

# Fighting rather than Bargaining\*

James D. Fearon  
Department of Political Science  
Stanford University

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## Abstract

Virtually all interstate and civil wars involve significant periods during which the combatants simply fight and do not exchange serious offers. In a model where a government cannot commit against changing its proposal if a rebel group accepts, a “ratchet effect” is shown to undermine the government’s ability to screen militarily weak adversaries via offers, leading it to use fighting to screen weak types. The argument provides an explanation for important facts about armed conflict that are puzzling for standard incomplete-information bargaining models (which do not explain long war duration and non-serious offers) and commitment-problem models (which do not explain eventual negotiated settlements due to battlefield learning).

A long tradition of scholarship sees war as a form of bargaining. For example, Clausewitz’s famous description of war as “a continuation of politics by other means” can be understood as the claim that in war leaders continue bargaining over their usual objectives, but using military actions to exert pressure on the other side to settle (Wagner, 2000). Thomas Schelling (1966) explicitly developed the idea of war as a bargaining process, and Kenneth Waltz (1979, 114) analogized wars to labor strikes and the associated bargaining between firms and unions. More recently, an extensive literature tries to explain interstate and civil war using Rubinstein-like bargaining models where rejection of an offer leads to a period of

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fighting.<sup>1</sup>

Parallel to models of strikes in labor relations, the core idea is that war is analogous to inefficient delay in reaching an agreement, with delay the result of state leaders having private information about their military capabilities, costs for fighting, or value for the interests at stake. Fighting and strikes are the means by which an uninformed player screens between types that vary in their willingness to make concessions.

The implications of these models, however, are hard to reconcile with important facts about civil and interstate war. First, both forms of armed conflict, and especially civil wars, often last a long time. Since 1945 the mean and maximum duration of interstate wars have been about 1 and 10 years, respectively, while the mean and maximum for civil wars are about 11 and 52 years.<sup>2</sup> By contrast, bargaining models in which delay is driven by screening typically predict delay on the order of minutes or days if the parties can make offers and counteroffers quickly (Hart, 1989). Hart argued on this basis that it is difficult for screening by itself to explain the duration of labor strikes, which in the U.S. last only about 40 days on average. In the literature on conflict, it is often suggested that the long duration of many civil and some interstate wars argues against private information as an important part of the explanation for such conflicts (Fearon, 2004; Powell, 2006; Blattman and Miguel, 2010).

Second, in bargaining models the parties always put *serious offers* on the table – offers that have a positive probability of being accepted. If this image of intra-war bargaining were accurate, we would expect to see state and rebel leaders devoting significant effort during a conflict to formulating and revising offers in light of rejection of a previous offer, and we would see relatively rapid back and forth and convergence on terms. At best, delay in ending the conflict would be explained by the time it took for the parties to formulate counteroffers

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<sup>1</sup>Some examples include Fearon (1995), Powell (1996*b*), Powell (2004*a*), Slantchev (2003), and Wagner (2000), but there are many more. See Reiter (2003) for an overview of work in Political Science on what he termed “the bargaining model of war,” and Jackson and Morelli (2011) for a more recent survey including work in Economics.

<sup>2</sup>Sources and more discussion of these estimates are provided below.

or decide to reject proposals (Powell, 2002, 7).

Actual wars, however, normally see months, years, or in some civil wars decades pass without either side making a serious offer for a negotiated settlement, or devoting any effort to formulating a new proposal. Leaders of states or rebel groups typically pose relatively extreme war aims that they do not expect the other side to concede unless the military or political situation changes significantly. In effect they adopt the position “let’s just fight for a while to see if we can win outright, or demonstrate that we must ultimately be given better terms.” Civil and interstate wars are characterized by long periods of *fighting rather than bargaining*, which are sometimes ended or punctuated by brief and intense negotiations in which serious offers are actually exchanged.<sup>3</sup>

In some cases, a plausible explanation for the lack of serious bargaining is that the conflict is driven not by private information but by a commitment problem – the deals that both sides would prefer are for some reason unenforceable. Thus, Acemoglu and Robinson (2001) explain costly revolutions by assuming that the rich can’t commit to implement redistribution in the future that would prevent revolution when the poor are relatively strong (or organized) in the present. Fearon (1998, 2004) explains ethnic wars and protracted insurgencies by the idea that after a peace agreement, the government’s relative capabilities will return to a level that allows them to renege on the agreement with the rebels (see also Walter 2002 and Powell 2012). In the interstate context, the allies in World War II made no serious offers, instead demanding unconditional surrender from January 1943 forward (a policy decided on at least eight months earlier, despite a grim military outlook at that time). In large part this was because they did not believe that deals with Hitler or the

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<sup>3</sup>For example, in the U.S. and Afghan governments’ war against the Taliban, the only serious negotiations to date have been intermittent discussions over *whether to hold* negotiations in which actual, serious offers might be exchanged. Each side’s announced war aims are so extreme that no one expects any chance of the other side would accept them as negotiated settlements. See, for example, Matthew Rosenberg and Rod Nordland, “US Abandoning Hopes for Taliban Peace Deal,” *New York Times* 2 October 2012, p. A1. For important empirical studies of war termination that stress the typical extremity of war aims and rarity of serious negotiations even after major military setbacks, see Iklé (1971), Reiter (2009), and Goeman’s (2000) study of war aims and bargaining during World War I.

Japanese military would be enforceable (Balfour, 1979; Reiter, 2009, chap. 6). Likewise, the sense that deals with Saddam Hussein on the issue of Iraq’s pursuit of nuclear weapons were unenforceable worked against negotiated solutions prior to the Iraq war. In wars of “regime change” like these two interstate wars and many civil wars, bargaining is often beside the point due to one or both side’s conviction that the other can’t be trusted.<sup>4</sup>

While compelling for some cases, a third fact about civil and interstate wars poses a difficulty for commitment-problem explanations of protracted conflict: wars sometimes *do* end with negotiated settlements. Moreover, historians often argue that this becomes possible precisely because the fighting has taught the combatants something about the military or political situation. In a pure commitment-problem story, conflict ends only if one side defeats the other militarily, or something exogenous occurs that renders agreements enforceable, such as third-party intervention.<sup>5</sup> Many interstate wars end with negotiated settlements, however, as do perhaps one third of civil wars, and not all due to third-party guarantees (Pillar, 1983; Walter, 2002). In addition, a substantial empirical literature by historians and political scientists argues for many cases that the combatants revised their beliefs about their odds of winning based on observing battlefield outcomes and that this battlefield learning is exactly what enabled a peace deal in the end (see especially Pillar, 1983; Blainey, 1973; Goemans, 2000).

In this paper I show that if we alter the standard bargaining model by assuming, first, that the parties cannot commit not to change their demands after they learn that the other side is willing to accept, and, second, that the private information is about military capabilities rather than values for the interests at stake, then long periods of “fighting rather than bargaining” emerge naturally. I consider a game in which a government makes offers to a rebel group that may be a strong type that cannot be militarily disarmed, or a weak

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<sup>4</sup>On “absolute” interstate wars motivated by commitment problems, see Reiter (2009). On commitment problems and the absence of bargaining prior to 2003 Iraq war, see Coe (2012) and Lake (2011).

<sup>5</sup>For a possible exception, see Leventoglu and Slantchev (2007), who suggest that war is driven by first-strike advantages but the temptation diminishes as fighting destroys stuff of value.

type that can be militarily defeated with some positive probability in each period of fighting. Consistent with the fact that interstate and government/rebel relations occur in an anarchical setting with no third party to enforce agreements, the government is unable to commit not to change a deal that the rebel group accepts. For sufficiently short time between offers, in equilibrium the government may choose to make non-serious (i.e., zero probability of acceptance) offers for months or years, forcing a war during which its belief that it faces the strong type increases as long as the rebels aren't defeated. Eventually, the government reaches a point at which it is willing to make a pooling offer that both strong and weak type will accept. Thus the conflict ends with either a military victory or with a negotiated settlement that arises because the government has learned something about relative military capability.

The intuition is that if the weak type of rebel group were to accept a would-be screening offer, the government would subsequently change the deal, pricing the rebel group down to its value for fighting. This “ratchet effect” was first observed in models of buyer-seller bargaining over the terms of a service or other rental good by Laffont and Tirole (1988) and Hart and Tirole (1988). In both the buyer-seller context and here, the ratchet effect undermines the ability to screen types *by offers*. In the economic models the seller's best alternative given the ratchet effect is to offer a low price that attracts all types of buyer, leading to immediate settlement – thus, no delay and no inefficiency.

By contrast, in the international or civil war contexts, uncertainty about relative military capabilities means that the disputants have another option: to screen between weak and tough types of opponent *by fighting*. I show that if the government starts the game sufficiently optimistic about its military prospects, then for small enough time between offers the unique equilibrium involves non-serious offers, screening by fighting, and eventually a self-enforcing peace deal if the rebels survive long enough. Thus the model provides an explanation both for the fact that nearly all international and civil wars see extended periods of fighting with no serious offers on the table, and the fact that such conflicts sometimes

end with a stable negotiated settlement based on a new understanding of the true balance of power (Blainey, 1973).

In principle, this mechanism might help explain why some strikes last a long time, if the union anticipates bargaining over future contracts, is concerned that concessions now might imply a worse deal in the next round of contract negotiations, and striking is associated with the possibility of a complete collapse of the union.<sup>6</sup> Much more broadly, the model may help to explain why a diverse range of social situations where competing groups can resort to force – whether these are states, governments and rebel groups, inner city gangs, or clans in a lightly governed area – show common characteristics such as obsession with honor and reputation, powerful concerns about displaying weakness, and, as Hobbes put it, a constantly “known disposition” “to contend by Battell” (Hobbes, 1651(1985; Waltz, 1979; Boehm, 1986). In anarchical or quasi-anarchical situations, concessions are more dangerous because contracts and third-party enforcement are not available to protect one from the consequences of losing a reputation for toughness.

The next section considers related literature. Section 2 presents and analyzes the model. Section 3 shows that the mechanism can generate long war durations from plausible parameter values, and that the results accord with typical differences between civil and interstate war durations. Section 4 discusses two extensions that weaken assumptions used in the basic model of section 3. Section 5 concludes, contrasting the mechanism here with alternative explanations for fighting rather than bargaining in military conflicts.

