Conflict, Settlement, and the Shadow of the Future*

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Abstract

Why is conflict in both its violent and non-violent forms, being so higly inefficient, still very common? Recent theoretical research argues that conflict arises as the optimal choice by an actor when long-term contracts that would enforce peace are not possible and when conflict today changes the relative bargaining powers of the actors tomorrow. Contrary to standard folk theorem intuition, higher discount factors lead to a higher valuation of future payoffs, a larger payoff to eliminating one's opponent, and a greater likelihood of conflict. We design a laboratory experiment to test this prediction. We find that subjects are, to a large degree, more likley to engage in risky conflict as the probability of future rounds increases.

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1 Introduction

It is difficult to understand conflict from an economic perspective, whether it is violent conflict like going to war or non-violent conflict like going to court or on strike. For, ideally, the resources expended on arming or lawyers and the possible destruction and inefficiency that can take place under conflict could conceivably be reduced, if not eliminated altogether, by some appropriate Coasian transfers.

The one type of explanation that has largely dominated the economics literature is that of incomplete or asymmetric information of one party about the preferences, endowments, available strategies, or other characteristics of another party. (See, for example, Brito and Intriligator, 1985.) In the presence of such information asymmetries – and the presumed inability of each side to credibly reveal the truth about itself to other parties – there can be states of the world in which one or more parties will choose conflict rationally, as part of some reasonable equilibrium concept.[1]

Whereas undoubtedly asymmetric information is relevant in many instances of conflict, there is scope for additional types of explanation that may add to informational explanations. In particular, there is another type of explanation for conflict that is potentially empirically important that has received almost no attention within economics. There are two key ingredients to that explanation. First, adversaries cannot write long-term contracts on an "enforcement" variable, like on arms or hiring lawyers to prepare for possible future litigation. However, the adversaries could write short-term contracts and settlement that are conditioned on such enforcement variables. Second, conflictual outcomes have different long-term implications for the strength of each adversary than peaceful settlement outcomes have. For example, the winner of a war could be expected to gain more resources, and therefore a strategic advantage, relative to the loser well into the future, whereas a peace-

[1] Other reasons, based on economic models, that may induce conflict include indivisibilities, increasing returns in production, risk seeking preferences. For a review of reason for going to war primarily concernced with international relations see Fearon (1995) and for a review based on conflict models that allow for bargaining see Skaperdas (2006).

ful settlement outcome would not be expected to have as dramatic a change in the future strategic positions of the adversaries. Similarly, going to court can be expected to enhance the property rights of the winner of a legal dispute and diminish those of the loser, whereas an out-of-court settlement keeps the relative position of litigants more constant.

For the case of war, Fearon (1995) first discussed this type of explanation and models that make the argument explicit include a finite-horizon model in Garfinkel and Skaperdas (2000) and infinite-horizon models in Powell (2006) and McBride and Skaperdas (2007).[2] Similarly, Robson and Skaperdas (2008) show how going to court in the case of legal disputes can be an equilibrium outcome.

One robust comparative static result of this and other models is that conflict becomes more likely and settlement less likely as the discount factor of the adversaries becomes larger or, to use a more evocative term, as the shadow of the future becomes longer. A longer shadow of the future makes the valuation of future payoffs higher relative to current payoffs, and the future rewards of an enhanced strategic position under conflict then loom larger than the settlement payoffs that involve enforcement expenditures well into the future. Moreover, enforcement expenditures also typically become higher when the future becomes more important[3] and since the winner of a conflict can lower or completely eliminate these expenditures in the future this is an analytically distinct reason for conflict being induced as a result of lower discounting of the future.

This effect of discounting is obviously opposite to that predicted by folk-theorem arguments. The supergame strategies that implement cooperative outcomes under repeated interaction are more likely to be adopted in stationary environments in which the long-term asymmetric effects of a conflict do not spill over into future by changing the relative strategic

[2] Powell (1993) was the first dynamic model that included similar considerations (and the main comparative static result regarding the "shadow of the future") but did not include the possibility of within-period transfers between adversaries. That is, there is a within-period indivisibility in Powell's model, something that is an analytically distinct reason for conflict. However, there is no reason that Powell's (1993) model could be not be adapted to allow for within-period transfers and still yield conflict as a possible equilibirum outcome.

[3] In addition to the papers mentioned above, Powell (1993), Skaperdas and Syropoulos (1996), and Mehlum and Moene (2007) also show how enforcement costs increase with higher discount factors.

positions of adversaries.

In this paper we experimentally examine this effect of the shadow of the future on conflict and settlement. Our subjects faced the choice between a certain current payoff to which each adversary has to agree and the uncertain outcome of a conflict. The shadow of the future is approximated by a constant continuation probability of the same game. In this last feature of the experiment we have followed Dal Bo (2005), who has examined the effects of the shadow of the future in stationary environments in which the folk theorem could apply. We find a clear tendency for a longer shadow of the future to increase the subjects' choice of conflict, especially compared to the one-shot case with zero continuation probability.

In section 2, we further elaborate why the type of explanation of conflict that we advance in this paper and the effect of the shadow of the future that we experimentally test may be empirically relevant. Section 3 develops an illustrative model on which the experiment is based. In section 4 we discuss our experimental design and in section 5 the results.

2 Preliminary Considerations: Fighting and Going to Court

The two necessary elements of the explanation of conflict we examine in this paper are (i) the impossibility of writing long-term contracts on enforcement levels and (ii) conflict and settlement have very different dynamic paths in terms of the initial conditions that adversaries face in the future. Condition (i) is very likely to be satisfied both in adversarial settings that can lead to war and in legal disputes. The main enforcement variable in wars is arming and in many cases it is impossible to write long-term disarmament contracts (although, it is typically possible as well as a frequent occurrence to have truces and cold wars – thought of as a series of short-term contracts – that are enforceable by each adversary's military strength). In legal disputes the main enforcement variable involves litigation expenditures on lawyers, paralegals, private investigators, or potential expert witnesses, and it is similarly difficult to write long-term contracts that would prevent potential legal adversaries from engaging in any such expenditures. However, the retention of lawyers and the threat to deploy them in court could help enforce shorter-term out-of-court settlements.

We next discuss why condition (ii) is plausible in many circumstances and why the type of explanation we examine here is promising.

2.1 Legal Disputes

As is the case with wars, information problems are considered the primary reason for legal disputes ending up in court (see, for example, Hay and Spier, 1998). However, going to court and settling out of court can have significantly different implications for the relative future strategic positions of potential litigants.

On the one hand, going to court enhances the strategic position of the winner and increases the chance of that winner prevailing in similar future disputes with the same or different adversaries. Conversely, the adversary who loses in court has a diminished future strategic position to prevail in similar disputes. In other words, going to court and obtaining a decision enhances the property rights of the winner and diminishes those of the loser well into the future.

On the other hand, settling out of court tends to leave the relative property rights positions of adversaries in the future more stable, though not necessarily constant. Settling out of court with someone who has sued you could invite future litigants who might sue you solely in order to extract an out-of-court settlement. Therefore, going to court, though costly in the short-run, could deter future litigation and the costs that would accompany such litigation. Moreover, in many legal systems the holder of an asset who does not periodically exercise some form of open demonstration of ownership, including possibly receiving a positive court decision, could lead to the loss of the asset or at least the "atrophying" of his or her property right over that asset (Buchanan, 1989).

