Journal of Economic Behavior & Organization 105 (2014) 75–89

Contents lists available at ScienceDirect

Journal of Economic Behavior & Organization

journal homepage: www.elsevier.com/locate/jebo

Conflict, settlement, and the shadow of the future ☆

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ARTICLE INFO

Article history:
Received 14 June 2013
Received in revised form 18 April 2014
Accepted 22 April 2014
Available online 9 May 2014

JEL classification:
C72
C91
D74
H1
H56

Keywords:
War
Settlement
Property rights
Shadow of the future

ABSTRACT

We examine a conflictual setting in which adversaries cannot contract on an enforcement variable (arms) and where the future strategic positions of adversaries are very different when there is open conflict than when there is settlement. We show that, as the future becomes more important in this setting, open conflict becomes more likely than settlement. We demonstrate the theoretical robustness of this finding and test it in a laboratory experiment. As predicted, we find that subjects are more likely to engage in destructive conflict as the future becomes more important.

> "Efforts to maintain collective security are at the heart of human history. . . .Yet, insecurity not only remains, it has become a primary development challenge of our time." World Bank, *World Development Report*, 2011, p. 1

1. Introduction

Peace and security are collectively produced; it only takes one party to prefer war to peace for war to occur. But why would an actor prefer war? Many explanations have been proposed, some of which resort to pathologies, revenge, defects in human nature, or other forms of irrationality. Economic (rational choice or rationalist) logic, however, has yielded at least three primary explanations (Fearon, 1995; Skaperdas, 2006). First, the contested good may be indivisible so that compromise is impossible. Second, one party has incomplete information about key characteristics of the opponent's characteristics, such

☆ We thank Michelle Garfinkel, Gary Richardson, and seminar participants at California State University – Fullerton, Loyola Marymount University, Paris School of Economics, University of California – Riverside, and University of Illinois – Urbana-Champaign, participants in the Economic Science Institute seminar at Chapman University, attendees at the "Rationality and Conflict" conference at Yale University and the Public Choice Society Meetings, and participants at the UC Irvine Theory, History, and Development Seminar and Institute for Mathematical Behavioral Sciences Colloquium for valuable comments. For financial support, we are grateful to the Center for the Study of Democracy and the Center for Global Peace and Conflict Studies, both at UC Irvine. McBride acknowledges financial support from Army Research Office Award No. W911NF-11-1-0332 and Air Force Office of Scientific Research Award No. FA9550-10-1-0569.

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http://dx.doi.org/10.1016/j.jebo.2014.04.023
0167-2681/

as strategic or tactical strength. If one party underestimates the opponent's strength, then that party may undertake war unwittingly, and this problem is compounded by the fact that each side has the incentive to misrepresent its strength, thereby limiting the credibility of efforts to reduce the uncertainty.[2] Third, adversaries face commitment problems, i.e., they are unable to make binding contracts, often because there is no third party (e.g., the state, courts) with the ability to enforce a contract. War thus arises when the parties are unable to self-enforce a bargained settlement. Any explanation for war must explain not only why war might be a reasonable option but also why war is preferred to bargained settlements that could prevent war.

Our paper examines a setting of this third kind. We present a formal model and experimental study of a conflictual setting in which peace must be collectively produced through bargaining. This setting has two main features. First, *adversaries cannot write long-term contracts on an enforcement variable (e.g., arms) but can sustain short-term cooperation under the threat of conflict*. Such cooperation can be thought of as cold wars and may involve the expenditure of substantial resources by each party to retain its bargaining position in future interactions. This condition is akin to that of the incomplete-contracts approach in the economic theory of the firm (see e.g., Grossman and Hart, 1986), whereby agents cannot write long-term contracts on relationship-specific investments but can engage in short-term bargaining. Second, *conflict today changes the relative strength of the two parties tomorrow in a way that peaceful settlement does not*. For example, the winner of a battle between relative equals might gain more resources, and therefore a strategic advantage, relative to the loser well into the future, whereas a cooperative settlement outcome might retain the relative equality in strength. These two features are found in many real-world conflict settings.

In other models (Fearon, 1995; Powell, 2006) or laboratory experiments (Tingley, 2011) that attribute conflict to commitments problems there is no arming, and conflict ensues because one side is a declining power and no current bargain will forestall conflict. Our approach differs from such models in several respects. First, in our model there is no need for one side's power to be declining over time. War can occur with both sides being identical in every respect, as they are in our model (although our model can routinely be extended to include declining power or other asymmetries). Second, in the declining-power approach for war to occur it is necessary that the declining power cannot compensate the rising power with an amount greater than the surplus ("cake") that is up for grabs in a particular period. If that were possible (by, for example, having the declining power borrow in order to compensate the rising power), conflict would not have to occur. In our approach, war occurs even without a constraint on compensation. Finally, and most significantly, the driving force behind conflict and settlement are the respective arming and other conflict costs under the two regimes in our model. By contrast, there is no arming in the other models.

