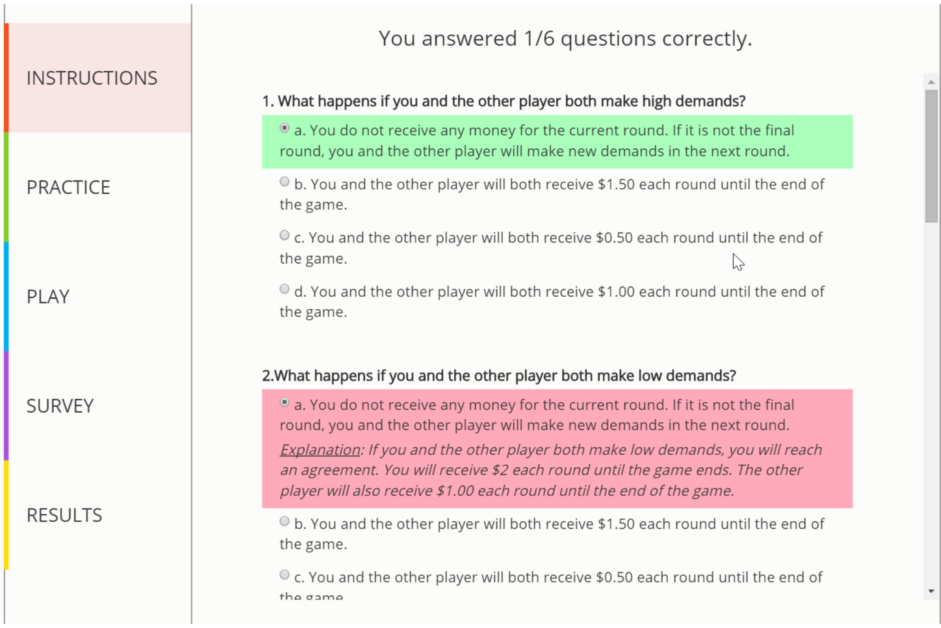
C.5 Experiment Interface Screenshots

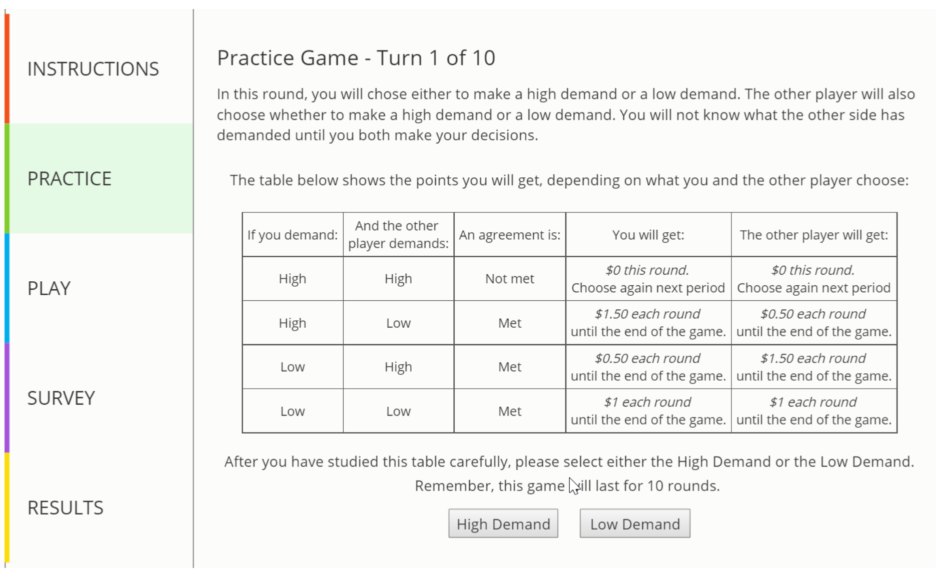


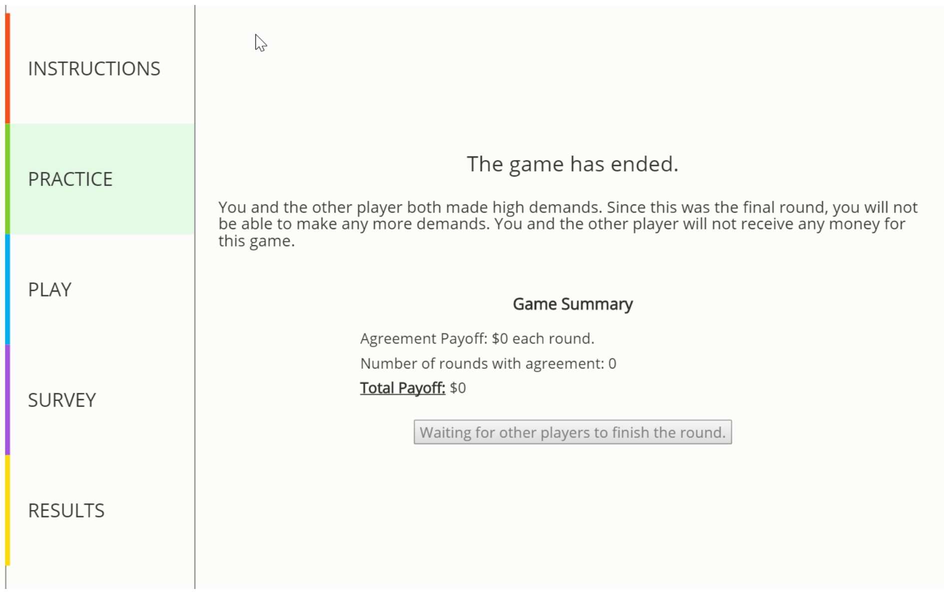


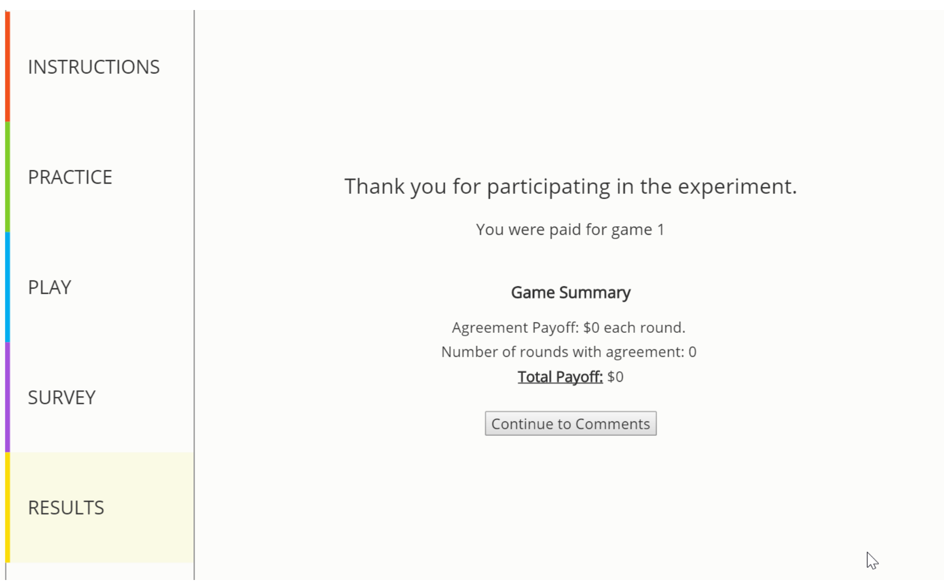

INSTRUCTIONS
PRACTICE
PLAY
SURVEY
RESULTS
As shown in the fourth row, if you and the other player both make low demands, then you will receive $1 each round until the end of the game. The other player will also receive $1 each round.
If you demand:
And the other player demands:
An agreement is:
You will get:
The other player will get:
High
High
Not met
$0 this round. Choose again next period
$0 this round. Choose again next period
High
Low
Met
$1.50 each round until the end of the game.
$0.50 each round until the end of the game.
Low
High
Met
$0.50 each round until the end of the game.
$1.50 each round until the end of the game.
Low
Low
Met
$1 each round until the end of the game.
$1 each round until the end of the game.
Previous
Next