Thus, going to court enhances property rights whereas not doing so might erode one's property right in several ways. Thus, going to court could well be an equilibrium outcome, even in the absence of any informational problems, when ensuring property rights in the future is deemed important.

2.2 Wars

For disputes that could potentially lead to war it is evident that war itself and a truce or a peace affect the adversaries' future strategic positions differently. Winners of wars can be expected to have a better future strategic position that they had prior to war and losers typically have a worse strategic position than they had prior to war. In the absence of war, strategic positions do not change much, although one side's power may be declining over time while the other side's power might be ascending because of economic, demographic, or other reasons.

Clearly informational problems can help explain many wars and other disputes. However, there is no reason to think that all wars in all of their aspects can be due solely to such problems, and we briefly offer some examples (discussed in Skaperdas, 2006) in which the hypothesis that we examine can be relevant and explain some aspects of warfare that it would be hard to explain with informational failures.

World War I is commonly discussed as a war that was started because of information problems (see, for example, Ch. 2 in Joll, 1992). Incompleteness of information might not be the whole story, however, if we were to consider that there was no peace after it became obvious to almost everyone that trench warfare brought stalemate and not quick victory. With trench warfare much of the initial incomplete information dissipated, the costs of the war continuing were horrendous with no end in sight and yet war continued. Reasonably, it could be argued that each side saw the chance of eventual dominance well into the future as the carrot that kept the war going. Moreover, we should also consider that all major adversaries had long-term strategic objectives that made them arm in the first place and at least some fraction of the elites within each of the major states involved saw a war as necessary for the defense of existing possessions or repossession of old ones close to them (like Alsace and Lorraine for France and Germany) or for the defense or capture of areas around the globe.

Also, relevant to our approach was the endgame of World War II. Why didn't the United States settle for the advantageous peace that Japan was bidding for? Why did the Soviet Union push so hard, and at such cost, in the Eastern front? Why were the Western allies rushing in the Western front? Certainly it could not be because they were not aware of Japan's or Germany's strength or the other way around. The allies were all looking into the future. They wanted the Axis powers crushed without the possibility of even a remote comeback, as it happened with Germany after World War I. They were also eyeing one another, jockeying for position in the post-war period - the Cold War had effectively started considerably before the end of the actual hot war.

Finally, since the Second World War, civil wars have been much more common than interstate wars. With an average duration of over seven years (Collier et. al., 2003), by that time both informational asymmetries and the costs of war become apparent. Similarly, civil wars within Northern Italian city-states in late medieval times often lasted for decades with tremendous costs to the participants (see, for the case of Genoa, Ch.8 in Greif, 2006). Before attributing all such conflicts to informational problems the gamble on gaining long-term advantage over opponents again appears as at least another, complementary to others, explanation of the many civil wars that have occurred.

2.3 Other types of conflict

In addition to warfare and litigation, there are other types of disputes that could be relevant for the approach we develop here. They include rent-seeking and related policy disputes, labor union and firm disputes, and possibly competition among firms that use marketing and advertising as major instruments of competition. For the case of rent-seeking and other policy disputes, the relevant enforcement variables are expenditures on lobbying and related activities that are clearly not contractible in the long-run. Settlement in this case would imply that the major sides to the policy dispute agree on a compromise proposal, whereas conflict would involve each side offering clearly different proposals, not compromising, and letting the lobbying and legislative process determine which proposal is eventually adopted.

For the case of disputes between labor unions and firms, the non-contractible variables would include the expenditures on the part of the union on strike preparation (including possibly the accumulation of a strike fund) and for the firms the resources expended on negotiation and preparations for a strike or a lockout. Conflict in this case would involve a strike or a lockout, whereas settlement would involve the signing of a new contract for a set period of time. For the case of competing firms, the non-contractible enforcement variable could be the resources expended on marketing and advertising, whereas conflict would be equivalent to a price war and settlement a more cooperative outcome on their part. In all these cases, the conflictual and settlement outcomes can bring about different future strategic position for the adversaries, and therefore our approach and the effect of the shadow of the future can be important for bringing about conflict or settlement. However, we do not pursue these applications further as the literature and applications do not appear to our knowledge to be as developed.

3 An Illustrative Model: Conflict vs. Settlement

Consider two agents, A and B, who interact over an indefinite horizon. In each period they compete over a prize of value Y. Because the two agents cannot write contracts on the ultimate source of enforcement each period they have to expend resources e_A and e_B to maintain their position. These expenditures are necessary regardless of whether Conflict or Settlement (under the threat of conflict) ultimately prevails. In the case that Conflict involves actual warfare, e_A and e_B would represent arming expenditures whereas in the case of litigation they would represent expenditures on lawyers' and related fees. In the event of Conflict, the enforcement expenditures e_A and e_B affect the probabilities of winning for each side; we denote these probabilities by q_A and q_B. (Obviously, we can expect one agent's enforcement expenditures to positively affect his own winning probability and negatively affect his opponent's winning probability. As our experiments do not involve an endogenous choice of these expenditures, we do not endogenize them here, although as we show in the Appendix the main comparative static results are preserved when enforcement expenditures are endogenously determined.) In the case of Settlement, e_A and e_B – through their effect on the probabilities of winning in the event of Conflict – influence each agent's bargaining position in arriving at a particular deterministic settlement (shares of the prize Y).

If Conflict were to take place only a fraction $\phi \in (0, 1)$ of Y can be consumed with the rest, $(1 - \phi)Y$, being destroyed by the conflict. In each period, then, the expected single-period payoff of agent $i = A, B$ in the event of Conflict is:

$$U_i^c = q_i \phi Y - e_i \tag{1}$$

Given that Conflict is destructive, in each period both sides would prefer to divide Y in shares that equal their winning probabilities since it would result in a payoff of $q_i Y - e_i > q_i \phi Y - e_i = U_i^c$. A range of other possible divisions of Y would also be Pareto superior to the expected payoffs under Conflict. With an indefinite repetition of such single-period interactions, there would never be an incentive to induce Conflict, provided the two agents could costlessly communicate and the prize Y were divisible.

Nevertheless, if Conflict were to occur, we would reasonably expect interactions between the two agents to be different in the future. Given that the winner of Conflict would receive ϕY and the loser nothing, the resources that the winning side could command in the future can be expected to be higher than those of the winner which, in turn, could bias future conflicts even further in favor of today's winner. Such induced asymmetries could well make Conflict an attractive possibility by trading off a lower expected payoff for today for higher levels of it in the future.

For simplicity, we allow a stark and simple form of dependence of future power on today's

Conflict. We suppose that the loser of Conflict in any period would be unable to raise the resources that are necessary to challenge the winner in future periods and, thus, the winner would be able to enjoy the prize Y in all future periods whereas the loser receives nothing. (McBride and Skaperdas, 2007, illustrate how the main results extend to the less stark setting in which for an agent to drop completely out of contention there is a series of small conflicts with probabilistic outcomes, and not just one, that would have to be lost.)