Our analysis reveals that conflict arises in this setting as equilibrium behavior despite its cost and risk because it can be an investment in one's future strength. By winning a conflict today, an actor improves its relative strength and reduces its arming in the future. In the case that the loser is eliminated entirely after a conflict, the winner pays arming costs in the future. The "shadow of the future" (Axelrod, 1984) plays a crucial role: a higher discount factor implies a higher valuation on the strategic advantage obtainable only through direct conflict and implies a higher future cost, because of enforcement expenditures, of sustaining the status quo. With sufficiently high discount factors, conflict is the equilibrium. That conflict is more likely with higher discount factors stands in contrast, though not in contradiction, to the standard intuition from the folk theorem arguments. The different effects of the shadow of the future reflect different mechanisms and environments. Disarmament sustained by threats of future punishment (e.g., trigger strategies) will not exist in our setting when a loser is eliminated and therefore cannot punish in future periods. The threats that enforce peace or cooperation in many well-studied settings will thus not produce peace in our setting.

We note that peaceful settlements in our setting involve short-term transfers that depend on the relative bargaining positions of the adversaries which, in turn, depend on arming or other enforcement variables that are strategically chosen by each adversary. Such peace may also be characterized as armed peace or cold war because this peace is between adversaries who cannot trust one another enough to commit to disarmament. It is also distinguished from complete disarmament (i.e., full cooperation), which could potentially be achieved with enforceable long-term contracts on arms or some other means, or from ongoing feud (Nikiforakis et al., 2012). We note, however, that complete disarmament is very difficult to achieve in practice and is not the type of peace that has typically prevailed for much of history.[3] The decision between a bargained armed peace and open conflict, which forms the focus of our paper, is thus empirically relevant and conceptually distinct from universal peace with disarmament.

Elements of our theoretical argument can be found in the literature on war. As mentioned above, Fearon (1995) discussed the importance of commitment problems, and models that make the argument explicit include finite-horizon models in Garfinkel and Skaperdas (2000) and Robson and Skaperdas (2008) and infinite-horizon models in Powell (2006), McBride and Skaperdas (2007), and McBride et al. (2011). Powell (1993) was the first dynamic model that included similar considerations

[2] Brito and Intriligator (1985) was an early article to be explicitly dedicated to modeling the outcome of war as due to incomplete information. Since then a large number of such models have appeared both in economics and political science. Two recent overviews are Sanchez-Pages (2012) and Warneryd (2012). Chassang and Padro i Miquel (2009) and Slantchev and Tarar (2011) are recent contributions that emphasize, respectively, mutual fear and mutual optimism as causes of war.

[3] Other than statelets like Andorra or San Marino, it would be difficult to find either historical or contemporary examples of states that are completely disarmed. Today, there are very few countries that devote less that 1% of their GDP to military expenditures, with the average for 2007 hovering around 2.5% of GDP (see Stockholm International Peace Research Institute, 2008, p. 10).

including the impact of the shadow of the future on arming but did not include bargaining or the possibility of within-period transfers between adversaries.[4] In the other papers mentioned, conflict becomes more likely and peace less likely as the discount factor of the adversaries becomes larger.[5] In this paper, however, we identify conditions behind this shadow of the future result when there is explicit bargaining, demonstrate that these features are common to both violent and non-violent conflict settings, and, using an original laboratory experiment, present empirical evidence that a longer shadow of the future leads to more conflict in such settings.

Our experiment is the first to test the specific theoretical mechanism described above, but it is instructive to compare our findings with three experimental literatures.[6] The first considers the effect of the shadow of the future in repeated interaction games. Dal Bó (2005), for example, shows that cooperation in prisoners dilemma games is sustained in higher levels as the possibility of future interaction increases. The second is the experimental literature on contests in which adversaries expend costly efforts to obtain prizes. Though most of this literature examines contests without bargaining, Kimbrough and Sheremeta (2010) is an exception. The third is the literature that considers conflict and bargaining more explicitly, of which Tingley (2011) is a good example.[7] Our experimental design differs from prior studies in that it captures our conflictual setting of interest. We provide the first experimental evidence of conflict and bargaining in a setting where losers can be eliminated and where the increasing the shadow the future increases the likelihood of conflict.