INSTRUCTIONS
PRACTICE
PLAY
SURVEY
RESULTS
1. What happens if you and the other player both make high demands?
a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.
b. You and the other player will both receive $1.50 each round until the end of the game.
c. You and the other player will both receive $0.50 each round until the end of the game.
d. You and the other player will both receive $1.00 each round until the end of the game.
2.What happens if you and the other player both make low demands?
a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.
b. You and the other player will both receive $1.50 each round until the end of the game.
c. You and the other player will both receive $0.50 each round until the end of the game.
d. You and the other player will both receive $1.00 each round until the end of the game.


INSTRUCTIONS
PRACTICE
PLAY
SURVEY
RESULTS
You answered 1/6 questions correctly.
1. What happens if you and the other player both make high demands?
a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.
b. You and the other player will both receive $1.50 each round until the end of the game.
c. You and the other player will both receive $0.50 each round until the end of the game.
d. You and the other player will both receive $1.00 each round until the end of the game.
2.What happens if you and the other player both make low demands?
a. You do not receive any money for the current round. If it is not the final round, you and the other player will make new demands in the next round.
Explanation: If you and the other player both make low demands, you will reach an agreement. You will receive $2 each round until the game ends. The other player will also receive $1.00 each round until the end of the game.
b. You and the other player will both receive $1.50 each round until the end of the game.
c. You and the other player will both receive $0.50 each round until the end of


INSTRUCTIONS
PRACTICE
PLAY
SURVEY
RESULTS
Practice Game - Turn 1 of 10
In this round, you will chose either to make a high demand or a low demand. The other player will also choose whether to make a high demand or a low demand. You will not know what the other side has demanded until you both make your decisions.
The table below shows the points you will get, depending on what you and the other player choose:
If you demand:	And the other player demands:	An agreement is:	You will get:	The other player will get:
High	High	Not met	*$0 this round.* Choose again next period	*$0 this round.* Choose again next period
High	Low	Met	*$1.50 each round* until the end of the game.	*$0.50 each round* until the end of the game.
Low	High	Met	*$0.50 each round* until the end of the game.	*$1.50 each round* until the end of the game.
Low	Low	Met	*$1 each round* until the end of the game.	*$1 each round* until the end of the game.
After you have studied this table carefully, please select either the High Demand or the Low Demand.
Remember, this game will last for 10 rounds.
High Demand
Low Demand


INSTRUCTIONS
PRACTICE
PLAY
SURVEY
RESULTS
The game has ended.
You and the other player both made high demands. Since this was the final round, you will not be able to make any more demands. You and the other player will not receive any money for this game.
Game Summary
Agreement Payoff: $0 each round.
Number of rounds with agreement: 0
Total Payoff: $0
Waiting for other players to finish the round.


INSTRUCTIONS
PRACTICE
PLAY
SURVEY
RESULTS
Thank you for participating in the experiment.
You were paid for game 1
Game Summary
Agreement Payoff: $0 each round.
Number of rounds with agreement: 0
Total Payoff: $0
Continue to Comments

D Additional Statistical Analysis & Robustness Checks

D.1 Tables for Main Results

In the paper, I reported the main results graphically. Table 3 displays the cumulative proportion of five-round and ten-round games that reached an agreement after each of the first five rounds. This table corresponds to the coefficient plot displayed as Figure 1 in the main text.