Next, consider the negotiations that would result in either Settlement or Conflict in any particular period in which no Conflict has occurred in the past and the agents have already expended resources on enforcement (i.e., $e_i's$ have been expended and represent sunk costs). Further, and without loss of generality, suppose agent A is the one that has the initiative in making a proposal. In the case of Settlement, the agent would receive the whole value of Y and would make an offer of subsidy S to agent B, which would either accept or reject A's offer. If the offer were to be rejected, Conflict would ensue. The resources that each party has invested on enforcement are considered sunk so that they play no more in current negotiations.

Assuming a discount factor $p \in (0,1)$[4], the discounted expected payoff for agent i in the event of Conflict is the following:

$$V_i^C = q_i \phi Y + q_i \Sigma_{t=1}^{\infty} p^t Y + (1 - q_i) \Sigma_{t=1}^{\infty} p^t 0 = q_i(\phi + \frac{p}{1-p})Y \tag{2}$$

Note how in the event of Conflict, since one agent would be eliminated from contention, in the future no resources would be devoted to enforcement. Agent B would accept any offer S from agent A that satisfies the following inequality:

$$S + pV_B(S) \geq V_B^C \tag{3}$$

where $V_B(S)$ denotes the continuation payoff of agent B when she is a responder given

[4] Given risk neutrality, could also be interpreted as a the constant probability of the game continuing in each period, an interpretation that we maintain in the experiments.

the subsidy S. As part of any Markov Perfect Equilibrium in which a positive subsidy is given, agent A would offer a subsidy S^* that satisfies (3) as an equality. Assuming that S^* would be accepted in this period, it would be acceptable in all future periods and therefore $V_B(S^*) = \frac{S^*-s_B}{1-p}$. Then, from (3) and (2), the subsidy would be:

$$S^* = q_B[\phi(1-p)+p]Y + pe_B \tag{4}$$

Note that this subsidy that must be offered by agent A to agent B in order to prevent Conflict depends positively on the power of agent B (as proxied by her probability of winning q_B), on the share of output that is not destroyed in the event of Conflict, on the discount factor, as well as on the value of the prize Y. However, this minimally acceptable subsidy to agent B might not be in agent A's interest to offer. In particular, the resultant payoff of agent A should be preferable to her expected payoff under Conflict, or

$$Y - S^* + pV_A(S^*) \geq V_A^C \tag{5}$$

where $V_A(S^*) = \frac{Y-S^*-e_A}{1-p}$ is the continuation payoff of agent A if Settlement were to prevail forever. Supposing the probabilities of winning for the two sides sum to one (i.e. $q_A+q_B = 1$), it is straightforward to show that the condition for Settlement (so that (3) and (5) are both satisfied) is as follows:

$$Y \geq \frac{p\,(e_A+e_B)}{(1-\phi)(1-p)} \tag{6}$$

When this inequality is reversed, there would not be a subsidy that is feasible, and Conflict would ensue. Thus, based on (6), Conflict is more likely and Settlement is less likely, the lower is the contested output Y;the higher are the resources devoted to arming (e_A+e_B) by the two agents; the less destructive Conflict is (or, the higher is ϕ); and, the higher is the discount factor (or, the game's constant continuation probability) p is.

It is this last effect of "shadow of the future" that we are interested in testing experimentally.

4 Experiment Design

Our experiment consists of three experiment sessions conducted at the California Social Science Experimental (CASSEL) Laboratory at UCLA. Each session used subjects recruited from the CASSEL subject pool database. After learning about the laboratory from advertisements or friends, a UCLA students registers in the subject pool online through the laboratory's web site. All subjects in the pool were sent an email notifying them of an experiment session. An interested student then registers specifically for our session. No student was allowed to participate in more than one session. Each subject accumulated "points" based on her choices, the choices made by her matched partner in a given round, and random draws by the computer. The more points earned, the more U.S. currency the subject received at the experiment session's end, with the exact amount determined by a publicly announce point-dollar exchange rate. Each subject also received a \$5 show-up payment. The average earned amount was \$30 for about 75 minutes of participation.

A Single Match. A single session consists of a number of matches. Each match captures the reduced settle-or-fight decision scenario depicted in the model. Specifically, in a single match two subjects are paired and round one begins. Both are publicly told that the "point value" is 100 (prize Y in Section 2's notation), the "standard fee" is 30 (arming cost c), the "flipping fee" is 30 (total destruction dY), and the "continuation probability" (probability p) which takes three values (see below). Each subject then selects either "split" (settle) or "flip" (fight). Payments are then received according to the model depicted in Section 2. That is, in round 1 each receives 20 ($= \frac{1}{2}Y - c$) if both chose split; and if at least one chose flip, then a random draw by the computer selects one of the subjects to be the winner and the other to be the loser, where the winner's round 1 payment is 40 ($= Y - dY - c$) and the loser's round 1 payment is -30 ($= -c$). The computer then randomly determines whether the match continues to round 2. If both chose split in round 1, then the round 1 settlement applies to any future rounds. Thus, should round 2 be reached, settlement in round 1 implies settlement in round 2, and each receives 20. If there was conflict in round 1, then the winner from round 1 receives 100 in round 2, and the loser in round 1 receives 0 in round 2. Any other future rounds, should they be reached, have the same payoff structure as round 2. Having each subject only make one choice per match (rather than making a choice in each round following peace) simplifies the decision process for the subjects, speeds up the experiment, and facilitates the making of hypotheses (see below).

Continuation Probability. The continuation probability p is the key treatment variable. It takes one of three values: 0, 0.5, and 0.75. A match lasts a single round if $p = 0$. If $p = 0.5$ or $p = 0.75$, then the exact number of rounds in a given match is determined randomly by the computer. With $p = 0.5$, the expected number of rounds in a given match is 2, and if $p = 0.75$, the expected number of rounds is 4. Subjects are told the continuation probability at the same time they are told the other parameters, immediately prior to making the split-or-flip (settle-or-fight) decision. These values for p were selected for two reasons. First, because they are the same used by Dal Bó (2005), they provide a point of comparison with other experimental work. Second, as discussed below, they allow for sharp predictions.

Computer Interface. We used specially designed software to manage the experiment. Figure ??? depicts the user interface as seen by an experimental subject for the $p = 0$ treatment. Under the other treatment values $p = 0.5$ and $p = 0.75$, the interface is identical except the points diagram in the upper left would differ to accurately reflect the possible payments under those other values for the continuation probability. We used the computer manage the experiment because it greatly facilitated all aspects of experiment management, instruction, and data collection.