The two aspects of the environments that we examine in this paper are that (i) long-term contracts cannot be written on enforcement levels and (ii) conflict and settlement have very different effects on the conditions that adversaries face in the future. Condition (i) is very likely to be satisfied in adversarial settings that can lead to war. 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). Similarly, condition (ii) appears plausible for disputes that could lead to war. Winners can obtain a better future strategic position that they had prior to war, and losers typically have a worse strategic position than prior to war. In the absence of war, strategic positions do not change as 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. However, as has now been articulated by multiple authors, many aspects of war are difficult to explain by information problems. For example, commitment rather than information problems better explain the length of wars (Fearon, 2004). Consider that civil wars have been much more common than interstate wars since World War II and have an average duration of over seven years (Collier et al., 2003). By that time, we expect that 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 appears as at least another, complementary to others, explanation of the many civil wars that have occurred. Moreover, in many cases it can be argued that many key participants in ethnic and religious conflict tend to value the future highly, because of their close identification with the future of their ethnic group or with religious salvation, and thus contribute to the intensification of conflicts and the difficulties in achieving peaceful settlements.

The outbreak of some wars may also be difficult to explain by informational problems. Powell (2006) explains that informational problems cannot explain the start of World War II. World War I is also frequently mentioned as a war that 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, and that all major adversaries had long-term strategic objectives that made them arm in the first place. 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

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[4] Jackson and Morelli (2009) analyze a dynamic model similar to that of Powell and allow for mixed strategies, with conflict taking place for at least some realizations of mixed-strategy equilibria. Bester and Konrad (2004) provide alternative variations in terms of the timing about the choice of the enforcement variables, the possibility of settlement, and asymmetries across players. Konrad (2012) provides an overview of dynamic effects in conflict and contests, including the case of heterogeneous players.

[5] In addition to the papers mentioned above, Skaperdas and Syropoulos (1996) and Mehlum and Moene (2006) also show how enforcement costs increase with higher discount factor when there is conflict, even though none of these papers allow for settlement. This effect on enforcement costs provides an analytically distinct reason for conflict that relates to the shadow of the future.

[6] We note that two newer experimental studies have used our theory and experiment as a starting point. Smith et al. (2014) consider a similar setting but where destruction is a function of arming levels, and McBride et al. (2014) consider a litigation setting in which relative strengths proxy for the degree of property rights.

[7] Tingley tests Fearon's (1995) idea about the effect of declining bargaining power on the incidence of conflict. Both the theoretical and experimental findings about the shadown of the future are similar to our, though the mechanism behind the findings and experimental design are different from ours. The ultimate reason for conflict in Fearon's model is the presence of bounds on transfers, a restriction which we do not assume. In other experimental work on conflict, Durham et al. (1998) provide evidence of a static model of conflict like that of Hirshleifer (1991) which is also similar to a stage game of the dynamic model in Appendix A. Abbink and Brandts (2009) study experimentally the choice between conflict and settlement in a static setting when settlement is always efficient.

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.

Section 2 develops an illustrative formal model on which our experiment is based. The model yields the key prediction that conflict is the equilibrium outcome when discount factors are higher than a critical level. Particular extensions and elaborations, provided in Appendix, illustrate how the main prediction is robust to changes in the adversaries' environment and the particular types of conflict they face. In Appendix we endogenize the enforcement choices (e.g., arming) of each side. Section 3 discusses the experiment design and results. Our subjects faced a choice between a certain payoff from settlement or the uncertain outcome of a conflict. The shadow of the future is approximated by a constant continuation probability of the game. In this last feature of the experiment we have followed Dal Bó (2005), who examined the effects of the shadow of the future in stationary environments in which the folk theorem applies. 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.

2. 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, in 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, and the two agents could be parties in a domestic dispute that could lead to civil war or adversarial states.

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. We suppose that one agent's enforcement expenditures 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 we show in Appendix that the main comparative static results are, if anything, strengthened when enforcement expenditures are chosen endogenously.[8] 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, then 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 because 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. The winner may have eliminated the loser's ability to carry out war in the future, or he could command more resources conducive to waging war than the loser in the future. In effect, conflict biases 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 today for higher payoffs 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 any particular period in which no conflict has occurred in the past and the agents have already expended resources on enforcement (i.e., e'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. (Other protocols of moves, including the sharing of the potential gains of settlement which we follow in the experiments, would not change the parameter values under which conflict and settlement would take place.) 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 is rejected, conflict ensues. The resources that each party has invested on enforcement are considered sunk so that they play no more in current negotiations.