Table 3: Differences in the Cumulative Proportion of Agreements by Round

Round	**5-Round Games**	**10-Round Games**	**Difference**	**p-value**
1	0.53	0.49	0.04	0.16
2	0.69	0.63	0.06	0.11
3	0.78	0.69	0.08	0.03
4	0.87	0.76	0.10	0.00
5	0.89	0.81	0.08	0.02

Table 4 below illustrates the difference in aggregate payoffs between five- versus ten-round games, the average welfare lost, and the experiment model's predictions. P-values are two-tailed.[3] This table corresponds to Figere 2 in the main text.

Table 4: Welfare Differences between 10-round & 5-round games

	Prediction, K = 10	Prediction, K = 5	Observed, K = 10	Observed, K = 5	Observed Difference	p-value
Game Payment	\$10.48	\$5.25	\$15.82	\$7.57	\$8.25	0.00
Total Lost	\$9.52	\$4.75	\$4.18	\$2.43	\$1.75	0.00
Percentage Lost	47.6%	45.0%	20.9%	24.3%	-3.4%	0.26

D.2 Power Calculations for Experiment Results

Table 5: Power Calculations for T-Test Results by Round

Round	N (per group)	Delta	Std. Dev.	Sig. Level	Power
1	240	0.041	0.50	0.05	0.14
2	240	0.063	0.47	0.05	0.31
3	240	0.083	0.44	0.05	0.54
4	240	0.104	0.39	0.05	0.84
5	240	0.075	0.35	0.05	0.64

[3]Wild bootstrapped standard errors clustered on player 1's and player 2's user ID.

The table above gives the power calculations for the T-tests reported in the text of the paper. As a reminder, there were 48 students across 4 experimental sessions, and students were randomly matched with each other. Because students played the long version of the game 10 times and the short version of the game 10 times, we have 240 observed games for each treatment condition.

As you can see, these calculations illustrate that many of the tests are underpowered– meaning there was a high probability of incorrectly failing to reject the null hypothesis. In particular, there is an 86% and 69% chance of failing to reject the null hypothesis when there is a treatment effect after rounds 1 and 2 respectively, and this lack of power could be the reason why the core results in the paper do not reach standard levels of significance until round 3.

D.3 Cross-over Design Validation

Table 6: OLS Regression of Cumulative Proportion of Agreements by Round

	Dependent variable:				
	Round 1 Agreement	Round 2 Agreement	Round 3 Agreement	Round 4 Agreement	Round 5 Agreement
	(1)	(2)	(3)	(4)	(5)
5-round first	−0.050	−0.038	−0.042	0.012	0.025
	(0.031)	(0.046)	(0.043)	(0.040)	(0.036)
Constant	0.546***	0.683***	0.763***	0.813***	0.842***
	(0.014)	(0.033)	(0.038)	(0.036)	(0.032)
Observations	480	480	480	480	480
R^2	0.003	0.002	0.002	0.0003	0.001
Adjusted R^2	0.0004	−0.001	0.0002	−0.002	−0.001
Residual Std. Error	0.500	0.473	0.438	0.386	0.353
F Statistic (df = 1; 478)	1.200	0.755	1.085	0.126	0.600

Note: *p<0.1; **p<0.05; ***p<0.01

Following the main analysis in the paper, I used wild bootstrapped standard errors clustered on user's ids. As you can see from Table 6, games were not played differently in experimental sessions where students played the five-round games first compared to when they played the ten-round games first. Table 7 below shows that students who played the five-round games first were not significantly more or less likely to place a low demand than the students who played the ten-round games first. These results validates the crossover design used in this experiment.

Table 7: Discrete Time Survival Analysis of Placing a Low Demand

	Dependent variable:	
	Low Demand	
	(1)	(2)
Period 2	−0.758***	−0.175*
	(0.124)	(0.103)
Period 3	−1.181***	−0.479***
	(0.114)	(0.095)
Period 4	−0.760***	0.138
	(0.132)	(0.118)
Period 5	−1.326***	−0.344***
	(0.126)	(0.109)
Period 6	−1.219***	−0.126
	(0.155)	(0.147)
Period 7	−1.700***	−0.585***
	(0.153)	(0.133)
Period 8	−1.763***	−0.650***
	(0.146)	(0.138)
Period 9	−1.913***	−0.853***
	(0.153)	(0.164)
Period 10	−0.383**	0.865***
	(0.169)	(0.163)
5-round first	0.061	0.208
	(0.141)	(0.269)
Constant	−0.863***	−1.792***
	(0.132)	(0.210)
User Fixed Effects	No	Yes
Observations	2,472	2,472
Log Likelihood	−1,184.214	−897.077
Akaike Inf. Crit.	2,390.428	1,908.154
Note:	*p<0.1; **p<0.05; ***p<0.01	