Rotation Matching. Dal Bó (2005) uses a rotation matching procedure "to avoid potential interaction and contagion effects between the different" matches (1596). In each session, subjects are divided into two equally-sized agents: Blue and Red. In any given match, a Blue and Red are paired. In the next match, the Blue is matched with a different Red, and so on. One full rotation (also called a zipper) consists of each blue being paired exactly once with each Red. With 24 subjects split into Blue and Red agents each of size 12, one rotation consists of 12 matches. With three treatment values for the continuation probability, we thus have 4 matches per treatment variable in one rotation. We use Dal Bó's rotation mechanism primarily for comparison with Dal Bó's design. The contagion effects that might arise in Dal Bó's (2005) repeated game context are unlikely to be present in our setting. Unlike the mixed-motive prisoner's dilemma game, the weakly dominant strategy yields the highest expected payoff *ex ante*, thus leaving no dynamic incentive to play meta-strategies across matches.

Sessions. We conducted three sessions to consider various manners in which changes in the treatment variable may impact decisions. Session 1 uses one matching rotation (12 matches) with an ABC design: four matches of $p = 0$, followed by four matches of $p = 0.5$, followed by four matches of $p = 0.75$. We supposed that this order would be easiest for subjects as they increased their familiarity with the game. Session 2 uses one rotation with a CBA design: four matches of $p = 0.75$, followed by four matches of $p = 0.5$, followed by four matches of $p = 0$. We reverse the order, as compared with Session 1, to consider a priming effect. Session 3 uses two full rotations (24 matches) with an ABCCBA design: subjects do one full rotation akin to Session 1, are then reagented into Blues and Reds, and then do another full rotation akin to Session 2. This design combines elements of both Sessions 1 and 2 thereby controlling for both priming and learning. Table 1 provides summary information about the three sessions. For convenience, the bottom panel of the table breaks Session 3 into its first and second matching rotations and calls them Sessions 3(a) and 3(b).

Instructions. After being seated at computers in the lab, the subjects were instructed in the basic payoff structure of the decision making environment. As part of this instruction, they participated in four practice matches. In the first practice match, the continuation probability was $p = 0$, and each subject was told to select split. In the second practice match, the continuation probability was again $p = 0$, but each Blue was told to select split while each Red was told to select flip. The third and fourth practice matches had $p = 0.5$

and $p = \frac{3}{4}$, respectively, and subjects were asked to choose split or flip on their own. This instructional period was designed to make subjects familiar with both the computer user interface as well as the payoff structure and strategic decision making environment.

Bankruptcy Prevention. Because losing a contest involves a net loss of 30 points, it is possible for subjects to lose points throughout the experiment. To prevent bankruptcy and the risk-loving behavior that may accompany it, each subject in Sessions 1 and 2 was given an initial 240 points. Because subjects in Session 3 participated in two matching rotations, they were given 240 points twice, once at the start of each rotation. No subject in any session experienced bankruptcy.

Questionnaire. After the last match but before leaving the laboratory, each subject filled out a questionnaire that asked for age, sex, major, year in school, number of economics courses taken, number of statistics courses taken, and so on. We use information from the questionnaire for rough qualitative comparisons of the subjects across sessions.

4.1 Hypotheses

Having one choice per match collapses the potentially infinitely repeated game, in expected payoff terms, into a simple 2×2 matrix normal form game. Figure 1(a)-(c) presents the matrix for each treatment value of the continuation probability. In each case, the game is a type of Hi-Lo game depicted in Figure 2(d). If the expected payoff when both choose split, $\frac{1}{1-p}\left(\frac{1}{2}Y - c\right) \equiv x$, is strictly greater than that when at least one flip is chosen, $\frac{1}{2}\left(\frac{1}{1-p}Y - dY\right) - c \equiv z$, then each player has a unique weakly dominant strategy to choose split. Alternatively, if $z > x$, then each has a dominant strategy to choose flip. Accordingly, an expected payoff maximizer has a weakly dominant strategy to choose split if $p = 0$ but choose flip if $p = \frac{1}{2}$ or $p = \frac{3}{4}$.

We note that each game in Figure 2(a)-(c) has multiple Nash equilibria. With $p = 0$, there are two pure strategy Nash equilibria (split,split) and (flip,flip). With $p = 0.5$ or $p = \frac{3}{4}$, there are three pure Nash equilibria (flip,flip), (flip,split), and (split,flip). However, there is only one pure Nash equilibrium in each case if we eliminate the weakly dominated strategy for each player. Thus, applying standard game theoretic solution concepts (dominance solvability or Trembling Hand Perfection) will yield an unique prediction: (split,split) under $p = 0$ and (flip,flip) under $p = 0.5$ and $p = \frac{3}{4}$. Past experimental work also suggests that subjects overwhelmingly go for the higher expected payoff in Hi-Lo games (e.g., see Bacharach 2006). A possible moderating factor is that flipping is very risky. Thus, a risk averse subject may be inclined to choose the less-risky choice over a choice with a slightly higher expected payoff but more risky choice. Such reasoning would apply with $p = 0.5$. Our first hypothesis follows.

Hypothesis 1 (Choices)

(a) We will observe more flips under $p = \frac{3}{4}$ *than under* $p = 0$.

(b) We will observe more flips under $p = 0.5$ *than under* $p = 0$.

(c) We will observe more flips under $p = \frac{3}{4}$ *than under* $p = 0.5$.

Our second hypothesis focuses on outcomes not individual choices, though the former are clearly derived from the later.

Hypothesis 2 (Outcomes)

(a) We will observe more conflict under $p = \frac{3}{4}$ *than under* $p = 0$.

(b) We will observe more conflict under $p = 0.5$ *than under* $p = 0$.

(c) We will observe more conflict under $p = \frac{3}{4}$ *than under* $p = 0.5$.

We are also interested observing the patterns of choices by individual. Given Hypothesis 1, we predict the following.

Hypothesis 3 (Choices by subject) *Most subjects will choose more flips under* $p = \frac{3}{4}$ *than under* $p = 0.5$ *and more flips under* $p = 0.5$ *than under* $p = 0$.

The first two hypotheses are meant to test the impact of an increasing shadow of the future on conflict when actors can undertake risky conflict to eliminate their opponents.

Given the structure of this game, it is natural to suppose each subject follows a cut-off rule when deciding whether to choose split or flip. However, we are less interested in where this cut-off is for each subject (as it may differ from subject to subject) and more interested in whether or not the subjects are following such a cut-off rule. For this reason, we selected two values of the treatment variable that have clear predictions due to clear payoff dominance (split under $p = 0$ and flip under $p = \frac{3}{4}$) and one value which may have a moderating risk consideration ($p = 0.5$). The last hypothesis is meant to "unpack" any verification or rejection of the first hypothesis. By looking more closely at the choices by individual we can discern what other factors, if any, figure prominently in the subjects' decision making.

5 Results

5.0.1 Individual Choices

Table 2 reports the percent of flips by session and continuation probability. When pooling the data from all sessions, we see that, consistent with Hypothesis 1, subjects choose flip more often under $p = 0.75$ than under $p = 0.5$ and more under $p = 0.5$ than under $p = 0$. However, we observe that the percent of flips under $p = 0.5$ and $p = 0.75$ are very similar, while the percent of flips under $p = 0$ is substantially smaller than under $p = 0.5$ and $p = 0.75$. We conducted a series of (Pearson) chi-square tests to test if the proportion of flips are the same under two given treatment values for p. As shown in Table , we reject at very high significance levels the hypothesis that the proportion under $p = 0$ equals the proportion under $p = 0.75$ and reject the hypothesis that the proportions under $p = 0$ and $p = 0.5$ are the same, but we cannot reject the hypothesis that the proportions are the same under $p = 0.5$ and $p = 0.75$. Looking at choices by session, we see that the choices in Session 1 match Hypothesis 1 very closely, while choices in Sessions 2 and 3 match Hypothesis 1(a) and 1(b) but not 1(c). The percent of flips under $p = 0.5$ is actually higher than under $p = 0.75$ in those two sessions, although the chi-square tests indicate that they are essentially equal statistically.