[8] Models of conflict that examine the endogenous determination of arming in static settings include Hirshleifer (1991, 1995), Grossman and Kim (1995), and Esteban and Ray (1999, 2008), whereas models dedicated to litigation have been examined by Farmer and Pecorino (1999) and Hirshleifer and Osborne (2001).

Assuming a discount factor $p \in (0, 1)$,[9] the discounted expected payoff for agent $i = A, B$ in the event of conflict is the following:

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

Note how in the event of conflict, because 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 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 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 $V_B(S^*) = (S^* - e_B)/(1 - p)$. Then, from (3) and (2), the subsidy would be

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

Note that this conflict-deterring subsidy from A to B 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, agent A will only make this offer if the expected payoff under settlement exceeds that under conflict,

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

where $V_A(S^*) = (Y - S^* - e_A)(1 - p)$ 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:

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

If inequality (6) holds, then there is a feasible and optimal subsidy that makes settlement preferred to conflict. Alternatively, 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 is conflict (or, the higher is ϕ); and, the higher is the discount factor p (i.e., the game's constant continuation probability).

We may manipulate inequality (6) to give us the condition that yields conflict, here restated in terms of the discount factor p, which is our main variable of interest:

$$p > p^* = \frac{Y(1-\phi)}{e_A + e_B + Y(1-\phi)}.$$

For given levels of output Y, destructiveness ϕ, and enforcement for the two sides, discount factors over a critical level (p^*) yield conflict. As the discount factor increases, the present value of future enforcement costs under settlement become higher and overwhelm the cost of destruction, $Y(1 - \phi)$, brought about by conflict. It is this last effect of the shadow of the future that we test experimentally.

3. An experiment: conflict vs. settlement

3.1. Experimental design

Our experiment consists of three 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 student registers in the subject pool 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 for a specific sessions; none participated in more than one session. To facilitate experiment management, instruction, and data collection, we conducted the experiment using software specially designed with the Multistage experimental platform. 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

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

rate. Each subject also received a $5 show-up payment. The average earned amount was $30 for about 75 minutes of participation.

3.1.1. A single match

A single session consists of a number of matches (trials). Each match captures the reduced settlement-or-conflict decision scenario depicted in the model, the only difference being that, instead of having subjects choose the settlement amount as in the model above, we suppose settlement involves an equal split of the surplus. The main comparative statics of the model are unchanged with this simpler exogenous settlement amount, and this set-up is easier for subjects to understand.

In a single match, two subjects are paired and round one begins. Neutral language is used to mitigate framing effects. Subjects are publicly told that the "point value" is 100 (prize Y in Section 3's notation), the "standard fee" is 30 (arming cost $e = e_A = e_B = 30$), the "flipping fee" is 30 (total destruction $(1-\phi)Y$), and the "continuation probability" (probability p) which takes one of three values (see below). Each subject then selects either "split" (settlement) or "flip" (conflict). Payments are then received according to the model presented earlier. That is, in round 1 each receives 20 $(=\frac{1}{2}Y-e)$ 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 $(=\phi Y - e)$ and the loser's round 1 payment is -30 $(=-e)$. 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).

3.1.2. Continuation probability

The continuation probability p is the key treatment variable as it reflects the shadow of the future. It takes one of three values: 0, 0.5, or 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. The expected number of rounds is 2 under $p = 0.5$ and 4 under $p = 0.75$. Subjects are told the continuation probability at the same time they are told the other parameters – immediately prior to making the split-or-flip (Settlement-or-Conflict) decision. These values for p were selected because, first, they are the same used by Dal Bó (2005), thereby providing a point of comparison with his study, and, second, they allow for sharp predictions as discussed below.

3.1.3. Rotation matching

Dal Bó (2005) uses a rotation matching procedure "to avoid potential interaction and contagion effects between the different" matches (p. 1596). In each session, subjects are divided into two equally sized groups of 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 groups each with 12 subjects, 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 even though the contagion effects that might arise in his repeated game context are unlikely to be present in our setting. Contrary to the mixed-motive prisoner's dilemma game, the weakly dominant strategy in our setting yields the highest expected payoff *ex ante*, thus removing the incentive to play meta-strategies across matches.