D.4 Individual Strategy Analysis

In the main manuscript, I compared the proportion of games that had reached an agreement by each of the first five rounds to examine the relationship between the shadow of the future and bargaining delay. But We can also examine the relationship between the shadow of the future and bargaining delay by analyzing individual strategies. According to Fearon (1998), long time horizons increase bargaining delay because they incentivize states to concede with a lower probability. Table 6 displays two discrete-time survival models of the likelihood of a player placing a low demand. In these models, the dependent variable is the time until a player places a low demand. Model 1 includes player fixed-effects so it estimates the treatment effect by examining within-player variation. However, because Model 2 includes player-specific covariates that do not vary across games, player fixed-effects are excluded. Both models are estimated via logistic regression with wild bootstrapped standard errors clustered on player ID.[4] Negative coefficients mean that the corresponding variable decreases the likelihood of making a low demand.

If Fearon's hypothesis is correct, we would expect the coefficient on the ten-round indicator to be negative. This is true for both models in Table 6. Because Model 1 examines within-player variation, the results indicate that the same player was significantly less likely to concede their preferred agreement in ten-round games than he or she was when playing a five-round game. In substantive terms, the odds that an individual conceded in round k were 19.3% ($e^{(-0.214)}$) lower when he or she was playing a ten-round game. Again, since players conceded at lower rates in the ten-round game, these results illustrate that a longer shadow of the future increases bargaining delay. The relationship persists in Model 2, and the coefficient changes only slightly.

Model 2 also illustrates the ways behavioral characteristics affect how participants played the experiment's games. Since the individual-level covariates are constant across all repetitions of the games, the coefficients for these variables are estimated only by examining the variation between the ways different individuals played. The results from Model 2 indicate that many behavioral characteristics – including player's risk aversion, time preferences, and levels of altruism – did not significantly affect the strategies players adopted in the games. However, gender, age, and a participants' comprehension of the game, did significantly impact the patterns of game play. Most strikingly, the odds of a woman conceding her preferred agreement were 71.3% higher than the odds of a man conceding his preferred agreement. Older participants were also more likely to place low demands. These results are consistent with work in behavioral economics, which find that women and older participants are more likely to behave selflessly in strategic games (Ortmann and Tichy 1999; Carpenter et al. 2008). Notably, participants with higher scores on the instructions quiz were more likely to stand firm by placing high demands.

[4] Wild bootstrapped standard errors are suited for inference robust to heteroskedasticity of unknown form. I use the Rademacher distribution following Cameron, Gelbach, and Miller (2008). Using other specifications for the standard errors does not change these results.