Figure 2 displays the percent flips by match for each session. Each point captures the percent of subjects who chose flip in a given match and session. Matches have been grouped by continuation probability to facilitate comprehension. In each session, we observe a dramatic rise or drop in flips as the continuation probability changes from or to 0, consistent with our shadow of the future argument. We observe the increase in flips from $p = 0.5$ to $p = 0.75$ in Session 1, and we see no similar change in flipping rate in the other sessions.

The overall picture is that Hypotheses 1(a) and 1(b) are strongly confirmed, while evidence in support of Hypothesis 1(c) is mixed. That Hypotheses 1(a) and 1(b) are so strongly confirmed provide the best evidence that increasing the shadow of the future does increase the incidence of conflict because they consider stark changes in the continuation probability. The mixed evidence for Hypothesis 1(c) is not necessarily evidence against our main argument that the increased shadow of the future increases the occurrence of conflict because an expected payoff maximizer would choose flip under both $p = 0.5$ and $p = 0.75$. Thus, an equal number of flips under $p = 0.5$ and $p = 0.75$ would arise if all subjects were risk neutral. Because Hypothesis 1(c) was based on the premise that many subjects would be risk averse, one interpretation of our results is that subjects in Session 1 were more risk averse than those in Sessions 2 and 3, who were, on average, more risk neutral. Another interpretation is that the direction of changes in the treatment variable produces confounding effects. For example, subjects in Session 1 proceeded in what we consider the easiest format, experiencing $p = 0$ first and then experiencing "natural" increases in p; subjects in Session 2 proceeded in the more difficult format of highest p first; and subjects in Session 3 proceeded in a combination structure that was not natural for learning.

5.0.2 Outcomes

Table 4 reports the distribution of outcomes by session and continuation probability. The key measure is the percent of split-split outcomes; this outcome corresponds to peace while the other two outcomes correspond to conflict. Consistent with Hypotheses 2(a)-(c), in the pooled data we observe that the occurrence of peace decreasing as the continuation probability increasing, but by session we observe slight variation. Session 1 closely matches Hypothesis 2, whereas Sessions 2 and 3 match Hypothesis 2(a)-(b) but not Hypothesis 2(c). This pattern closely matches that of individual choices. Chi-square tests (not shown) confirm the pattern. Conflict is much more likely when the shadow of the future is large ($p = 0.5$ or $p = 0.75$) than when it is small ($p = 0$).

5.0.3 Classifying Subjects' Choices

Above, we have touched upon the possibility that subjects may differ in their preferences for risk. Hypothesis 3 follows from an assumption that most subjects are fairly risk neutral, yet we recognize that subjects' preferences may differ in other meaningful ways. To evaluate Hypothesis 3 and investigate the presence of other preference considerations, we classified subjects by their observed choices. Table 5 reports the results of our classification. The columns partition the behavior into disjoint choice patterns. Column (1) corresponds to the selection of flip in all matches of the session, column (2) corresponds to the selection of split in all matches, and so on. Column (4) corresponds to the choice pattern that corresponds most closely to the behavior predicted in Hypothesis 3, i.e., a preference for high payoffs but a dislike for risk. To be placed in that column, a subject must have chosen flip weakly more often under $p = 0.75$ than under $p = 0.5$ and weakly more often under $p = 0.5$ than under $p = 0$, and the number of chosen fiips must not be equal under all three continuation probabilities.

Table 5 reports that the most common choice pattern corresponds to the behavior predicted in Hypothesis 3. That is, the modal choice pattern is one in which there is a preference for higher payoffs but a dislike for risk, and this choice pattern is modal both for the pooled data as well for each session. It represents 56% (40 out of 72) of the subjects overall; more than half of the subjects (weakly) increased the number of times they chose flip as the continuation probability increased. We note, however, that according to this classification scheme there is wide variation in choice behavior. For example, some 6% (4 out of 72, column (8) plus (9)) flipped most under $p = 0$, while 7% (5 out of 72) never flipped and

4% (3 out of 72) always flipped. While these and the other classifications do not match the behavior predicted in Hypothesis 3, they are not necessarily irrational. For example, a subject who cares about payoff equity and not her own payoff would choose split under each of the treatment values for p; an extremely risk averse subject would also choose split under each value for p; a very risk-loving subject who disliked extreme inequity might flip under $p = 0$ but not $p = 0.5$ or $p = 0.75$; and a subject who wants a high expected payoff so long as it was not too inequitable might flip under $p = 0.5$ but not under $p = 0.75$ or $p = 0$.

Table 6 shows that the wide variation holds when looking at subsets of the subjects by subject characteristics. The table shows the distribution of choice patterns by sex, program type (undergraduate or graduate), number of economics courses taken (0 or 1+), and number of statistics courses taken (0 or 1+). There are no striking differences across any of these characteristics, though we note that the number of graduate students is small (only 4 out of 72) thereby limiting any inference about subjects of different program type.

Another possibility is that some of the observed choice patterns reflect a lack of misunderstanding the decision making environment. Ruling this out is not possible, yet the questionnaire does provide some insight into this possibility. The last question of the questionnaire asked, "Were you more likely or less likely to select FLIP as the continuation probability increased? Why or why not?" If a subject provides answered yes and provided some explanation for why she did so, then we say that subject "comprehends" the decision making environment; otherwise the subject is said to "not comprehend." An answer that signified comprehension needed to say something akin to "the chance of winning more money increased." Overall, 72% (52 out of 72) of the subjects expressed such comprehension. The bottom pane of Table 6 details the number of subjects by choice pattern according to whether or not they comprehend the experiment. We see that 67% (35 out of 52) of the comprehend subjects increased their flipping as the continuation probability increased, while only 25% (5 out of 20) of the not comprehended subjects did so. This measure is not a perfect measure of comprehension for various reasons, e.g., clearly not all subjects who said they were more likely to flip under the higher continuation probability did so, it was asked after subjects completed their choices and had time to consider an optimal strategy, and the very asking of the question may have prompted an answer more indicative of what the subject thought the experimenter wanted to hear. Nonetheless, it provides some indication that understanding the payoff structure of the game led subjects to increase their flipping as the continuation probability increased. It also indicates that the basic logic of the theory meaningfully explains the observed behavior.

6 Conclusion

We have discussed, modeled, and shown experimentally how a longer shadow of the future can induce more conflict and less settlement under the threat of conflict.

[Discuss high levels of discount factor; possibility of cooperation and "investments in conflict management".]