3.1.4. Sessions

We conducted three sessions to consider how changes in the treatment variable may impact decisions. Session 1 uses one matching rotation (12 matches) with an ABC design: 4 matches of $p = 0$, then 4 matches of $p = 0.5$, and then 4 matches of $p = 0.75$. We supposed that this order would be easiest for subjects. Session 2 uses one rotation with a CBA design: 4 matches of $p = 0.75$, then 4 matches of $p = 0.5$, and then 4 matches of $p = 0$. The reverse order is meant to identify whether there is an order effect. Session 3 uses two full rotations (24 matches) with an ABCCBA design: subjects do one full rotation akin to Session 1, are then re-agented into Blues and Reds, and then do another full rotation akin to Session 2. Session 3 is meant to capture both the learning and priming effects. Table 1 summarizes basic information about the three sessions. 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).

Table 1
Session information.

	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	12	Increase	40	13/11	54%	71%	$30
Session 2	24	12	Decrease	40	13/11	42%	79%	$30
Session 3	24	24	Increase–decrease	80	13/11	42%	50%	$34
Session 3(a)	24***	12	Increase	80	13/11	42%	50%	$34
Session 3(b)	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 (**) reported 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.

3.1.5. Instructions

After being seated at computers in the lab, the subjects were instructed in the basic payoff structure of the decision making environment, and then they participated in four practice matches.[10] This instructional period was designed to familiarize subjects with both the computer user interface as well as the payoff structure and basic strategic environment.

3.1.6. 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 or came close to bankruptcy.

3.1.7. 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[11] to compare the subjects across sessions.[12]

3.2. 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. Fig. 1(a)–(c) presents the matrix for each treatment value of the continuation probability. In each case, the setting is the Hi-Lo game depicted in Fig. 1(d). If the expected payoff when both choose split, $\frac{1}{1-p}\left(\frac{1}{2}Y - e\right) = \frac{20}{1-p} \equiv x$, is strictly greater than that when at least one flip is chosen, $\frac{1}{2}\left(\frac{1}{1-p}Y - (1-\phi)Y\right) - e = \frac{1}{2}\left(\frac{100}{1-p} - 30\right) - 30 \equiv z$, then each player has a unique weakly dominant strategy to choose split when $p < p^* = \frac{1}{3}$ and choose flip when $p > p^* = \frac{1}{3}$. Though each game in Fig. 1 has multiple Nash equilibria, applying standard game theoretic solution concepts (dominance solvability or Trembling Hand Perfection) yields an unique prediction of (split, split) under $p = 0$ and (flip, flip) under $p = 0.5$ or $p = 0.75$. [13] Past experimental work also suggests that subjects overwhelmingly go for the higher expected payoff in Hi-Lo games (e.g., see Bacharach, 2006). Our first hypothesis follows.

Hypothesis 1 *(Choices).*

(a) We will observe more flips under $p = 0.75$ than under $p = 0$.
(b) We will observe more flips under $p = 0.5$ than under $p = 0$.

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

[10] 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 $p = (3/4)$, respectively, and subjects were asked to choose split or flip on their own.

[11] A supplemental appendix with instructions and questionnaire is available from the authors upon request.

[12] Our experiment differs from Tingley (2011) in the various ways, including the following. First, the winning probabilities differ in round 1 from any other future periods. Second, there is no cost of arming in Tingley. Third, in each period the players engage in an ultimatum game.

[13] With $p = 0$, there are two pure strategy Nash equilibria: (split, split) and (flip, flip). With $p = 0.5$ or $p = 0.75$, 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.

(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

Fig. 1. Payoff matrix by continuation probability.

Hypothesis 2 *(Outcomes).*

(a) We will observe more conflict under $p = 0.75$ than under $p = 0$.
(b) We will observe more conflict under $p = 0.5$ than under $p = 0$.

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

Hypothesis 3 *(Choices by subject).* Most subjects will choose more flips under $p = 0.75$ than under $p = 0$ and more flips under $p = 0.5$ than under $p = 0$.

The first two hypotheses test the effect of the shadow of the future on conflict. Given the structure of the interaction, it is natural to suppose each subject follows a cut-off rule with respect to p when deciding to Settle or Fight. We are less interested in where this cut-off is for each subject, as it may differ from subject to subject due to variation risk preferences or other considerations, 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 to yield clear predictions via a clear payoff dominance (split under $p = 0$ and flip under $p = 0.75$). The other value, $p = 0.5$, yields flipping under risk neutrality but might yield splitting under $p = 0.5$ if subjects have sufficient risk aversion. Bearing this mind, we make no explicit hypothesis about the frequency of flips under $p = 0.5$ compared to under $p = 0.75$.

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. We also note that all hypotheses are falsifiable using standard statistical tests.

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.