## 1 Related literature

Bargaining models of armed conflict initially made war a game-ending choice, representing it as a costly lottery and looking at conditions under which states would abandon offers

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<sup>6</sup>Kennan (2001) derives cycles of pooling and separating offers in a model of repeated buyer-seller bargaining where the buyer’s types follows a Markov process; ratchet-effect considerations increase the buyer’s bargaining leverage but do not make for “fighting rather than bargaining” because the private information is about valuations rather than about capabilities to survive, say, a strike.

and initiate a military conflict (Fearon, 1995; Powell, 1996*a*). Wagner (2000) asked why, if a war started because one side guessed wrong about what the other was willing to accept, the “war” wouldn’t then stop so quickly as to not constitute a war, since the state that guessed wrong could make a new offer. This is essentially a “Coase conjecture” critique: If in bargaining an uninformed party can’t commit not to make a new offer right away after rejection, then the amount of delay should be very small (Coase, 1972; Gul, Sonnenschein and Wilson, 1986; Fudenberg, Levine and Tirole, 1985).

Following Geoffrey Blainey’s (1973) argument that wars occur when states “disagree about their relative power” and that peace breaks out when fighting teaches them what the true balance is, Wagner (2000) and Smith and Stam (2004) proposed a possible resolution to this puzzle: They explain protracted fighting (war) by assuming that the states can be mutually optimistic about their chances for winning based on conflicting prior beliefs. Fighting gradually reveals the truth so that war aims are revised down and eventually a proposal is accepted. In this non-common priors approach, states reject offers based on the belief that their analysis of the military situation is simply superior to the other side’s. The enemy’s conflicting estimate is thought to arise not from different information but from irrationality. In the model developed here, which has common priors, the weak type of rebel group rejects offers because accepting would lead to being pushed to a different and worse final outcome.<sup>7</sup>

In Powell (2004*a*), states have common priors about their costs for fighting or ability to prevail in battle, so that reactions to offers can reveal information about costs or odds of winning. When the private information concerns costs, war is avoided when states can make offers rapidly; when it concerns the odds of winning a battle, war may occur but will not last long if the time between battles is short.<sup>8</sup> Slantchev (2003) likewise has private information

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<sup>7</sup>Fey and Ramsay (2006) criticize the non-common priors approach. I discuss differences with the non-common priors explanation further in the Conclusion.

<sup>8</sup>Or, I would expect based on the results presented here, if the states were allowed to make offers during a battle.

about odds of winning, but fighting in a period results in a finite territorial change rather than stalemate or victory. Screening occurs in the equilibrium he focuses on, which suggests that there would be very little war if the time between offers is made arbitrarily small. In these models, some type always makes a serious offer when it has a chance. In the non-common priors models, the states think their offers are serious but that the other side just doesn't "get it."

All these models of intra-war bargaining assume the states are bargaining over a flow payoff, which is natural since we are talking about policy choices or divisions of territory that yield flow payoffs. However, they implicitly assume that once both sides have agreed to a division, it will automatically be enforced thereafter. In the anarchical setting of international politics or government-rebel relationships, this assumption is too strong. It is relaxed in papers that study how shifts in bargaining power may create a commitment problem that can make for costly fights (Acemoglu and Robinson, 2001; Fearon, 1998, 2004; Powell, 2004*b*, 2012).<sup>9</sup> But in this approach there is no private information and thus no role for learning in the course of conflict, which seems to be empirically relevant in many cases (for examples see Blainey, 1973; Pillar, 1983; Goemans, 2000; Reiter, 2009).

In the economics literature, Hart and Tirole (1988) examine buyer-seller bargaining over the division of a flow payoff (a service or a durable good) under various assumptions about what contracts can be written; see also Schmidt (1993). The model studied here corresponds most closely to Hart and Tirole's "rental model under non-commitment," in which the seller cannot commit to a rental price for more than one period. The main difference is that here the types of "buyer" (the rebel group) are distinguished by ability to survive at war rather than a fixed value for the good, which provides the government with a costly way to learn the rebel group's type that is not present in the economic setting. In

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<sup>9</sup>In Powell (2013), the government can change the distribution of military power if the rebels agree, so shifts in power are endogenous. He shows that war can still arise if a new surplus from monopolization of power is large enough; the government's inability to commit *ex ante* on divisions of the surplus means that rebels will only accept a consolidation path that is unacceptably slow for the government.

section 2 I show that if the uncertainty is only about costs for fighting, then equilibrium entails immediate acceptance of an offer and thus no war, parallel to the buyer-seller case (see also Fey et al. 2013).

Economists have suggested several ways of explaining delay in bargaining despite the Coase conjecture, some of which could be relevant to protracted armed conflict. In models with two-sided incomplete information it can be possible to construct equilibria with delay by having the parties fear that making a better offer will lead to a harsh inference about their desire for an agreement; attrition dynamics can then result (e.g., Cramton 1984). However there may be equilibria with Coasian dynamics as well (Cho, 1990), and Feinberg and Skrzypacz (2005) give a plausibly weak condition under which any equilibrium in the two-sided case (with one side making offers and common knowledge of gains from trade) exhibits zero delay in the limit.<sup>10</sup> Myerson (1991) and Abreu and Gul (2000) showed how attrition dynamics can arise uniquely and for almost any bargaining protocol if the parties may be irrational types that are committed to a particular demand strategy. Still, the latter paper shows that in general the amount of delay goes to zero as the probability of irrational types gets small. Also, with attrition dynamics offers are still serious in that there is a positive probability at each moment that the other side will accept the demand. As noted, this is hard to reconcile with leaders' war aims and expectations in armed conflicts, where the expectation that the other might give in seems not normally to be about bargaining strategy but about the chance of military victory.<sup>11</sup>

In the theoretical literature on strikes, Hart (1989) showed how substantial delay could result in a screening model if the firm was known to face a large decline in profitability if the strike lasts a certain amount of time; Fuchs and Skrzypacz (2011) provide more general

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<sup>10</sup>Their main point is that delay necessarily occurs, under some parameter conditions, if the seller has private information about her beliefs about the buyer's valuation.

<sup>11</sup>Langlois and Langlois (2012) analyze a continuous-time model in which states with privately known costs for fighting choose offer functions while a costly conflict occurs that has a deterministic path to either stalemate or victory for one side. They propose an equilibrium that has attrition dynamics. Off-path beliefs and strategies are not described, however, which makes assessment difficult.

results concerning the effects of exogenously given deadlines. This mechanism might be relevant for armed conflict if there are cases where it is known that one side will “collapse” or substantially lose fighting capability at a certain time in the future, but this is not typically the case. In screening models of strikes (Admati and Perry, 1987; Card, 1990; Cramton and Tracy, 1992), it is assumed that players can commit not to make or respond to an offer for chosen length of time, which allows them to use delay to signal type. In the present context, this is assuming part of what we would like to explain (how is it that parties to armed conflict can rationally refuse to bargain for extended periods).

## 2 Model and analysis

The government,  $G$ , and rebel group,  $R$ , interact in successive periods  $t = 0, 1, 2, \dots T$ , where for almost all of the analysis  $T = \infty$ . In each period, the government makes an offer  $x_t$  to the rebel group. The rebel group either accepts or rejects the offer. If the rebel group accepts, payoffs in that period are  $x_t$  for the rebels and  $\pi - x_t$  for the government, where  $\pi > 0$  can be thought of as total tax revenue or other resources produced by the state or the region over which the two sides are in conflict.

If the rebel group rejects the offer, the two sides fight for the period, receiving payoffs  $g < \pi$  for the government  $r < \pi$  for the rebels in that period. We take fighting to be inefficient, so that  $g + r < \pi$ . In what follows I will assume that  $r > 0$ .<sup>12</sup>

Fighting may result in the government eliminating the rebel group completely, in which case the strategic interaction ends. This occurs with probability  $1 - \beta$ . If the rebels are crushed, when  $T = \infty$  the government’s payoff from this period looking forward is thus  $g + \delta\pi/(1 - \delta)$ , while the rebels get  $r + 0 + 0 + \dots = r$ . With probability  $\beta$  the rebels survive and play proceeds to the next period.  $\delta \in (0, 1)$  is a common discount factor.

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<sup>12</sup>This is simply to rule out uninteresting cases in the incomplete information analysis. If  $r < 0$  for both types then the government has no reason to try to separate weak from tough, as both would get  $x_t = 0$  for all  $t$  in the complete information equilibrium after separation.

A rebel group's type is characterized by a pair  $(\beta, r)$ , its probability of surviving a period of fighting and its value for each period of fighting. Analysis of the incomplete information version of the game will mainly consider the case of two types, with Nature choosing at the start a “weak” type  $(\beta_w, r_w)$  with commonly known prior probability  $p \in (0, 1)$ , or a “strong” type  $(\beta_s, r_s)$  with probability  $1 - p$ . The latter is stronger in the sense that  $(\beta_s, r_s) \geq (\beta_w, r_w)$ , which is to say that the strong type is either weakly more likely to survive a period of fighting, or has weakly lower costs while fighting, or both.<sup>13</sup>

The game just described can be termed the *no commitment case*: if the rebel group accepts an offer the government is committed to implement it only for a single period, which can be made arbitrarily short. An important comparison below is to *the commitment case*, which is the same game but modified by the assumption that if the rebel group accepts an offer  $x_t$ , strategic interaction ends and the government is committed to implement this deal in all subsequent periods.

## 2.1 Complete information and criteria for equilibrium

We begin by considering the complete information game in which the government knows the rebel group's type  $(\beta, r)$ . (Proofs are in the Appendix.)

**Proposition 1** *(a) Both the commitment and no-commitment versions of the infinite-horizon game have a subgame perfect equilibrium in which  $G$  always offers*

$$\hat{x}(\beta, r) \equiv r \frac{1 - \delta}{1 - \delta\beta}$$

*and  $R$  always accepts any offer  $x_t \geq \hat{x}(\beta, r)$  and rejects otherwise. In the commitment version, this equilibrium is unique. In the no-commitment version, there exist multiple subgame*

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<sup>13</sup>The game can be redescribed to depict interstate bargaining as follows: Rename  $G$  and  $R$  as states 1 and 2, respectively. The two states control territory represented by the interval  $[0, \pi]$ , with state 1 possessing  $[0, q]$  and state 2 possessing  $(q, \pi]$ , where  $q$  is the status quo. Let  $g = q - c_1$  and  $r_i = \pi - q - c_{2i}$ , where  $c_1$  is state 1's per-period cost of fighting and  $c_{2i}$ ,  $i = s, w$ , is state 2's cost, depending on type ( $c_{2s} \leq c_{2w}$ ). States' preferences over territory are linear. State 1 has a military advantage in the sense that it can (potentially) take territory from state 2 by force whereas state 2 cannot take territory from state 1.

perfect equilibria, including, when  $\delta > 1/(1 + \beta)$ , equilibria in which  $G$  always offers  $x^*$  on the equilibrium path and  $R$  always accepts, where

$$x^* \in \left[ \hat{x}(\beta, r), (\pi - g) \frac{1 - \delta}{1 - \delta\beta} \right].$$

(b) Consider a finite-horizon version of the no-commitment case, with  $T$  rounds of play. This game has a unique subgame perfect equilibrium that converges, as  $T$  approaches infinity, to the equilibrium in the infinite horizon case where  $G$  always offers  $\hat{x}(\beta, r)$  and  $R$  always accepts offers at least this large.