Table 8: Discrete Time Survival Analysis of Placing a Low Demand

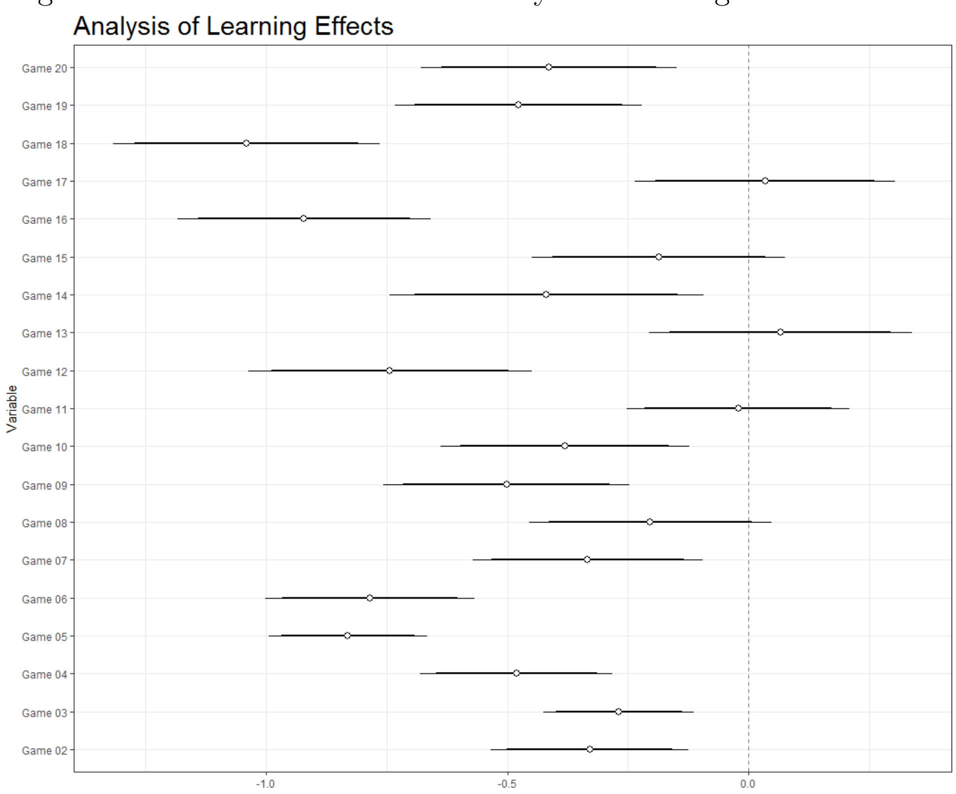
	Dependent variable:	
	Low Demand	
	(1)	(2)
10-Rounds	−0.214***	−0.203***
	(0.065)	(0.067)
Female		0.538***
		(0.159)
Risk Acceptance		−0.001
		(0.001)
Time Horizons		0.0005
		(0.002)
Altruism		0.001
		(0.002)
Economics Major		0.029
		(0.181)
Age		0.055***
		(0.009)
Quiz		−0.199***
		(0.062)
Constant	−1.478***	−1.235***
	(0.217)	(0.407)
User FEs	Yes	No
Round FEs	Yes	Yes
Observations	2,472	2,231
Log Likelihood	−895.658	−1,043.858
Akaike Inf. Crit.	1,907.316	2,123.715
Note:	*p<0.1; **p<0.05; ***p<0.01	

D.5 Analysis of Learning & Fatigue Effects

In appendix D3, I show that those who played the five-round version of the experimental game first did not play differently than those who played the ten-round version first. Therefore, we can be reasonably confident that counterbalancing was successful: treatment should be uncorrelated with any order effects that could have biased the results of this study. Still, we may be interested in how participants learned throughout the experiment.

As a first cut at understanding learning effects, we can examine how individuals changed their strategies in each game of the experiment. Figure 2 displays the coefficient estimates and confidence intervals for the game number indicators in the discrete time survival analysis model of individual strategies.[5] Recall that negative coefficients mean that students were less likely to concede their preferred agreement. As you can see, even though it appears that players were more likely to hold out after the first round, there is not a strong consistent pattern throughout the rest of the game play.

Figure 2: Discrete Time Survival Analysis of Placing a Low Demand



One thing that is striking about Figure 2 is how the confidence intervals on these estimates grew larger throughout the experiment, which suggests that subjects were playing

[5]Wild bootstrapped standard errors clustered on P1 and P2 user-ID. Using other specifications for standard errors do not change these results.

more erratically in later rounds. This could be indicative of subject fatigue. While counter-balancing should mean that treatment is uncorrelated with these order effects, we may want to investigate explicitly how learning or fatigue could be affecting the results of the study.