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APPENDIX: ENDOGENOUS ENFORCEMENT

In this Appendix we present an extension of the model presented in Section 3 so as to allow for endogenous enforcement levels and it is based on McBride and Skaperdas (2007). The main comparative static result regarding the effect of the shadow of the future is shown to hold in this setting as well.

To allow for endogenous enforcement, we first need to specify how probabilities of winning depend on enforcement. We suppose that these probabilities depend on arming through the following additive contest success function (see Tullock, 1980, and Hirshleifer, 1989):

$$q_i(e_A, e_B) = \frac{e_i^m}{e_A^m + e_B^m} \text{ where } i = A, B \text{ and } m \in (0, 1] \tag{7}$$

In each period, the sequence of moves by the two sides is the following:

1. Levels of enforcement, e_A and e_B, are chosen simultaneously by the two agents.

2. The two agents bargain, with agent A making an offer of dividing the period's surplus (denoted by the subsidy S to B). If the offer is accepted by B, agent B receives S, agent A receives $Y - S$, and the next period repeats the same two steps. If the offer is not accepted by B, Conflict takes place with the winning probabilities described above. The winner receives ϕY for the period and Y for every period thereafter, whereas the loser receives 0 for the period and thereafter.

Note that when agent A contemplates whether to offer a subsidy to agent B or decide to engage in Conflict, the continuation payoff of agent B would still be the one described in (2). Conditional on Settlement, the subsidy that would just induce B not to go to Conflict is the following variation of (4):

$$S^*(e_A, e_B) = q_B(e_A, e_B)[\phi(1 - p) + p]Y + pe_B \tag{8}$$

This subsidy is derived under the condition that the same level of enforcement, (e_A, e_B), would be chosen in every future period as well as in the current period. Note how this subsidy to agent B depends on its probability of winning, which is increasing in the enforcement level of the agent, as well as directly on the enforcement level of the agent, for under Settlement the agent would have to incur this cost of enforcement in every period.

The payoffs of the two agents under Settlement can now be calculated. Agent A would receive in every period the total surplus minus the subsidy, $Y - S^* = Y - q_B(e_A, e_B)[\phi(1 - p) + p]Y + pe_B$, whereas in every period it would pay the cost of enforcement, e_A.We denote by (e_A^P, e_B^P) the future levels of enforcement as part of a Markov perfect equilibrium, whereas the choices in the current period are denoted by (e_A, e_B). Then, agent A's payoff is as follows:

$$\begin{aligned} V_A^P(e_A, e_B) &= \frac{1}{1-p}\left\{Y - q_B(e_A, e_B)\left[\phi(1-p)+p\right]Y - pe_B^P - pe_A^P\right\} \\ &\quad -e_A \end{aligned} \tag{9}$$

agent A receives the subsidy $S^* = q_B(e_A, e_B)[\phi(1 - p) + p]Y + pe_B$ in every period and pays the cost of arming (e_B) in every period as well. Then, agent B's payoff reduces to the following:

$$V_B^P(e_A^P, e_B^P) = \frac{1}{1-p}\{q_B(e_A, e_B)\left[\phi(1-p)+p\right]Y\} - e_B \tag{10}$$

The payoffs are not symmetric because agent A is always the proposer and the subsidy offered is just the one that would equate the Settlement payoff of B to B's expected payoff under Conflict.

The Markov perfect equilibrium strategies under Settlement are such that e_A^P maximizes $V_A^P(e_A, e_B^P)$ whereas e_B^P maximizes $V_B^P(e_A^P, e_B)$. To solve for these equilibrium strategies, first differentiate to obtain the first order conditions $\frac{\partial V_A^p}{\partial e_A} = 0$ and $\frac{\partial V_B^p}{\partial e_B} = 0$. Next, use

$$\frac{\partial q_B}{\partial e_A} = \frac{-me_A^{m-1}e_B^m}{(e_A^m + e_B^m)^2} \tag{11}$$

$$\frac{\partial q_B}{\partial e_B} = \frac{-me_A^m e_B^{m-1}}{(e_A^m + e_B^m)^2} \tag{12}$$

obtained from (7) and the first order conditions to show that

$$e_A^P = e_B^P = \frac{m}{4}\frac{(\phi(1-p)+p)}{(1-p)}Y \tag{13}$$

Both sides choose the same level of arming despite the asymmetry of payoffs in (9) and (10) because the cost of arming is the same and what becomes effectively contestable is the discounted total surplus under Conflict $\left(\frac{(\phi(1-p)+p)}{(1-p)}Y\right)$.

Note the strong positive dependence of enforcement on the discount factor, through the effect of the discounted total surplus under Conflict $\left(\frac{(\phi(1-p)+p)}{(1-p)}Y\right)$. For example, supposing $\phi = 0.5$, an increase in the discount factor from 0.9 to 0.95 more than doubles the term $\frac{(\phi(1-p)+p)}{(1-p)}$ from 9.5 to 19.5. As we've seen in section 3 (see (6)), a higher discount factor, as well higher levels of (fixed) arming, increases the likelihood of Conflict. Since with endogenous enforcement levels a higher discount factor increases equilibrium enforcement, the set of parameters for which Conflict becomes an equilibrium must increase compared to the case with exogenous enforcement.

Before deriving such a set of parameters, we consider the case of Conflict. The payoffs under Conflict are the following:

$$V_i^W(e_A, e_B) = q_i(e_A, e_B)\frac{(\phi(1-p)+p)}{(1-p)}Y - e_i,\ i = A, B \tag{14}$$

It is straightforward to show that equilibrium enforcement is not just symmetric but the same as under Settlement:

$$e_A^C = e_B^C = \frac{m}{4}\frac{(\phi(1-p)+p)}{(1-p)}Y = e_i^S,\ i \in A, B \tag{15}$$

The reason for the identical levels of enforcement under both Settlement and Conflict is that, even under Settlement, the determinant of equilibrium enforcement is the payoff under Conflict, and the latter determines the disagreement point in bargaining for the two sides. Under both Settlement and Conflict the relevant portion of B's payoff that can be influenced by its choice of arming is $q_B(e_A, e_B)\frac{(\phi(1-p)+p)}{(1-p)}Y$, whereas for A it is either

$-q_B(e_A, e_B)\frac{(\phi(1-p)+p)}{(1-p)}Y$ (for the case of Settlement) or $q_A(e_A, e_B)\frac{(\phi(1-p)+p)}{(1-p)}Y$ (for the case of Conflict) which equals $(1 - q_B(e_A, e_B))\frac{(\phi(1-p)+p)}{(1-p)}Y$, both of which leads to the same marginal incentives in the choice of enforcement.