By rejecting all offers rebel type  $(\beta, r)$  guarantees itself an expected per-period payoff of  $\hat{x}(\beta, r)$ , which is its reservation value. Subgame perfection and the take-it-or-leave-it structure endow the government with all the bargaining power in the commitment version and in the finite-horizon version of the no-commitment case, so this is what the rebel group gets, uniquely, in these variants. In the no-commitment version with an *infinite* horizon, however, it is possible to construct equilibria in which the rebel group is offered an  $x^* > \hat{x}(\beta, r)$  in every period. The trick is to have the rebel group anticipate that if it fails to fight in response to an offer less than the expected  $x^*$ , the government will switch to always offering  $\hat{x}(\beta, r)$ . This can work provided  $\delta$  is large enough.<sup>14</sup>

Following Hart and Tirole (1988) and Schmidt (1993), in the main analysis of the incomplete information game I restrict attention to Perfect Bayesian Equilibria (PBE) in which the government has all the bargaining power in the following sense: If in period  $t$  the rebel group takes an action that leads the government to infer that it faces type  $(\beta, r)$  for sure, then the government will henceforth play the equilibrium strategy of the complete information game in which it always offers  $\hat{x}(\beta, r)$ . Note that this is necessarily the case in the finite-horizon approximation of the infinite horizon game with incomplete information. In section 4, however, I consider how results are affected when we weaken the assumption. In short, they hold up provided that there is a large enough gap between what a tough type

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<sup>14</sup>By contrast, in the commitment case the subgame perfect equilibrium is unique for  $T = \infty$  because agreeing to an offer  $x_t \in (\hat{x}, x^*)$  does not lead to a subsequent, discontinuous drop in the rebel's payoff.

and weak type would get in the complete information equilibria (that is, when a type is revealed).

For somewhat technical reasons, when analyzing infinite-horizon versions of the game with incomplete information, I will restrict attention further to PBEs in which the strong type of rebel group always certainly accepts an offer at least equal to its reservation value,  $\hat{x}(\beta_s, r_s)$  (except in section 4). A backwards induction argument can be used to show that this is true of any PBE in the finite-horizon approximation (with two types), so again we can think of this criterion as selecting PBEs that correspond to PBEs of the finite-horizon game as  $T$  gets large.<sup>15</sup>

In sum, in what follows, let an *equilibrium* of the incomplete information game with  $T = \infty$  be a perfect Bayesian equilibrium in which (a) the government and rebel group play the complete information equilibrium in which the government always offers  $\hat{x}(\beta, r)$  when type  $(\beta, r)$  is revealed, and (b) the strong type of rebel group always accepts offers at least as great as  $\hat{x}(\beta_s, r_s)$ .

## 2.2 Commitment not to change offers implies rapid settlement

Now suppose that the government begins the game uncertain if the rebel group is a strong type or a weak type, and that the government *can* commit not to change an accepted offer. This situation is nearly isomorphic with standard cases considered in buyer-seller bargaining models; the slightly non-standard aspect is the risk of elimination for the rebel group, but the effect is similar to additional discounting. Standard “Coase conjecture” results from buyer-seller models can be shown to apply: as the time between offers grows short, the time until the rebel group accepts an offer goes to zero.

Let  $\Delta > 0$  be the time between offers. Let  $\delta = e^{-\rho\Delta}$ , where  $\rho > 0$  is the common discount rate, and let  $\beta_i = e^{-\lambda_i\Delta}$ ,  $i = w, s$ , where  $\lambda_i$  is type  $i$ 's hazard rate for being defeated

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<sup>15</sup>Hart and Tirole (1988) (two types) and Schmidt (1993) (more than two types) study limiting behavior in finite horizon models of repeated buyer-seller bargaining.

militarily in war. (Note that this means that the weaker type has the higher hazard rate,  $\lambda_w \geq \lambda_s$ .)

**Proposition 2** *Consider the commitment case of the infinite horizon game with initial beliefs  $p \in (0, 1)$  that the rebel group is type  $(\beta_w, r_w)$ . As the time between offers approaches zero, in an equilibrium the amount of time before the rebel group accepts an offer from the government (if it has not yet been defeated) approaches zero, as does the probability that the game will end with a military defeat.*

With the government committed to implement a deal that the rebels agree to, but unable to commit against making another offer if the rebels reject a proposal, the government has almost no bargaining power and settlement is rapid. Either initial beliefs put enough weight on  $R$  being the strong type that the government wants to gain immediate acceptance (and no fighting at all) by making the pooling offer  $\hat{x}_s \equiv \hat{x}(\beta_s, r_s)$ , or the government makes an increasing sequence of screening offers, all of which are serious in that there is positive probability that the weak type will accept.<sup>16</sup>

If bargaining in interstate and civil wars were well represented by such a screening process, then delay in settlement would be explained by the time it took to put together new counteroffers. But as noted combatants typically make extreme demands that are kept in place for extended periods of time, and little or no attention is given to formulating revised offers in light of the other side's rejection of one's war aims.

### 2.3 Inability to commit to implement a deal undermines screening by offers

Buyer-seller and union-firm contracts are usually enforceable by the courts, but this is almost never the case (in any straightforward manner) for deals between states or between a government and a rebel group. So we next examine the model with no commitment to

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<sup>16</sup>Moreover, as shown by Fudenberg, Levine and Tirole (1985) and Gul, Sonnenschein and Wilson (1986) for related models in buyer-seller contexts, these dynamics hold up for a richer, continuous type space.

offers by the government. To be as clear as possible about where non-serious offers and equilibrium war are coming from, I first show that these *do not* arise if we assume that the private information is about the rebel group’s value for disagreement rather than about its ability to survive a period of fighting.

Let the strong and weak types have identical military capabilities,  $\beta = \beta_s = \beta_w$ , so they differ only in their costs for fighting or the rents they can extract during war. Thus  $r_s > r_w$ , and the prior probability that  $R$  is the weak type is again  $p \in (0, 1)$ . This game is now very close to that studied by Hart and Tirole (1988) and Schmidt (1993), who model  $T$  periods of repeated buyer-seller bargaining with no commitment and two or more types of buyer (seller, in the case of Schmidt). The only salient difference is that there is an exogenous risk that  $G$  gets the whole pie whenever an offer is rejected. Hart and Tirole note that in their  $T$  period game, by working from the last round it can be shown that the seller never offers more than the low valuation buyer’s reservation price and that this type of buyer always accepts offers at least this large. The exogenous risk of victory by  $G$  has no effect on this logic, implying that with a finite number of rounds, in a perfect Bayesian equilibrium  $G$  never offers more than the strong type’s reservation value, which converges to  $\hat{x}(\beta, r_s)$  in almost all periods as  $T$  gets large. Hart and Tirole show further that the finite-horizon equilibrium approaches, as  $T$  grows large, the equilibrium of the infinite-horizon game in which the seller always pools both high and low valuation buyers by offering the low valuation type’s reservation price. Thus there is no screening, no delay, and no “war.”<sup>17</sup>

Adding a chance of government victory following rejected offers does not change this result. Since repeating the Hart and Tirole proof for this case is tedious and not in any event the point of the paper, I show that the same result holds for the infinite-horizon model if we restrict attention to perfect Bayesian equilibria that satisfy conditions (a) and (b) above, and, in addition, are Markov in the sense that the government’s offer is a function of its

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<sup>17</sup>Schmidt (1993) shows that with more than two types of buyer the result requires the additional assumption that the lowest valuation buyer certainly accepts an offer equal to its reservation value.

beliefs in round  $t$ ,  $p_t$ , and not the prior history of offers and responses.

**Proposition 3** *Let  $\delta > 1/(1 + \beta)$ , and consider the incomplete information game with no commitment to offers and types  $(\beta, r_s)$  and  $(\beta, r_w)$ . In any perfect Bayesian equilibrium that satisfies conditions just stated, on the equilibrium path  $G$  makes a pooling offer  $\hat{x}_s = \hat{x}(\beta, r_s)$  in every period and both types always accept any offer at least this large; thus no fighting occurs. Moreover, such an equilibrium exists for any initial beliefs  $p \in (0, 1)$ .*

Thus when the private information is about the rebel group’s costs for fighting or value for the issues at stake, dropping the standard assumption about commitment to offers does not change the Coase conjecture conclusion about inefficiency: In fact, not only do we get no protracted fighting, we get no fighting at all. This is because the state’s ability to screen types of rebel group by offers is undermined by a “ratchet effect,” or equivalently, the fact that the government knows that a weak type of rebel group would reject attempted screening offers in order to preserve a reputation for possibly being the tough type. Losing this reputation is costly here because the government is not committed to its proposal, and so can change the deal.

Crucial to this conclusion, and highlighted in the proof of Proposition 3, is the fact that both types of rebel group have the same probability of surviving a period of fighting. If this is not so, the government can have a reason to induce both types to reject an offer, as the fighting will then reveal information about the rebel group’s type.

#### **2.4 No commitment to offers: Screening by fighting**

So we now consider the model where the uncertainty is about the rebel group’s ability to survive the government’s counterinsurgency campaign. Purely to make the notation simpler, I examine the case of a strong type that cannot be decisively defeated by the government ( $\beta_s = 1$ ) and a weak type that survives each period of fighting with probability  $\beta_w = \beta < 1$ . Again to ease notation, let both rebel types value a period of fighting at  $r = r_s = r_w$ . The

two types are thus  $(1, r)$  and  $(\beta, r)$ ; they differ only in their military capability.