To do so, I estimate new discrete time survival models of individual strategies that include time controls. Table 8 displays these results.[6] Both models reported in this table include user and round fixed-effects. To control for order effects in model 1, I estimate order effects with linear, quadratic, and cubic time trends based on game number. In model 2, I include game number fixed effects.

In model 1, the linear time trend should control for the effect of fatigue if we think that fatigue is increasing throughout the duration of the experiment. This functional form for fatigue seems the most likely given that the size of the confidence intervals on the learning analysis increased consistently each game. However, we might worry about other functional forms fatigue or learning could take. For instance, we might think that students are most attentive during the first and last few games, with their attentiveness dropping off in the middle of the game. If this is the case, the quadratic time trends should control for these effects. Alternatively, we may think that student's attentiveness was decreasing as the games passed on up until they were notified that the length of the games were changing after game 10, and this notification spiked their attentiveness once again. But as they completed games 11 through 20 their attentiveness dropped back down again. Here, the cubic time trend is helpful for controlling for these effects.

Model 2 includes both my main variable of interest and game fixed effects. This allows me to control for order effects without assuming a functional form that they should take.

As a reminder, a negative coefficient in this discrete time survival analysis means that players were less likely to concede their higher paying agreement, which leads to overall longer bargaining delay. In both models, the estimated effect of a longer shadow of the future is negative and significant, and the size of the coefficient changes only slightly.

The effects of a longer shadow of the future are robust across both model specifications. In model 1 and model 2, the coefficient on ten-round games was negative and significant. This means that when participants were playing the ten-round games, they were significantly less likely to concede the higher paying agreement than they were when they were playing the five-round games. Further, the coefficients between models without time trends (referenced in appendix D4) and the coefficients in models controlling for order effects are quite consistent (between -2.14 and -0.232 for models with user fixed effects). In fact, the estimated effect of the shadow of the future grows larger in models that control for order effects. Thus, the finding that the shadow of the future increases bargaining delay still holds when accounting for order effects like learning and fatigue.

[6] Wild bootstrapped standard errors clustered on player 1 and player 2 user IDs.

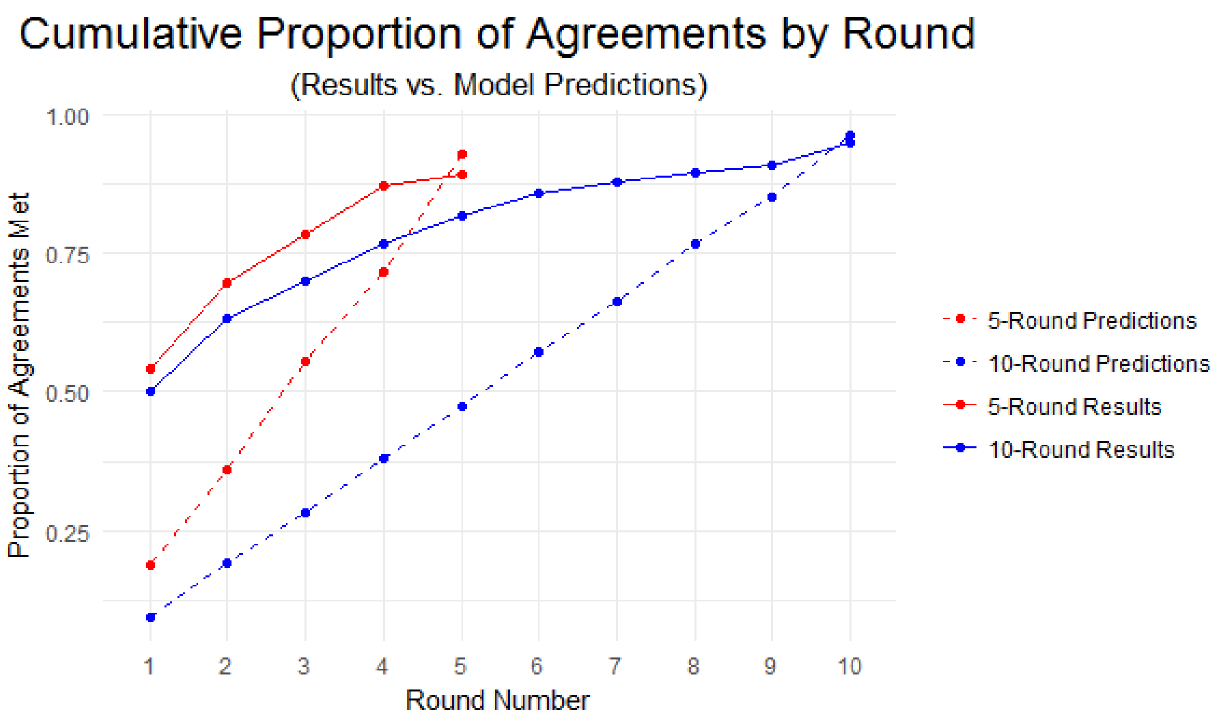
Table 9: Discrete Time Survival Analysis of Placing a Low Demand