The set of parameters under which either Settlement or Conflict prevail can be derived by substituting the cost of enforcement into (6) or, equivalently, by determining whether or not, conditional on this period's arming, the total discounted surplus under Settlement is higher or lower than the total discounted surplus under Conflict. Taking the latter approach, Conflict will occur if and only if

$$\frac{Y}{1-p} - pe_A^P - pe_B^P = \frac{Y}{1-p} - \frac{2pm}{4}\frac{(\phi(1-p)+p)}{1-p}Y < \frac{\phi(1-p)+p}{1-p}Y \tag{16}$$

where the left-hand-side of the inequality represents the total discounted surplus under Settlement and the right-hand-side the total surplus under Conflict. Note that the left-hand-side represents the present discounted value of all the surplus Y minus the discounted value of enforcement costs, whereas the right-hand side represents the reduces surplus from Conflict today (ϕY) plus the discounted value that accrues to the winner of Conflict from next period ($\frac{p}{1-p}Y$). Conflict occurs if and only if the current loss from Conflict ($(1-\phi)Y$) is lower than the discounted sum of total enrofcement costs under Settlement. Then inequality (16) reduces

$$\frac{pm\,(\phi(1-p)+p)}{2(1-p)^2(1-\phi)} < 1 \tag{17}$$

From (17) we can conclude that Conflict is more likely and Settlement less likely when

(i) the effectiveness of conflict as represented by m is high;

(ii) the higher is the discount factor p; and

(iii) the less destructive Conflict is (or, the higher is ϕ).

The effect of the discount factor is, if anything, stronger here because as we mentioned above a higher discount factor not only increases the discounted value of the future cost of arming under Settlement but also increases the equilibrium level of arming. For even small discount factors, the cost of arming (in (13) or (15)) is large enough we might expect the adversaries to face serious liquidity constraints so that Conflict might be averted in some cases. If the liquidity constraints were to be binding for both adversaries, we would then revert to the analysis of the previous section or continue with the more complex one in terms of states in the next section.

Table 1: Session Information

	Date	Number of subjects	Number of matches	Direction of change in continuation probability	Exchange rate (points/ dollar)	Number of males/ females	Percent with 1+ economics courses*	Percent with 1+ statistics courses*	Average take-home earnings**
Overall	--	72	--	--	--	39/33	46%	67%	$32
Session 1	24-Sep-2008	24	12	Increase	40	13/11	54%	71%	$30
Session 2	9-Oct-2008	24	12	Decrease	40	13/11	42%	79%	$30
Session 3	30-Oct-2008	24	24	Increase-decrease	80	13/11	42%	50%	$34
Session 3(a)	30-Oct-2008	24***	12	Increase	80	13/11	42%	50%	$34
Session 3(b)	30-Oct-2008	24***	12	Decrease	80	13/11	42%	50%	$34

Notes: Sessions 3(a) and 3(b) comprise the first and second halves of Session 3, respectively; i.e., the subjects in Sessions 3(a) and 3(b) (***) are the same subjects listed for Session 3. Information on courses (*) is obtained from subject questionnaires. This average take-home earnings (**) reporrted do not account for round-offs made before paying subjects, but reported earnings do include initial amounts given to prevent bankruptcy. Subjects in Sessions 1 and 2 were given an initial amount of $6, and subjects in Session 3 were given an initial amount of $3 in each half.

Figure 1: Payoff Matrix by Continuation Probability

(a) Expected Payoff Matrix for p=0

		Red split	Red flip
Blue	split	20,20	5,5
	flip	5,5	5,5

(b) Expected Payoff Matrix for p=1/2

		Red split	Red flip
Blue	split	40,40	55,55
	flip	55,55	55,55

(c) Expected Payoff Matrix for p=3/4

		Red split	Red flip
Blue	split	80,80	155,155
	flip	155,155	155,155

(d) Hi-Lo Game Payoff Matrix

		Red split	Red flip
Blue	split	x,x	z,z
	flip	z,z	z,z

Table 2: Percent Flips by Continuation Probability, Overall and by Session

	Continuation Probability		
	0	0.5	0.75
Overall	27%	63%	66%
Obs.	384	384	384
Session 1	22%	51%	73%
Obs.	96	96	96
Session 2	35%	59%	57%
Obs.	96	96	96
Session 3	26%	71%	68%
Obs.	192	192	192
Session 3(a)	22%	71%	65%
Obs.	96	96	96
Session 3(b)	29%	71%	71%
Obs.	96	96	96

Notes: The overall average uses all data from Sessions 1, 2, and 3. Sessions 3(a) and 3(b) comprise the first and second halves of Session 3, respectively.

Table 3: Chi-square Test Statistics for Hypothesis 1, Overall and by Session

	Hypothesis		
	1(a) Proportion of flips under p=0 equals proportion under p=0.75	1(b) Proportion of flips under p=0 equals proportion under p=0.5	1(c) Proportion of flips under p=0.5 equals proportion under p=0.75
Overall	119.261	100.168	0.964
p-value	< 0.01	< 0.01	0.33
Session 1	50.157	17.626	9.747
p-value	< 0.01	< 0.01	< 0.01
Session 2	9.237	11.051	0.086
p-value	< 0.01	< 0.01	0.79
Session 3	68.659	78.949	0.440
p-value	< 0.01	< 0.01	0.51
Session 3(a)	35.675	46.267	0.858
p-value	< 0.01	< 0.01	0.35
Session 3(b)	33.333	33.333	0.000
p-value	< 0.01	< 0.01	1.00

Notes: The overall average uses all data from Sessions 1, 2, and 3.