The greater survival prospects of the strong type imply that its complete-information offer is better than what the weak type gets:  $\hat{x}(1, r) = r > \hat{x}(\beta, r)$ . As a result the ratchet effect appears in this game as well. For large enough  $\delta$  or short enough time between offers, it is impossible for the government to screen out the weak type by making offers less than  $r$ . An offer large enough to compensate a rebel group with low capabilities for the fact that the government will subsequently change the terms against them is also large enough that a strong type of rebel group would accept the agreement in order to “eat” the short-run benefits and then return to war.

**Proposition 4.** *For  $\delta > 1/(1 + \beta)$ , there is no equilibrium in which, in some period, the government makes an offer that is accepted for sure by the weak type and rejected for sure by the strong type.*

That the government cannot distinguish the strong and weak type of rebel groups by their reaction to peace offers does not imply that war must occur. As in the case of private information about costs for fighting, it could be that this forces the government to make a peace offer that both types would accept. If supportable, the government would offer  $x_t = r$  in every period, leaving  $\pi - r$  for itself.

However, the government now has another option: to fight in hopes that it can eliminate the rebel group, after which it can have all the revenues. For the government to wish to pool, it must prefer doing so to making a non-serious offer for one period, which induces a fight, and then returning to the pooling offer of  $\pi - r$  if the rebel group survives.<sup>18</sup> The time-averaged payoff for this gambit is

$$(1 - \delta)g + p\delta[(1 - \beta)\pi + \beta(\pi - r)] + (1 - p)\delta(\pi - r).$$

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<sup>18</sup>In the proof of Proposition 7 it is shown that given the assumption that the strong type always accepts  $x_t \geq r$ , the weak type must also, so that  $G$  can guarantee getting  $\pi - r$  in any period. As noted, a backwards induction argument can be used to show that this must be true in any PBE of the finite-horizon version of the game with two types.

Algebra shows that this is worse than just sticking with the pooling offer when

$$p < \left( \frac{1 - \delta}{1 - \beta} \right) \left( \frac{\pi - (g + r)}{\delta r} \right) \equiv p^*. \quad (1)$$

The proof of Proposition 5 describes a pooling equilibrium with no war that can be supported when the government's initial belief that it faces the weak type is low enough, that is, when  $p \leq p^*$ .

**Proposition 5.** *If  $p \leq p^*$  and  $\delta > 1/(1 + \beta)$ , then the game has an equilibrium in which  $G$  always offers  $x_t = r$  on the equilibrium path, and both types of  $R$  always accept any  $x_t \geq r$  and always reject  $x_t < r$  provided that they have never deviated from this rule in the past.*

Next consider the more interesting case where  $G$  initially thinks the rebel group is relatively likely to be the weak type:  $p > p^*$ . From Proposition 4 we already know that when  $\delta > 1/(1 + \beta)$  there is no equilibrium in which  $G$  makes an offer that is certainly accepted by one type and rejected by the other (in the first or in any period). So if there is no separating equilibrium (on offers) and no equilibrium in which the government would make an offer both types of rebel group would accept, then the only remaining pure-strategy possibility is for  $G$  to make an offer that both types of rebel group will reject.<sup>19</sup>

Suppose that both types are expected to reject offers in every period up to period  $t$ . Let  $p_t$  be the government's belief that  $R$  is the weak type in period  $t$ . By Bayes' rule,

$$\frac{p_t}{1 - p_t} = \beta^t \frac{p}{1 - p}.$$

Let  $m$  be the smallest integer such that

$$\beta^m \frac{p}{1 - p} \leq \frac{p^*}{1 - p^*}. \quad (2)$$

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<sup>19</sup>In principle one could also look for an equilibrium in which the government makes an offer that the strong type accepts and the weak type rejects, but this obviously won't work since the weak type would want to mimic by accepting.

That is,  $m$  is the first period such that if fighting has occurred up to this time and the rebels have not been defeated, the government is willing to play the pooling equilibrium of Proposition 5.

Suppose that  $p > p^*$ ,  $\delta > 1/(1 + \beta)$  and that  $m = 1$ . That is, if the rebels survive one period of fighting then the government's updated belief that the rebels are the weak type is low enough that the government is willing to pool both types on the good offer  $x_t = r$ . Proposition 6 establishes that in this case, there is an essentially unique equilibrium in which the government makes an offer in the first period that *both types are sure to reject*, after which, if the rebels survive, the government makes the pooling offer and a stable peace begins.<sup>20</sup>

**Proposition 6.** *Consider the infinite horizon game with no commitment and types  $(1, r)$  and  $(\beta, r)$ . If  $p > p^*$ ,  $\delta > 1/(1 + \beta)$ , and  $m = 1$ , then there is an essentially unique equilibrium in which, on the path,  $G$  offers any  $x_0 < r$  and  $x_t = r$  in periods  $t > 0$ . Both types of  $R$  reject any offer less than  $r$ , and accept any offer greater than or equal to  $r$ . Off the path, if  $R$  accepts an offer of  $x_t < r$ ,  $G$  assumes that  $R$  is the weak type and subsequently offers  $\hat{x}(\beta, r)$ , which the weak type would accept and the strong type would reject.*

In a simple manner, then, this example captures the real-world pattern: non-serious offers while the parties fight to learn about relative strengths, followed by serious offers and a negotiated settlement.<sup>21</sup>

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<sup>20</sup>The equilibrium is “essentially unique” in that the government can offer a range of non-serious offers that would be rejected for sure.

<sup>21</sup>The government would be better off, and the rebels no worse off, if the government could commit to implement its first-period offer in all later periods, since in this case war may be avoided in the first period if the rebels are the weak type. Let  $x_{sep}$  be the offer that, under commitment, makes the weak rebel group indifferent between accepting and rejecting, that is,  $x_{sep} = r(1 - \delta) + \delta\beta r$ .  $G$ 's payoff under commitment is at least as great as what it gets if it offers  $x_{sep}$  and this is accepted by the weak type for sure (this follows from arguments in Hart (1987) and Fudenberg and Tirole (1991, 410)). It is easy to show that this payoff is always strictly greater than  $G$ 's expected payoff in the no-commitment equilibrium of Proposition 6. Both types of rebel groups get the same payoff with no commitment as with commitment, though they would get strictly more under commitment if we were to give them some surplus above their reservation value in the

## 2.5 Fighting rather than bargaining: the general case

The game is more difficult to analyze when it would take more than one period of fighting for the government to be willing to pool both types on the good offer should the rebels survive (that is,  $m > 1$ ). If the weak type faces several periods of fighting in order to get to the good offer, it may prefer to accept an offer in  $t = 0$  that is less than  $r$ , revealing itself to be the weak type. But we already saw above that when  $\delta > 1/(1 + \beta)$  there can be no equilibrium in which the strong type rejects and the weak type accepts an offer. For some parameter values the only equilibrium may involve mixed strategies and gradual separation of the weak type.<sup>22</sup> However, if we send the time between offers, and thus the time the government is committed to a deal, towards zero, we find that the only equilibrium is in pure strategies and involves fighting rather than bargaining.

Suppose both types were to reject for sure all offers until period  $m$ , at which point the government begins offering  $x_t = r$  for  $t \geq m$ . The weak type's payoff for this path is

$$r \frac{1 - \delta^m \beta^m}{1 - \delta \beta} + r \frac{\delta^m \beta^m}{1 - \delta}. \quad (3)$$

The first term is the sum of  $r$ 's received during fighting, discounted by time preference and the probability of being eliminated each period. The second term is the value of receiving the good offer  $r$  forever, discounted by its occurring  $m$  periods hence and by the probability of surviving that long,  $\beta^m$ .

The weak rebel group prefers to accept the first offer  $x_0$  when  $x_0 + \delta \hat{x}(\beta, r)/(1 - \delta)$  is greater than (3), which algebra reduces to the condition

$$x_0 > r \left[ \frac{1 - \delta^m \beta^m}{1 - \delta \beta} + \frac{\delta^m \beta^m}{1 - \delta} - \frac{\delta}{1 - \delta \beta} \right].$$

If parameters are such that the term in brackets is greater than 1, then by the same logic

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complete information game.

<sup>22</sup>The mixed strategy equilibrium is similar to the semi-separating equilibrium in the commitment case of buyer-seller bargaining, except that, as shown below, as the time between offers goes to zero, in this no-commitment case it ceases to exist, replaced by fighting rather than bargaining.

behind Proposition 6, the game has an equilibrium in which  $G$  makes non-serious offers less than  $r$  until period  $m$ , which are rejected by both types of rebel group. If the rebel group survives to period  $m$ , the government begins offering  $r$  in each period, which both types accept.

Algebra shows that the term in brackets is greater than 1 when

$$(\delta\beta)^m > 1 - \delta. \quad (4)$$

From (2), the condition defining  $m$ , we have that  $m$  is the integer in the interval

$$\left[ \frac{\ln A}{\ln \beta}, \frac{\ln A}{\ln \beta} + 1 \right),$$

where  $A = \frac{1-p}{p} \frac{p^*}{1-p^*}$ . (Note that  $p > p^*$  implies  $A < 1$ .) Since the left-hand side of condition (4) is a nonlinear function of  $m$ , which is in turn a nonlinear and discontinuous function of  $\beta$  and  $\delta$  through  $p^*$ , it is difficult to gain insight about when (4) holds in the general case. However, much insight can be gained by making the natural assumption that nothing stops the government from making offers in rapid succession.

As above, let the time between offers be  $\Delta$ ,  $\delta = e^{-\rho\Delta}$  where  $\rho > 0$  is the discount rate, and  $\beta = e^{-\lambda\Delta}$  where  $\lambda > 0$  is the rate at which the weak type of rebel group may be defeated. (Thus, as  $\lambda$  increases it takes less time for the government to get the same probability of defeating the rebels.  $1/\lambda$  is the expected time till a weak rebel group is defeated in a war to the finish with the government.) Let  $\sigma \equiv \pi - (g + r)$  be the surplus from not fighting for one period, that is, the costs of fighting.

**Proposition 7.** *As  $\Delta \rightarrow 0$ , condition (4) is certainly satisfied, and  $p^*$  approaches  $\rho\sigma/\lambda r$ . If  $p$  is greater than this value, then the game has an essentially unique pure strategy equilibrium in which the government offers any  $x_t < r$  for all periods  $t < m$ , and  $x_t = r$  thereafter. Both types of rebel group reject any offer less than  $r$ , and accept any offer greater than or equal to  $r$ . Off the path, if the rebel group ever accepts an offer less than  $r$ , the government assumes it faces the weak type and offers  $\hat{x}(\beta, r)$  thereafter, which a weak type accepts and a strong*

*type rejects.*

Thus if the government is at first not sufficiently convinced of the rebel group's military capability ( $p > p^*$ ), it makes non-serious offers while the two sides fight. As time passes, if the rebels survive the government increases its belief that the rebels can't be defeated militarily (or perhaps not at an acceptable cost), so that eventually the government is willing to agree to a peace settlement that the tough type of rebel group is willing to abide by. At this point the conflict ends and peace is self-enforcing, because acceptance does not signal weakness.