3.3. Results

3.3.1. 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 $p = 0$ and more often under $p = 0.5$ than under $p = 0$. 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 3, we reject at very high significance levels the hypothesis that the proportion under $p = 0$ and $p = 0.75$ and under $p = 0$ and $p = 0.5$ are equal. Similar patterns are observed when looking at the data by session. Flips are more frequent in a statistically significant manner under $p = 0.75$ and $p = 0.5$ than under $p = 0$.

We observe that the percent of flips under $p = 0.5$ and $p = 0.75$ are similar in the pooled data but with some variation across the sessions. While more flips occur under $p = 0.75$ than $p = 0.5$ in Session 1, the percent flips is nearly identical under those two treatment values in Sessions 2 and 3. The final column in Table 3 reports that the difference in flips is statistically significant in Session 1 but not in Sessions 2 and 3. Again, we note that this could be due to variation in subjects' risk preferences, with subjects in Session 1 exhibiting more risk aversion, on average, than those in Sessions 2 and 3. Fig. 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.

The overall picture is that Hypothesis 1 is strongly confirmed: increasing the shadow of the future does increase the incidence of conflict. This pattern is observed when the data are pooled and when the data are separated by session. There is also some evidence that risk aversion may factor into some subjects' decision, especially for values of p that are greater than but close to p^*. 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

Table 3
Chi-square test statistics for Hypothesis 1, overall and by session.

	Hypothesis 1		
	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 $p = 0.5$	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.

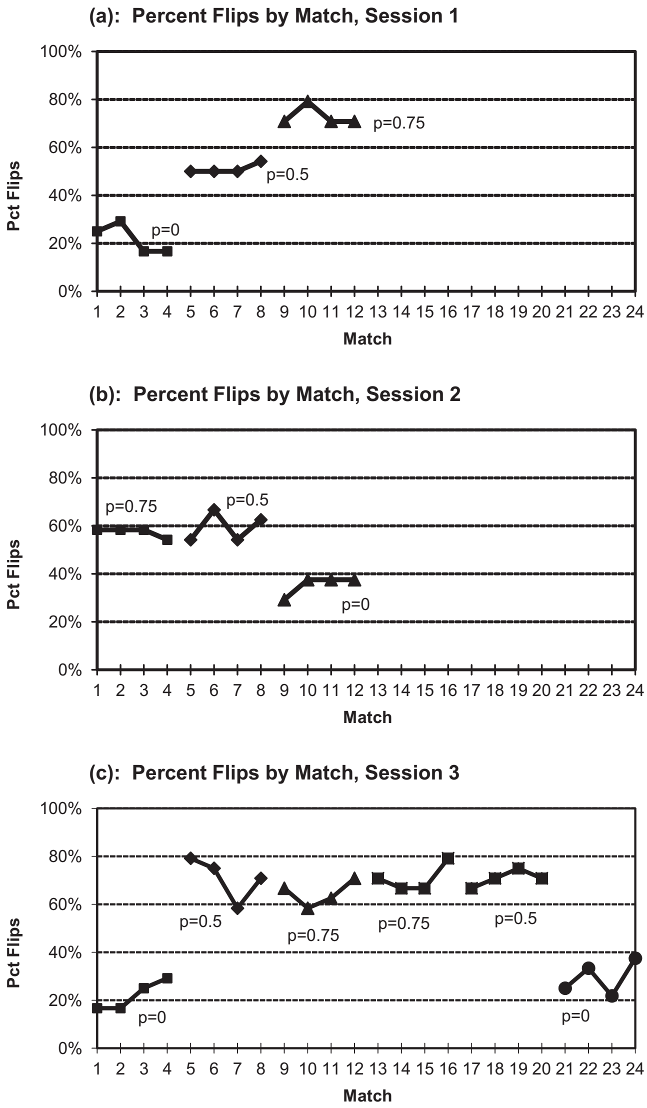

Fig. 2. (a) Percent flips by match, Session 1. (b) Percent flips by match, Session 2. (c) Percent flips by match, Session 3.

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.

3.3.2. Outcomes

Table 4 reports the distribution of outcomes by session and continuation probability. The easiest way to understand the table is to look at the percent of split–split outcomes; this outcome corresponds to settlement while the other two outcomes correspond to conflict. Consistent with Hypothesis 2, in the pooled data we observe the occurrence of settlement to be lower under $p = 0.75$ and $p = 0.5$ than under $p = 0$. The same pattern holds when looking by session, and it also 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 ($p = 0$).