Figure 2(a): Percent Flips by Match, Session 1

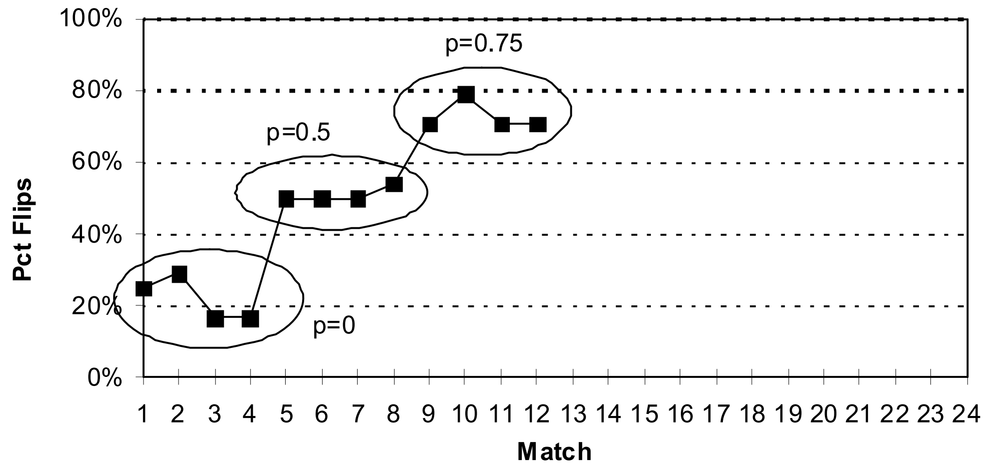

Figure 2(b): Percent Flips by Match, Session 2

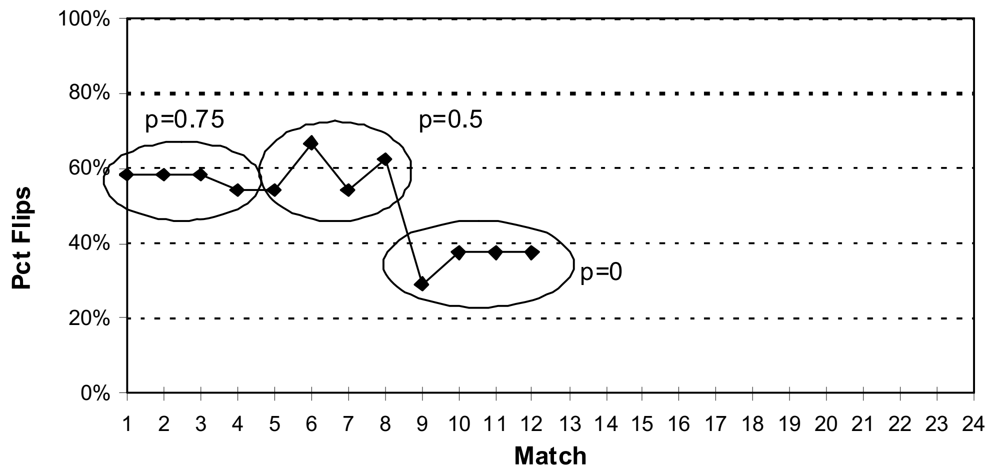

Figure 2(c): Percent Flips by Match, Session 3

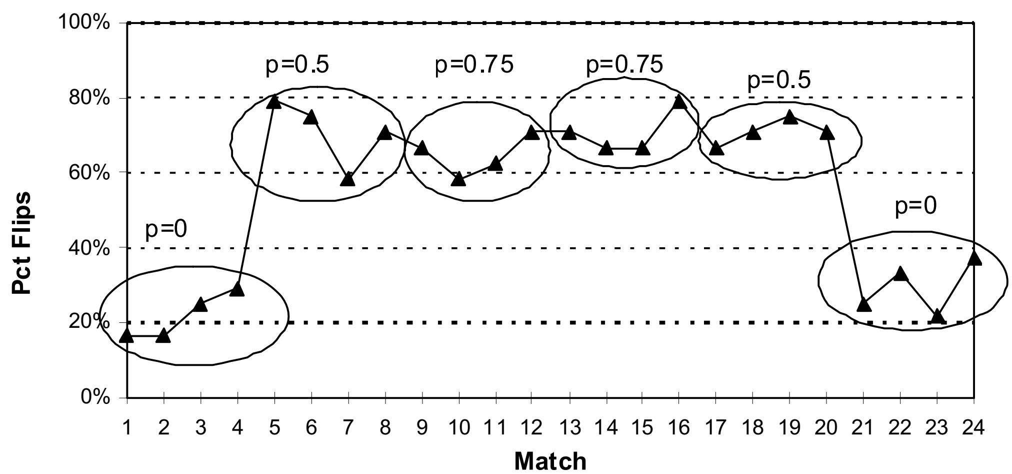

Table 4: Percent Outcomes by Continuation Probability, Overall and by Session

	Continuation Probability		
	0	0.5	0.75
Overall			
Flip-flip	5%	39%	41%
Flip-split	45%	49%	51%
Split-split	51%	13%	8%
Session 1			
Flip-flip	0%	23%	52%
Flip-split	44%	56%	42%
Split-split	56%	21%	6%
Session 2			
Flip-flip	8%	31%	27%
Flip-split	54%	56%	60%
Split-split	38%	13%	13%
Session 3			
Flip-flip	5%	50%	43%
Flip-split	41%	42%	50%
Split-split	54%	8%	7%
Session 3(a)			
Flip-flip	4%	52%	40%
Flip-split	35%	38%	50%
Split-split	60%	10%	10%
Session 3(b)			
Flip-flip	6%	48%	46%
Flip-split	46%	46%	50%
Split-split	48%	6%	4%

Notes: The overall average uses all data from Sessions 1, 2, and 3. Sessions 3(a) and 3(b) comprise the first and second halves of Session 3, respectively. Averages may not sum to 100 due to round-off error.

Table 5: Number of Subjects by Choice Classification, Overall and by Session

	Choice Classification									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Flips0 = Flips0.5 = Flips0.75 = all	Flips0 = Flips0.5 = Flips0.75 = 0	0 < Flips0 = Flips0.5 = Flips0.75 < All	Flips0.75 ? Flips0.5 ? Flips0 (not all equal)	Flips0.75 ? Flips0 ? Flips0.5 (not all equal)	Flips0.5 ? Flips0.75 ? Flips0 (not all equal)	Flips0.5 ? Flips0 ? Flips0.75 (not all equal)	Flips0 ? Flips0.75 ? Flips0.5 (not all equal)	Flips0 ? Flips0.5 ? Flips0.75 (not all equal)	Total
Overall	3	5	1	40	7	7	5	2	2	72
Session 1	1	3	1	15	2	1	1	0	0	24
Session 2	2	2	0	11	2	2	3	2	0	24
Session 3	0	0	0	14	3	4	1	2	0	24
Session 3(a)	0	0	0	16	0	4	2	1	1	24
Session 3(b)	1	2	0	13	1	2	1	3	1	24
Overall using 3(a) and 3(b)*	4	7	1	55	5	9	7	6	2	96

Notes: The overall total uses all data from Sessions 1, 2, and 3. Sessions 3(a) and 3(b) comprise the first and second halves of Session 3, respectively. Column (4) best matches the predicted behavior of expected payoff maximization. The overall total (*) that uses 3(a) and 3(b) treats the subjects in Session 3 as if they are different persons in 3(a) than in 3(b).

Table 6: Number of Subjects by Choice Classification, Overall and by Session

	Choice Classification									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Flips0 = Flips0.5 = Flips0.75 = all	Flips0 = Flips0.5 = Flips0.75 = 0	0 < Flips0 = Flips0.5 = Flips0.75 < All	Flips0.75 ? Flips0.5 ? Flips0 (not all equal)	Flips0.75 ? Flips0 ? Flips0.5 (not all equal)	Flips0.5 ? Flips0.75 ? Flips0 (not all equal)	Flips0.5 ? Flips0 ? Flips0.75 (not all equal)	Flips0 ? Flips0.75 ? Flips0.5 (not all equal)	Flips0 ? Flips0.5 ? Flips0.75 (not all equal)	Total
Male	3	2	0	23	4	4	0	2	1	39
Female	0	3	1	17	3	3	5	0	1	33
Undergraduate	2	4	1	38	7	7	5	2	2	68
Graduate	1	1	0	2	0	0	0	0	0	4
0 economics	2	3	0	20	5	3	5	0	1	39
1+ economics	1	2	1	20	2	4	0	2	1	33
0 statistics	1	1	0	15	1	3	2	0	1	24
1+ statistics	2	4	1	25	6	4	3	2	1	48
Comprehend*	2	2	0	35	5	4	2	1	1	52
Not compre.*	1	3	1	5	2	3	3	1	1	20

Notes: Data from all sessions are used. Subject characteristics were obtained from the questionnaire. A subject is classified as comprehend (*) or not comprehend based on her written answer to the question "Were you more likely or less likely to select FLIP as the continuation probability increased? Why or why not?" She is included under comprehend if her answer said she was more likely to flip and her answer included an explanation why; otherwise, she is included under not comprehend.