This result may seem puzzling at first. How can it be that as the time between offers gets small, the weak type of rebel group *necessarily* prefers to fight in hopes of surviving to get the good offer at some point in the future? Why is there no first-period offer that the weak type would accept but the strong type would reject?

The answer is that if the weak type reveals itself by accepting a lesser deal, the government will subsequently push the weak rebel group down to its reservation value for fighting. So the weak type's choice is between accepting, which gives a momentary good deal followed by a deal equivalent to its value for fighting, versus rejecting, which yields its value for fighting for a time plus some positive probability that it will get "the big prize" if it survives long enough. So, from the weak rebel group's perspective, better to fight in hopes of surviving long enough to get serious concessions than to accept a deal that is hardly better than fighting forever with no prospect of larger concessions.

War occurs in the model when the government is sufficiently optimistic about its odds of defeating the rebel group militarily ( $p > p^*$ ). Blainey (1973, chap. 3) likewise stressed optimism about military chances as the explanation for interstate wars, but he also argued that "wars usually begin when fighting nations *disagree* about their relative strength" (p. 122). By contrast, here the government's beliefs about its chances of winning by battle are correct in expectation and in fact the weak type of rebel group is pessimistic in that it knows its odds of military defeat are greater than what the government guesses. The strong type,

on the other hand, “disagrees about relative strength,” and fights to demonstrate that it is not the defeatable weak type. The weak type fights to avoid revealing itself as weak, which in anarchy can have worse consequences than it would in a domain with enforceable contracts.

The maximum duration of a conflict depends on how far and how fast the government’s belief that the rebel group is defeatable has to fall. Maximum duration – the time until  $G$  makes a serious offer – is  $m\Delta$ , which converges to  $\ln A^{-1}/\lambda$  as  $\Delta$  gets small. In words, the maximum duration is the mean duration of a purely military contest between the government and a weak rebel group,  $1/\lambda$ , increased by a factor that is the difference between the log odds of the government’s initial belief and the log odds of the belief at which the government decides to negotiate. Thus the greater the gap between  $G$ ’s initial belief  $p$  and its “pooling threshold”  $p^* = \rho\sigma/\lambda r$ , the longer the maximum duration. Maximum duration increases with  $G$ ’s belief that the rebel group is weak; decreases with per period costs of fighting; increases with the size of rebel group rents while fighting; and increases when the parties put more weight on future payoffs. Increasing  $\lambda$ , the measure of government capability to defeat the rebels, has two effects: it increases the hazard rate of military victory but also makes the government willing to fight longer before negotiating (lower  $p^*$ ). As a result maximum (and expected) duration can be an “inverse U” in  $\lambda$ .<sup>23</sup>

### 3 War duration

How much fighting before victory or a peace deal can the mechanism at work in the model imply? As noted in the introduction, standard bargaining models that can generate negotiated settlements imply no war in the normal sense if states can make offers quickly. Without wanting to put too much weight on the calibration of a model that makes many simplifying

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<sup>23</sup>Expected duration in the limiting case can be shown to be  $((1-p)\ln A^{-1} + p(1-A))/\lambda$ . Expected duration has the same comparative statics as maximum duration except that it can have an inverse-U relationship with  $p$ , the prior that  $R$  is the weak type; increasing  $p$  increases maximum duration but also increases the likelihood the conflict will be settled by victory before that time is reached. The ex ante probability that the conflict ends with a military victory is  $(p - p^*)/(1 - p^*)$ , though note that for any given conflict the hazard rate of military victory is decreasing as the war proceeds.

assumptions, I next consider whether it can generate empirically more realistic war durations than standard bargaining models using plausible parameter values.

Suppose a common discount rate of 10% per year, and consider a guerrilla-style war where the government has about a 20% chance per year of eliminating the weak type of rebel group militarily ( $\lambda = .2$ ). Let the ratio of the annual surplus from ending the conflict to the rebel group's value for the rents or other benefits it can obtain while fighting,  $\sigma/r$ , be  $1/5$ . Finally, suppose the government's initial belief is that there is a  $p = .75$  chance that the rebel group can be defeated by counterinsurgency (that is, is a weak type). Then as shown in the upper panel of Table 1, the expected duration of the conflict is almost 8 years, and it takes 16 and a half years to get to the point that the government is willing to make a serious offer that can form the basis of a stable peace. Ex ante, there is a 72% chance that the conflict ends with the government defeating the rebel group militarily, which corresponds to a 96% chance that the weak type of rebel group is defeated by force of arms.

The parameters for the lower panel are the same except that the ratio of the costs of war to what the strong type of rebel group needs each period to prefer peace has been increased to 1. Now the government prefers to make the pooling offer to gain immediate peace if it expects the weak type of rebel group to be very hard to defeat ( $\lambda = .1$ ), but otherwise the median conflict durations are unchanged and the mean and maximum durations are only somewhat reduced (reductions are larger for the more guerrilla style conflicts with low  $\lambda$ ).

As noted in the introduction, civil wars since 1945, which have mainly been guerrilla or militia-based conflicts, have seen very long median, mean, and maximum durations – 7.1, 11.1, and 52 years, by the estimates in Fearon (2004), or 3, 4.0, and 23 years using the Correlates of War (COW) civil war list for the same period. For interstate wars since 1945, the median, mean, and maximum durations according to the COW codings are .3, 1.1, and 10.2 years.<sup>24</sup>

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<sup>24</sup>From my calculations using the Correlates of War version 4.0 data (Sarkees and Wayman, 2010). The COW civil war duration estimates are smaller than those in Fearon (2004) mainly because COW's civil war

Table 1: Examples of war duration varying relative military capability

war duration in years						
$\lambda$	median	mean	maximum	P(mil victory)	$p$	$p^*$
0.1	10.99	13.09	24.85	0.69	0.75	0.2
0.2	5.49	7.73	16.48	0.72	0.75	0.1
0.5	2.2	3.62	8.55	0.74	0.75	0.04
1	1.1	1.99	4.99	0.74	0.75	0.02
2	0.55	1.09	2.85	0.75	0.75	0.01
3	0.37	0.76	2.03	0.75	0.75	0.01

$\lambda$  = annual hazard rate for military defeat of weak type of  $R$   
 $p$  = prior probability of weak type;  $p^*$  = pooling threshold  
 $\rho = .1$ ;  $\sigma/r = .2$ .

war duration in years						
$\lambda$	median	mean	maximum	P(mil victory)	$p$	$p^*$
0.1			no war		0.75	1
0.2	5.49	3.87	5.49	0.5	0.75	0.5
0.5	2.2	2.62	4.97	0.69	0.75	0.2
1	1.1	1.55	3.3	0.72	0.75	0.1
2	0.55	0.87	2.02	0.74	0.75	0.05
3	0.37	0.62	1.49	0.74	0.75	0.03

$\lambda$  = annual hazard rate for military defeat of weak type of  $R$   
 $p$  = prior probability of weak type;  $p^*$  = pooling threshold  
 $\rho = .1$ ;  $\sigma/r = 1$ .

Comparative statics of duration in the model are consistent with these broad patterns of war duration. In guerrilla wars relatively small numbers of rebel fighters avoid set-piece battles and seek to control the countryside by night, often extracting revolutionary taxes or revenues from contraband or natural resources. This military technology is well known to be hard to defeat decisively when the rebels have favorable terrain, a supportive local population, or an external patron (for example, Petraeus and Amos 2006). Low hazard rates for total military defeat (low  $\lambda$ ) and low ratios of war costs to the rents the group can extract during fighting (low  $\sigma/r$ ) are thus plausible for guerrilla wars. By contrast, in interstate warfare, large formations of costly regular troops typically meet in a smaller number of large, often extremely destructive battles, which in turn may be fairly decisive in terms of military defeat of one side or the other. Higher values for  $\lambda$  and higher values for  $\sigma/r$  are plausible for conventional conflicts between regular armies.

## 4 Extensions

The analysis so far has restricted attention to equilibria in which the government has all the bargaining power if and when the rebels' type is revealed. In this section I briefly note results for the more general case. I also show that the main findings are not changed by allowing for arbitrarily many types of rebel group.

### 4.1 Rebel bargaining power

In the model, equilibrium fighting rather than bargaining is driven in part by the weak rebel group's expectation that if it were to accept an offer that the strong type would reject, the government would push it down to a deal that is about as bad as fighting. We also saw, however, that in the infinite horizon game with complete information and no commitment, there exist subgame perfect equilibria in which the rebel group gets more each period than

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criteria require 1,000 battledeaths for each year of the conflict rather than 1,000 total over the course of a conflict.

its option value for war,  $\hat{x}(\beta, r)$ . So we should ask if giving the weak type some bargaining leverage in the complete information game would undermine fighting rather than bargaining and bring back Coasian dynamics.

Suppose that the players expect that if the government believes it faces the weak type of rebel group with certainty, both play the complete information equilibrium strategies in which the government always offers some  $x^w \in [\hat{x}(\beta, r), \bar{x}(\beta, r)]$  and the rebels always accept on the path of play.  $\bar{x}(\beta, r) = (\pi - g)(1 - \delta)/(1 - \delta\beta)$  is the maximum supportable offer for the weak type in a subgame perfect equilibrium of the complete information game; any more and the government gets less than its value for forcing a fight.

Likewise, if the government believes it faces the strong type for sure, assume that both expect to play the equilibrium in which the government always offers  $x^s \in [r, \pi - g]$  and the rebels always accept on the path of play. We make the natural assumption that  $x^s > x^w$ . That is, greater military capability translates into at least some bargaining advantage for the rebel group in any situation where military capability is known.