3.3.3. Choice patterns

To evaluate Hypothesis 3, we classified subjects by their observed choices as reported in Table 5. 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. Columns (4) and (5), which are in bold lettering, correspond to the choice pattern predicted by Hypothesis 3. Column (4) is the strict variant such that all subjects included here chose strictly more flips under $p = 0.75$ and $p = 0.5$ than under $p = 0$, while column (5) includes subjects who did not choose strictly more for both but did choose weakly more for both. The most common choice pattern corresponds to the

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.

behavior predicted in Hypothesis 3. By the strict measure, 54% (39 out of 72) of the subjects chose as predicted; by the weaker measure (combining columns (4) and (5)), the number increases to 65% (47 of 72). This choice pattern is also modal within each session, with roughly the same frequencies, i.e., the predicted pattern accounts for more than half in each session (not shown). Moreover, as shown in Table 5, it is also the modal behavior for various subsamples by characteristic: male or female, undergraduate or graduate, exposed to economics or statistics or not exposed.

We observe a wide variation in choice behavior among the other subjects. For example, some 6% of all subjects (4 of 72) flipped most under $p = 0$, 7% (5 of 72) never flipped, and 4% (3 of 72) always flipped. The distribution of choice patterns is also similar across sessions (not shown). The various choice patterns may reflect preferences for risk, equity, or some combination of these or other concerns.[14] Another possibility is that these other choice patterns reflect misunderstanding the decision making environment. Ruling this out is not entirely possible, yet we gain some insight from the last question of the questionnaire, which asked, "Were you more likely or less likely to select FLIP as the continuation probability increased? Why or why not?" We find that 72% (52 of 72, line J column 10) of the subjects answered yes and provided some explanation why (e.g., "the chance of winning more money increased"), and of these subjects, 67% (35 of 52) acted consistently with the predicted behavior when using the strict criterion, and 75% (39 of 52) did so when using the weak criterion. Only 20% (4 of 20) of the other subjects did so as measured strictly; only 40% (8 of 20) did so when measured weakly. This is not a perfect measure of comprehension for many reasons.[15] Nonetheless, it suggests that understanding the strategic setting led subjects to increase their flipping as the continuation probability increased. Indeed, no other characteristic, such as sex, exposure to statistics, and so on, seems to better predict their behavior; comprehension of the strategic environment best predicts whether or not a subject acted in accordance with our hypothesis. Altogether, this evidence suggests that a large majority of the subjects understood the basic "shadow of the future" logic, and this logic guided their behavior in the predicted manner.

[14] We note that these other choice patterns need not be classified as 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 $p = 0$.

[15] Clearly not all subjects who said they were more likely to flip under the higher continuation probability did so. The question was asked after subjects completed their choices and had time to consider an optimal strategy. The very asking of the question may have prompted an answer more indicative of what the subject thought the experimenter wanted to hear.

Table 5
Number of subjects by choice classification, overall and by subject characteristic.

	Choice classification									
	(1) Flips0 = Flips0.5 = Flips0.75 = all	(2) Flips0 = Flips0.5 = Flips0.75 = 0	(3) 0 < Flips0 = Flips0.5 = Flips0.75 < All	**(4) Flips0.75 > Flips0, Flips0.5 > Flips0 (Pct)**	**(5) Flips0.75 >= Flips0, Flips0.5 >= Flips0, both not strict (Pct)**	**(6) 4 +5 (Pct)**	(7) Flips0.75 >= Flips0, Flips0.5 < Flips0	(8) Flips0.75 < Flips0, Flips0.5 >= Flips0	(9) Flips0.75 < Flips0, Flips0.5 < Flips0	(10) Total
(A) Overall	3	5	1	**39 (54%)**	**8 (11%)**	**47 (65%)**	7	5	4	72
(B) Male	3	2	0	**23 (59%)**	**4 (10%)**	**27 (69%)**	4	0	3	39
(C) Female	0	3	1	**16 (48%)**	**4 (12%)**	**20 (61%)**	3	5	1	33
(D) Undergraduate	2	4	1	**38 (56%)**	**7 (10%)**	**45 (66%)**	7	5	4	68
(E) Graduate	1	1	0	**1 (25%)**	**1 (25%)**	**2 (50%)**	0	0	0	4
(F) 0 economics	2	3	0	**18 (46%)**	**5 (13%)**	**23 (59%)**	5	5	1	39
(G) 1+economics	1	2	1	**21 (64%)**	**3 (9%)**	**24 (73%)**	2	0	3	33
(H) 0 statistics	1	1	0	**14 (58%)**	**4 (17%)**	**18 (75%)**	1	2	1	24
(I) 1+statistics	2	4	1	**25 (52%)**	**4 (8%)**	**29 (60%)**	6	3	3	48
(J) Comprehend*	2	2	0	**35 (67%)**	**4 (8%)**	**39 (75%)**	5	2	2	52
(K) Not comphnd.	1	3	1	**4 (20%)**	**4 (20%)**	**8 (40%)**	2	3	2	20

Notes: Data from all sessions are used. Columns (4) and (5) best match the predicted behavior of expected payoff maximization. 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. Percentages given for columns (4), (5), and (4) +(5).