	Dependent variable:	
	Low Demand	
	(1)	(2)
10 Rounds	-0.216^{***}	-0.232^{***}
	(0.066)	(0.066)
Game Number	-0.178^{***}	
	(0.033)	
Game Number^2	0.019^{***}	
	(0.003)	
Game Number^3	-0.001^{***}	
	(0.0001)	
Game Number FEs	Yes	No
User FEs	Yes	Yes
Round FEs	Yes	Yes
Observations	2,472	2,472
Log Likelihood	−882.884	−894.216
Akaike Inf. Crit.	1,919.768	1,910.431
Note:	*p<0.1; **p<0.05; ***p<0.01	

D.6 Discussion of Underbidding

Behavioral effects may be driving the significant underbidding – that is, players placing a low demand before the model would predict – that appears in the results. Figure 3 displays the model's predictions about the cumulative proportion of games that should reach an agreement by each round versus what was observed in the experiment. The model predicts that only 19% of the five-round games would have an agreement after the first round, but 53% had an agreement in the experiment. In more concrete terms, the model predicts that five-round games would have had 2-3 rounds of bargaining delay, but we observed an average of 1.24 rounds of delay. Similarly, the model predicts 5-6 rounds of bargaining delay in the ten-round games compared to an average of 2.13 rounds in the experiment. Although this pattern of underbidding is consistent with other experiments on the war of attrition (Horish and Kirkchamp 2010), its implications for interstate bargaining are not obvious. Since the discrete survival analysis illustrates that individuals with a greater familiarity with the game are more likely to hold out for their preferred deal, we might expect that experienced diplomats would be less likely to underbid in this manner. This expectation is also supported by the fact that students were more likely to hold out in later repetitions of the game. An analysis of these learning effects can be found in appendix H.

Figure 3: Predicted vs. Observed Cumulative Proportion of Agreements by Round



It is possible that allowing an equal split of the per-period payment when both participants conceded created a focal point for cooperation, which could be another source of the underbidding. Even though splitting the per-round payment is equivalent in terms of expected utility as Fearon's (1998) fair lottery where both states concede at the same time, studies suggest that fair, symmetric outcomes create focal points for players to coordinate their behavior (Shubik 1994). The experiment's results are somewhat consistent with this explanation. 16.4% of games where agreements were made in the first round resulted from both players conceding. By comparison, both players conceded in only 7.0% of games where they did not reach an agreement in the first round. However, the trends in participants' patterns of play suggest that focal points can only explain a small portion of the underbidding. Only 41 out of the 480 games (approximately 8.5%) ended in the first round with both sides conceding their preferred agreement. This percentage creeps up to 11.9% if examining all games that end with both sides conceding, regardless of the round. Thus, even though there is some evidence of a focal point, this dynamic cannot explain the extent of underbidding exhibited in the experiment.