In an online appendix I show that for a range of  $x^w > \hat{x}(\beta, r)$  and  $x^s > r$ , “fighting rather than bargaining” will be the unique equilibrium for short enough time between offers. It is true that increasing either  $x^w$  or  $x^s$  above their minimum values can make a separating or semi-separating equilibrium possible. In fact, if  $r < x^w + x^s(1 - \beta)$  and the prior probability that the rebel group is the weak type is large enough, then the game has a separating equilibrium in which the government’s first period offer is rejected by the strong type of rebel group and accepted by the weak type, even though the government will renege on the deal in the next period. However, the case examined in section 2 is not “knife edge” in the sense that it depends on the government having all the bargaining power. What is critical is that revealing lower military capability by accepting an offer leads to some disadvantage in subsequent bargaining, as compared to being thought to be militarily stronger.

## 4.2 More continuous variation in rebel fighting ability

Do the main results in section 2 depend on the assumption that the rebel group is one of two types, either undefeatable militarily or defeatable with per-period probability greater than zero? One might suspect that if the rebel's military prospects can vary more continuously between zero and one, equilibria might appear in which the weaker types are gradually screened out by separating offers, and perhaps Coasian dynamics would reappear.

The main results generalize at least to the case of an arbitrarily large but finite set of types,  $B_0 = \{\beta_0, \beta_1, \dots, \beta_n\}$ , where  $0 < \beta_0 < \beta_1 < \dots < \beta_n = 1$ , and  $f_0(\beta) > 0$  representing the prior probability that the rebel group is type  $\beta \in B_0$ . For the game with this richer type space, the definition of an equilibrium is extended as follows. Let  $B_t \subset B_0$  be the set of types with positive support in period  $t$  of some perfect Bayesian equilibrium of the game, and let  $\bar{b}_t$  be the largest  $\beta$  in  $B_t$ . I restrict attention to perfect Bayesian equilibrium in which the government never offers more than  $\bar{x}_t \equiv \hat{x}(\bar{b}_t, r) = r(1 - \delta)/(1 - \delta\bar{b}_t)$  in  $t$  and subsequent periods. Further, for somewhat technical reasons (as discussed in Schmidt 1993) I consider equilibria in which the highest type with positive probability in period  $t$ ,  $\bar{b}_t$ , certainly accepts offers of  $x_t \geq \bar{x}_t$ .

In the on-line appendix it is shown, first, that for short enough time between offers we can always construct an equilibrium parallel to the two-type case. That is, if initial beliefs put enough weight on  $R$  being difficult to defeat, then the government offers  $x_t = r$  for all  $t$  on the path and all types of rebel group accept. If initial beliefs put enough weight on  $R$  being defeatable, then the government induces fighting by making non-serious offers. As before, the fighting lasts until a maximum time at which point the government switches to pooling on  $x_t = r$ .

Second, it is shown that in no equilibrium satisfying the above conditions (and for time between offers close enough to zero) can it be that, on the equilibrium path, the government makes an offer that is accepted by some types of rebel group and rejected by others, where

both sets have positive probability. The intuition is as follows. Suppose to the contrary that there is a set of types that accepts offer  $x_t < r$  while other types, which must at least include type  $\beta_n = 1$ , reject. Let the highest type that accepts be  $\beta' < 1$ . This type gets  $x_t + \delta \bar{x}_t / (1 - \delta)$  by accepting. But by rejecting  $\beta'$  could get at least its payoff for rejecting all subsequent offers until  $G$  shifts to pooling on  $x_s = r$ , for some  $s > t$ . As we have seen in the two-type case, for small enough time between offers type  $\beta'$  must strictly prefer to reject, as the short run benefit of  $x_t > \bar{x}_t$  pales in comparison to the chance at a permanently better deal  $r$  in the future. Thus there can be no such highest type and thus no equilibrium in which some types certainly reject and some types certainly accept an equilibrium path offer.

So the logic behind fighting rather than bargaining does not depend on assuming only two types of rebel group. Screening by offers is undermined if the strongest type that accepts a would-be screening offer anticipates that it would subsequently get its reservation value for fighting (the ratchet effect, or the cost of losing a reputation for possibly being a stronger type).

## 5 Conclusion

Several basic empirical features of interstate and civil war are hard to reconcile with standard models of bargaining, despite good reasons to conceive of war as some kind of a bargaining process. First, combatants usually declare and stick with extreme war aims that no one expects the other side to concede except after total military defeat – they choose to fight rather than to bargain in the sense of constantly formulating and exchanging serious offers. Second, both interstate and civil wars sometimes do end with negotiated settlements that are the product of exchanges of serious offers at a bargaining table, but such bargaining happens quickly and tends to come after significant periods of fighting without offers that have positive probability of acceptance in the near term. Further, historians and political scientists argue for many cases that the reason that serious bargaining can finally begin is that one or both sides have revised downwards their beliefs about the prospects of military

victory based on the accumulation of battlefield evidence.

This paper shows that introducing two natural assumptions about bargaining in the international and civil war contexts – that the parties can’t commit not to change a deal after an agreement, and that combatants have some private information about relative military capabilities – immediately yields “fighting rather bargaining” and negotiated settlements that ultimately become possible due to learning about the balance of military power. In anarchical settings, states or rebel groups can reasonably fear that accepting a deal will lead the other side to conclude that they can be pushed even further. This fear can undermine the parties’ ability to discriminate between tougher and weaker adversaries through the negotiating process, leaving fighting without making serious offers as a next best alternative for screening between types.

There are two main alternative explanations for “fighting rather than bargaining.”<sup>25</sup> First, in some models protracted fighting without serious offers is driven by a commitment problem occasioned by the fear that military power would shift against one side if it fails to fight or stops fighting (e.g., Fearon 1998, 2004; Powell 2006, 2012). Second, since Blainey (1973) a common argument has been that wars occur when the complexity of making military estimates allows two boundedly rational or otherwise biased leaderships to be mutually optimistic about their odds of winning (e.g., Wagner 2000, Smith and Stam 2004). War gradually teaches them who is right.

Both can be plausible as accounts of particular cases, and there is no reason why all three mechanisms might not operate in some mixture in the same case. Nonetheless, two empirical observations suggest that the ratchet effect problem may have added purchase beyond these existing explanations. First, as noted, both civil and interstate wars sometimes

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<sup>25</sup>Far less developed are models that would explain fighting rather than bargaining by reference to principal-agent problems in domestic politics. Goemans (2000) argues that the German government in World War I held their war aims steady or even increased them after some battlefield defeats because they expected to be deposed in a revolution if their war gains were not very large; they were “gambling for resurrection.” Some models of gambling for resurrection have been developed for decisions to go to war (e.g. Downs and Rocke 1994 and Hess and Orphanides 1995) but work extending the idea to intra-war bargaining is in its infancy.

end short of a decisive military resolution, with a negotiated settlement, whereas the shifting-power commitment problem explanation implies wars to the finish.

Second, the bounded-rationality/mutual optimism explanation predicts that combatants will *continuously* adjust their war aims and settlement offers as they update about relative military capabilities in the course of a war (Wagner, 2000; Goemans, 2000; Reiter, 2009). But states' and rebel groups' war aims in conflicts tend to be very sticky, experiencing little change until there is a sudden shift into negotiations (Iklé, 1971). A main finding of Reiter's (2009) examination of 22 "key decision" times concerning termination in six major interstate wars is that often state leaders did not change their aims or demands *at all*, or even increased them, after major battlefield setbacks. He gives "fears of adversarial non-compliance with war-ending agreements" and "the fear decision-makers sometimes have that making concessions will send signals of weakness" as two of three main reasons.<sup>26</sup>

From a normative perspective it could be useful to know whether protracted fighting due the ratchet effect or a pure commitment problem is more or less empirically common than protracted fighting due to ill-founded mutual optimism, and also how to identify one or the other in particular cases. When the problem is primarily mutual optimism, the most relevant policy intervention may be third-party provision of better military analysis in hopes of bringing expectations into accord. If the problem is the ratchet effect or the fear that bargaining power will shift for some other reason in the future, then the most relevant policy interventions may be third-party efforts to guarantee and enforce a negotiated deal.<sup>27</sup>

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<sup>26</sup>Reiter 2009, 221. His third main reason is that "leaders can be patient" and hope to turn things around in the future; this can result from "overconfidence" but also might reflect, as in the model, the weak type's incentive to hang on for the good offer even if the odds of getting it are low. Note that in Reiter's cases "fears of adversarial non-compliance" arise both due to fears of power shifts and fears of loss of reputation (as in "signals of weakness"). Pillar (1983), Iklé (1971), and Smith (1995, chapter 3) also stress fear of appearing weak as a significant barrier to serious negotiations in interstate wars.

<sup>27</sup>See, for example, Walter (2002) on third-party guarantees as an important component of civil war settlements.

## 6 Appendix

**Proof of Proposition 1** (a) These results for the commitment version follow from arguments exactly analogous to those for the buyer-seller model in which one side makes all the offers, and are omitted. For the no-commitment case, first note that in no subgame perfect equilibrium can  $R$ 's continuation payoff in any period be less than  $\hat{x}(\beta, r)/(1 - \delta)$  since  $R$  can guarantee at least this by always rejecting (and since  $r > 0$ , this is better than always accepting offers of zero). It is straightforward to check that for any  $\delta \in (0, 1)$ , the profile where  $G$  always offers  $\hat{x} = \hat{x}(\beta, r)$  and  $R$  always accepts offers at least this large and rejects otherwise is a SGP equilibrium. Note next that  $G$ 's time-averaged payoff in any SGP equilibrium is not less than

$$V_G(1 - \delta) = g(1 - \delta) + \delta(1 - \beta)\pi + \delta\beta V_G(1 - \delta) = \frac{g(1 - \delta) + \delta\pi(1 - \beta)}{1 - \delta\beta},$$

where  $V_G$  is  $G$ 's payoff if fighting occurs in every period;  $G$  guarantees at least this amount by always offering  $x_t = 0$ . Thus (from algebra) there is no equilibrium in which  $G$  offers more than  $\pi - V_G(1 - \delta) = (\pi - g)(1 - \delta)/(1 - \delta\beta) \equiv \bar{x}$  in every period.