4. Conclusion

We have argued and shown experimentally that a longer shadow of the future induces more conflict and less settlement in a particular conflict setting. It is important to reiterate the conditions under which this effect can be expected to occur, both in order to be cognizant of the settings to which it applies and for possibly furthering understanding about the determinants of peace and conflict more generally. One condition for the effect to occur is that open conflict changes the future strategic positions of the adversaries differently than settlement (in the shadow of conflict) does. This condition is satisfied in many conflictual settings and is clearly empirically relevant. The other condition under which the effect holds is that contracts on an enforcement variable like arming are not enforceable. That is, contracts can only be self-enforced through the choices on the enforcement variables made by the adversaries or that settlements only occur under the threat of conflict. This condition appears to apply in many conflictual settings. For situations that may involve actual warfare, the condition implies a level of absence of trust (or, equivalently of institutions of governance) between the adversaries that at best may lead to a protracted Cold War, which in our models would be represented by a series of settlements. Whether hot or cold, such wars are expensive, the former in terms of arming and destruction, the latter in terms of arming. Then, reducing the expense as well as the likelihood of war would amount to developing the trust or the institutions of governance that would make long term contracts on arming easier to enforce.

One way that trust could emerge has been extensively studied theoretically: through supergame strategies following the folk theorem. However, trust may be too elusive to achieve in many economic and political settings. Actual institutions of conflict management and of governance – independent courts and bureaucracies, checks and balances, other third parties – may be necessary to enforce long-term agreements. Such institutions are costly and take time to build, and as in the case of folk theorem settings we expect a longer value attached to the future to increase the incentives to invest in such costly institutions (for such models, see Genicot and Skaperdas, 2002; Gradstein, 2004, and McBride et al., 2011). That is, the settings – and the effect of the shadow of the future – that we have examined in this paper involve the absence of "property rights" that may be due to the absence of trust or institutions. Building such property rights would be more likely in conditions in which the future is highly valued. Thus, embedding the types of models we have examined here within more-encompassing ones that involve the endogenous emergence of trust and institutions would be a natural next step, both as means to further clarifying the effect of the shadow of the future and for improving understanding of why conflict occurs.

Appendix A. Endogenous enforcement

In this Appendix we present an extension of the model from Section 3 to allow for endogenous enforcement levels. It is a dynamic contest model that draws on McBride and Skaperdas (2007). Contest models have been applied in cases of war, litigation, rent-seeking and other settings (see Konrad, 2009 for an overview of the contests literature). The main comparative static result regarding the effect of the shadow of the future is shown to hold in this setting.

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; Hirshleifer, 1989; Skaperdas, 1996; Clark and Riis, 1998, and Hwang, 2012):

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

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. Agent A offers a division (subsidy) S of the period's surplus to B. If B accepts, then agent B receives S, agent A receives $Y-S$, and the next period repeats steps 1 and 2. If B rejects the offer, conflict occurs with winner selected according to probabilities q_A and q_B. The winner receives ϕY for the period and Y in each 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

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

Agent A receives 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

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

The payoffs are not symmetric because A is always the proposer and the subsidy offered is just the one that equates B's settlement payoff with his 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

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

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

$$e_A^P = e_B^P = \frac{m}{4}\frac{(\phi(1-p)+p)}{(1-p)}Y. \tag{12}$$

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. With endogenous enforcement levels, a higher discount factor increases equilibrium enforcement, and 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:

$$V_i^W(e_A, e_B) = q_i(e_A, e_B)\frac{(\phi(1-p)+p)}{(1-p)}Y - e_i, \quad i = A, B. \tag{13}$$

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

$$e_A^C = e_B^C = \frac{m}{4}\frac{(\phi(1-p)+p)}{(1-p)}Y = e_i^S, \quad i \in A, B. \tag{14}$$

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 endogenous enforcement levels from (14) or (6). Settlement occurs when

$$\frac{pm(\phi(1-p)+p)}{2(1-p)^2(1-\phi)} \le 1. \tag{15}$$

From 15 we 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.

Appendix B. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.jebo.2014.04.023.

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