Consider the following strategy profile:  $G$  offers  $x^* \in [\hat{x}, \bar{x}]$  in all periods  $t$ , and  $R$  accepts iff  $x_t \geq x^*$ , provided that  $R$  has never accepted an offer  $x_s < x^*$  in any period  $s < t$ . Else,  $G$  always offers  $x_t = \hat{x}$  and  $R$  accepts iff  $x_t \geq \hat{x}$ .  $R$  is thus willing to reject offers less than  $x^*$  provided that

$$r + \delta\beta \frac{x^*}{1 - \delta} \geq x^* + \delta \frac{\hat{x}}{1 - \delta}.$$

$\delta > 1/(1 + \beta)$  implies that if this inequality holds for  $x^* = \hat{x}$ , it also holds for  $x^* > \hat{x}$ , and it is easy to check that it holds for  $x^* = \bar{x}$ . Thus  $R$ 's off path threat to reject lower offers is credible when  $\delta > 1/(1 + \beta)$ .  $x^* < \bar{x}$  guarantees that  $G$  is better off offering  $x^*$  than inducing fighting for a period.

(b) Equilibrium offers are derived from backwards induction; equilibrium strategies for  $R$  follow immediately.  $G$  offers  $r$  in the last period,  $T$  (the game ends here, with no move by Nature determining a winner), and so in  $T - 1$   $G$  can demand  $x_{T-1}$  such that  $x_{T-1} + \delta r = r + \delta\beta r$ . (That is, if  $R$  accepts it gets  $r$  for sure in the next round, whereas rejecting yields a  $\beta$  chance of  $r$  in the next period.) Continuing in the same way yields

$$x_{T-i} + \delta r \frac{1 - (\delta\beta)^i}{1 - \delta\beta} = r \frac{1 - (\delta\beta)^{i-1}}{1 - \delta\beta},$$

which, with  $t = T - i$ , gives the equilibrium offer in period  $t$  as

$$x_t^{nc} = r \frac{1 - \delta + \delta^{T-t+1} \beta^{T-t} (1 - \beta)}{1 - \delta \beta}.$$

As  $T \rightarrow \infty$ ,  $x_t^{nc} \rightarrow \hat{x}(\beta, r) = r(1 - \delta)/(1 - \delta\beta)$  for any given  $t$ .

**Proof of Proposition 2** Fudenberg and Tirole (1991, Theorem 10.1) prove that as  $\delta$  approaches 1, the time until acceptance goes to zero in a buyer-seller model where the seller makes all the price offers; there are two types of buyer with valuations  $\underline{v}$  and  $\bar{v}$ ; and the seller has zero value for the good. The commitment case here can be expressed as this same buyer-seller game as follows. The government is the seller (of the good, peace) to the rebel group, which pays a price in concessions to buy it. Define

$$war_G^s = \frac{1 - \delta}{1 - \delta\beta_s} (g + \delta(1 - \beta_s) \frac{\pi}{1 - \delta}).$$

This is  $G$ 's time-averaged payoff for perpetual fighting (no agreement) with the strong type. Define the time-averaged surplus with respect to the strong type as  $\underline{v} = \pi - \hat{x}_s - war_G^s$ , and with respect to the weak type,  $\bar{v} = \pi - \hat{x}_w - war_G^s$ .  $\bar{v} > \underline{v}$  because  $\hat{x}_s > \hat{x}_w$ , and  $\underline{v} > 0$  follows from  $\pi > g + r_s$ . The price offered by  $G$  in period  $t$  is  $m_t = \pi - x_t - war_G^s$ . These affine payoff adjustments make this model equivalent to the case analyzed by Fudenberg and Tirole (see also Hart 1988 for a full specification of the equilibrium).

Since (from Theorem 10.1) for any  $p$  and  $\delta$  there is a maximum number of rounds before  $G$  offers  $\hat{x}_s$  which is accepted for sure, as the time between offers goes to zero the probability that  $R$  is not defeated militarily during the bargaining approaches one because  $\beta_i(\Delta)$  approaches one.

**Proof of Proposition 3** The proof has five steps. (1) First note that for any initial belief  $p \in (0, 1)$  we can construct a PBE in which  $G$  always offers  $\hat{x}_s = \hat{x}(\beta, r_s)$  (on the path) and both types always accept any offer  $x_t \geq \hat{x}_s$  and reject otherwise. Have  $G$  believe that if  $R$  ever accepts an offer less than  $\hat{x}_s$ ,  $R$  is certainly the weak type  $R_w$ . Then  $R_w$ 's payoff for accepting an offer  $x < \hat{x}_s$  is no greater than  $\hat{x}_s + \delta\hat{x}_w/(1 - \delta)$ , where  $\hat{x}_w = \hat{x}(\beta, r_w)$ . Algebra and the conditions  $r_s > r_w$  and  $\delta > 1/(1 + \beta)$  show this is strictly less than  $R_w$ 's payoff for rejecting,  $r_w + \delta\beta\hat{x}_s/(1 - \delta)$ . Facing certain rejection for offers less than  $\hat{x}_s$ ,  $G$  does better to stick with pooling on this offer. Next we show that there is no other PBE that meets the conditions given.

(2) In the infinite horizon game, if there is an equilibrium in which in some period  $t$   $G$  makes an offer on the path that is rejected with positive probability by at least one type of  $R$ , then for some  $p \in (0, 1)$  there is an equilibrium in which this happens in the first period,  $t = 0$ . We can simply use the belief  $p_t$  as  $p$  and the strategies from  $t$  forward as the

equilibrium of the game starting in  $t = 0$ . Thus it suffices to show that for all  $p \in (0, 1)$  there is no equilibrium in which either or both types of  $R$  reject  $x_0$  with positive probability.

(3) In no equilibrium of the infinite horizon game can  $R_s$  and  $R_w$  choose different pure strategies in response to  $x_0$ . Suppose to the contrary that, first,  $R_s$  rejects and  $R_w$  accepts  $x_0$ . For  $R_w$  to be willing to reject it must be that

$$x_0 + \delta \frac{\hat{x}_w}{1 - \delta} \geq r_w + \delta \beta \frac{\hat{x}_s}{1 - \delta}.$$

Algebra shows that if  $\delta > 1/(1 + \beta)$  then this condition holds only if  $x_0 > \hat{x}_s$ , which is not possible since then  $R_s$  prefers to accept the offer as well. (In the proposed separating profile,  $R_s$  gets  $r_s + \delta \beta \hat{x}_s (1 - \delta)$  which is less than what it could get by accepting  $x_0 > \hat{x}_s$  and then rejecting all subsequent offers.)

Nor can it be that  $R_s$  accepts for sure and  $R_w$  rejects with positive probability, since this implies that  $R_w$  gets its reservation value. If  $R_s$  is accepting,  $R_w$  must do strictly better than its reservation value to accept as well, since otherwise it would have to be that  $G$  will always offer no more than  $\hat{x}_w$  following acceptance, which implies that  $R_s$  would certainly prefer to reject.<sup>28</sup>

(4) In no equilibrium can both  $R_s$  and  $R_w$  reject  $x_0$  for sure. If they did, then by the Markov property  $p_1 = p$  so  $G$  offers  $x_1 = x_0$  again, both reject for sure, and this continues in all subsequent rounds.  $G$ 's time-averaged payoff is then (easily shown to be)

$$v_G = \frac{g(1 - \delta) + \delta(1 - \beta)\pi}{1 - \delta\beta},$$

on the path, and type  $i = s, w$  get their reservation values  $r_i/(1 - \delta\beta)$ . Both types of  $R$  would therefore definitely accept a deviation by  $G$  to  $x'_0 > \hat{x}_s$ , since even if  $G$  drew the harshest possible inference about  $R$ 's type following acceptance,  $R$ 's payoff is strictly better than under the proposed equilibrium. And  $G$  does strictly better to offer some such  $x'_0$  close enough to  $\hat{x}_s$ , since  $\pi - \hat{x}_s > v_G$  follows from algebra and  $\pi > g + r$ . So  $G$  can do better in the first period and no worse in subsequent periods by deviating.

(5) In no equilibrium does either type mix on reject and accept in the first period. Since (from (3) above) if  $R_s$  accepts an offer so does  $R_w$ , the restriction to PBEs in which  $R_s$  certainly accepts any  $x_t \geq \hat{x}_s$  implies that  $G$  can guarantee itself a time-averaged payoff of at least  $\pi - \hat{x}_s$  by always offering  $\hat{x}_s$ .<sup>29</sup> This implies that  $R_s$ 's time-averaged payoff is at

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<sup>28</sup>Note that we have used in these arguments the restriction to equilibria in which revealed type  $i$  gets  $\hat{x}_i$  in the continuation game, but not the Markov condition or the assumption that  $R_s$  must accept for sure  $x_t \geq \hat{x}_s$ .

<sup>29</sup>As noted in the text, this claim is true of any PBE in the finite horizon version of the two-type game.

most  $\hat{x}_s$ , and thus that  $R_s$  must reject any  $x_t < \hat{x}_s$  in any equilibrium meeting the conditions. Thus in no equilibrium can  $R_s$  mix. Last, we consider the remaining possibility:  $R_w$  mixes,  $R_s$  rejects? If so, it cannot be that in the next period,  $t = 1$ ,  $G$  offers  $\hat{x}_s$  and both types accept, since the Markov property implies that pooling would continue forever, and then the “no separating” result in (3) implies that  $R_w$  could not be indifferent between accept and reject in  $t = 0$ . Both types rejecting in  $t = 1$  has been ruled out by (4), and so has any mixing possibility except a repeat of  $R_w$  mixing and  $R_s$  rejecting for sure. The same argument applies for the next round and each round after that, so it would have to be that this type of mixing profile occurs in all rounds. The only way to make  $R_w$  indifferent between reject and accept in all periods is if  $G$  always offers  $\hat{x}_w$ , which of course  $R_s$  always rejects. The strategy profile implies that  $p_t$  must be strictly decreasing (by Bayes’ rule). It cannot be that  $p_t$  approaches zero, however, since if it did there is a  $p'_t > 0$  small enough such that  $G$  would do strictly better to offer  $\hat{x}_s$ , which both types accept.<sup>30</sup> If  $p_t$  does not approach zero it must be bounded away from zero, which is possible only if the limit of the probability that  $R_w$  puts on accept approaches zero as  $t$  increases.<sup>31</sup> But then the profile converges towards both types rejecting  $G$ ’s offer each period for sure, which is ruled out by the same kind of argument as in (4).

**Proof of Proposition 4** Let  $\hat{x}_w = \hat{x}(\beta, r)$  and  $\hat{x}_s = \hat{x}(1, r) = r$ . For the weak type to be willing to accept a separating offer, call it  $x_t$ , it must prefer  $x_t + \delta\hat{x}_w/(1 - \delta)$  to what it could get by rejecting the offer and mimicking the strong type, which is  $r + \delta\beta\hat{x}_s/(1 - \delta) = r + \beta\delta r/(1 - \delta)$ . Algebra leads to the condition that

$$x_t \geq r \left[ 1 + \frac{\beta\delta}{1 - \delta} - \frac{\delta}{1 - \beta\delta} \right]. \quad (5)$$

The term in brackets is greater than 1 when  $\delta > 1/(1 + \beta)$  which is true for large enough  $\delta$  and also certainly true as the time between offers,  $\Delta$ , goes to zero. Thus the same argument made in the proof of Proposition 3 (part 3) applies here.

**Proof of Proposition 5** To complete the description of proposed equilibrium strategies and beliefs: If  $G$  deviates by offering  $x_t < r$  and  $R$  accepts,  $G$  believes that  $R$  is certainly the weak type and henceforth always offers  $\hat{x}_w = \hat{x}(\beta, r)$ , which the weak type always accepts and the strong type (would) always reject. If, off the path,  $G$  offers  $x_t > r$  and  $R$  accepts,  $G$

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<sup>30</sup>To see this, note that under the mixing profile,  $G$ ’s best continuation payoff given  $p_t$  is no greater than what it would get if  $R_w$  mixed in the current round and then accepted  $\hat{x}_w$  for sure in  $t + 1$ . For small enough  $p_t$  this must be less than  $G$ ’s payoff for pooling on  $\hat{x}_s$ .

<sup>31</sup>Let  $a_t > 0$  be the probability that  $R_w$  puts on accept in period  $t$  in this proposed mixing profile. If the limit of  $a_t$  is not zero then for all positive integers  $s$ , there exists an  $\epsilon > 0$  such there exists an  $a_{t'} > \epsilon$ , where  $t' \geq s$ . By Bayes’ rule,  $p_t/(1 - p_t)$  is the product of  $p/(1 - p)$  and  $\prod_{s=0}^{t-1} 1 - a_s$ . Since there is an infinite subsequence of  $t$ ’s such that  $a_{t'} > \epsilon$ , this product is zero in the limit.

believes that  $p$  is still the probability that  $R$  is the weak type, so  $G$  returns to the equilibrium path offer as just described.

It is easy to show that when (1) holds,  $G$ 's equilibrium path payoff given the strategies above is greater than or equal to what  $G$  can get by deviating to an offer  $R$  will certainly reject for one period (the math works out the same as in the derivation of condition 1). If offered  $x_t < r$ , condition  $\delta > 1/(1 + \beta)$  guarantees that  $R_w$  prefers to mimic the strong type by rejecting the offer rather than saying yes, in which case it would get  $\hat{x}_w$  in subsequent periods by  $G$ 's strategy. Off the path, if  $G$  believes that it is certainly facing the weak type, it is sequentially rational for it to always offer  $\hat{x}_w$  and to interpret any subsequent deviations (rejections) by  $R$  as mistakes. It is clearly sequentially rational for both types of rebel group to accept any  $x_t > r$ , given that  $G$ 's beliefs will not change and it will return to offering  $r$  in the future.

**Proof of Proposition 6** (sketch) It is straightforward to check that the strategies are sequentially rational given beliefs that follow from Bayes' rule and the proposed strategies. Uniqueness (up to  $G$ 's choice of non-serious offers in the first period) follows from identical arguments as in Proposition 7 for the more general case.

**Proof of Proposition 7** (1) (Limits) Using  $\beta = e^{-\lambda\Delta}$  and  $\delta = e^{-\rho\Delta}$ , taking the the limit as  $\Delta \rightarrow 0$  shows that  $p^* \rightarrow \rho\sigma/\lambda r$ . To see that  $(\delta\beta)^m > 1 - \delta$  for small enough  $\Delta$ , note that its left-hand side is decreasing in  $m$ , so if it holds for  $m'$  equal to the least upper bound of the interval that defines  $m$ , it certainly holds for  $m$ . Taking logs we have

$$\left(\frac{\ln A}{\ln \beta} + 1\right) \ln \delta\beta > \ln(1 - \delta),$$

which can be rewritten as  $(\ln A/\lambda - \Delta)(\rho + \lambda) > \ln(1 - e^{-\rho\Delta})$ . The left-hand side approaches a finite negative limit as  $\Delta \rightarrow 0$  while the right-hand side approaches negative infinity, so the inequality certainly holds for small enough  $\Delta > 0$ .

(2) (That an equilibrium of the form described in the Proposition exists when  $p > p^*$ ) Condition (4) guarantees that for  $\Delta$  close enough to zero,  $R_w$ 's payoff for rejecting any offer  $x_t < r$  for  $t < m$  and then getting the pooling payoff starting at  $t = m$  (if it survives that long) is higher than for accepting any offer  $x_0 < r$  and subsequently getting  $\hat{x}(\beta, r)/(1 - \delta)$ . Since  $R_w$ 's payoff for waiting till period  $m$  increases as period  $m$  draws closer, it follows that the weak type prefers to reject any offer less than  $r$  in every period  $t < m$ .  $G$  thus prefers to make non-serious offers until period  $m$ , since both types of rebel group would accept  $x_t \geq r$ ,  $G$  would learn nothing, and  $p_t > p^*$  implies that  $G$  prefers a period of fighting to a period of pooling on the offer  $x_t = r$ .

(3) (Uniqueness) By the same argument as in Proposition 3 (step 3), in any equilibrium if  $R_s$  accepts an offer  $x_t$ , so does  $R_w$ . Since we have restricted attention to PBEs in which  $R_s$

certainly accepts an offer at least as great as  $r$ ,  $G$  can guarantee itself a time-averaged payoff of at least  $\pi - r$  by always offering  $r$ . Thus  $R_s$ 's equilibrium payoff is at most  $r/(1 - \delta)$ , which implies in turn that  $R_s$  will reject any offer less than  $r$ , and thus that  $R_s$  does not mix in any equilibrium.

Since from any period  $t$   $G$  can guarantee a continuation payoff of at least  $(\pi - r)/(1 - \delta)$ , in any equilibrium  $G$ 's payoff must be at least as great as what it could get by making offers that will surely be rejected by both types until the first period when  $p_t < p^*$ , after which it offers  $r$  in each period. Thus when  $p > p^*$  (and for small enough  $\Delta$ ), it cannot be an equilibrium for  $G$  to offer  $x_t = r$  (which both  $R$ 's would accept) for all  $t$  on the path, as this yields a strictly lower payoff than the former course. Uniqueness follows from steps similar to the proof of Proposition 3. We already know that condition (4) rules out any equilibrium in which one type of  $R$  accepts and the other rejects for sure on the path, and that there is no equilibrium satisfying the conditions in which  $R_s$  mixes on the path. The no-separating condition also rules out any equilibrium path in which in some period the weak type mixes in response to  $x_t < r$ , the strong type rejects, and in the next period  $G$  begins offering  $r$  each period. Nor can there be an equilibrium in which  $R_w$  mixes in every period while  $R_s$  rejects, as this would imply that there is a period  $t$  in which  $p_s < p^*$  for all  $s \geq t$ , at which point  $G$  must do better to offer  $r$  in every period (since the best  $G$  could do by offering  $x_t < r$  would be if  $R_w$  accepted, and this is less than the pooling payoff when  $p_t < p^*$ ). Thus the implied distribution on outcomes is unique in the class of PBEs that satisfy the condition that the strong type always accepts  $x_t \geq r$  (which, recall, is true of any PBE in the finite-horizon game, for any  $T$ ). Clearly, there are multiple equilibria in the sense that it is immaterial what  $G$  offers less than  $r$  in the fighting phase.

## References

- Abreu, Dilip and Faruk Gul. 2000. "Bargaining and Reputation." *Econometrica* 68(1):85–117.
- Acemoglu, Daron and James A. Robinson. 2001. "A Theory of Political Transitions." *American Economic Review* 91(4):938–63.
- Admati, Anat R. and Motty Perry. 1987. "Strategic Delay in Bargaining." *Review of Economic Studies* 54(3):345–364.
- Balfour, Michael. 1979. "The Origin of the Formula: "Unconditional Surrender" in World War II." *Armed Forces and Society* 5(2):281–301.
- Blainey, Geoffrey. 1973. *The Causes of War*. New York: Free Press.
- Blattman, Christopher and Edward Miguel. 2010. "Civil War." *Journal of Economic Literature* 48(1):3–57.
- Boehm, Christopher H. 1986. *Blood Revenge: The Enactment and Management of Conflict in Montenegro and Other Tribal Societies*. Philadelphia: University of Pennsylvania Press.
- Card, David. 1990. "Strikes and Wages: A Test of an Asymmetric Information Model." *Quarterly Journal of Economics* 105(3).
- Cho, In-Koo. 1990. "Uncertainty and Delay in Bargaining." *Review of Economic Studies* 57(4):575–95.
- Coase, Ronald H. 1972. "Durability and Monopoly." *Journal of Law and Economics* 15:143–149.
- Coe, Andrew J. 2012. "Costly Peace: A New Rationalist Explanation for War." Ms., Harvard University.
- Cramton, Peter C. 1984. "Bargaining with Incomplete Information: An Infinite-Horizon Model with Two-Sided Uncertainty." *Review of Economic Studies* 51:579–593.
- Cramton, Peter C. and Joseph S. Tracy. 1992. "Strikes and Holdouts in Wage Bargaining." *American Economic Review* 82:100–121.
- Downs, George W. and David M. Roake. 1994. "Conflict, Agency, and Gambling for Resurrection." *American Journal of Political Science* 38(2):362–80.
- Fearon, James D. 1995. "Rationalist Explanations for War." *International Organization* 49(3):379–414.
- Fearon, James D. 1998. Commitment Problems and the Spread of Ethnic Conflict. In *The International Spread of Ethnic Conflict*, ed. David A. Lake and Donald Rothchild. Princeton, NJ: Princeton University Press pp. 107–26.

- Fearon, James D. 2004. "Why Do Some Civil Wars Last So Much Longer Than Others?" *Journal of Peace Research* 41(3):275–301.
- Feinberg, Yossi and Andrzej Skrzypacz. 2005. "Uncertainty about Uncertainty and Delay in Bargaining." *Econometrica* 73(1):69–91.
- Fey, Mark, Adam Meirowitz and Kristopher W. Ramsay. 2013. "Credibility of Peaceful Agreements in Crisis Bargaining." *Political Science Research and Methods* 1(1).
- Fey, Mark and Kristopher W. Ramsay. 2006. "The Common Priors Assumption: A Comment on 'Bargaining and the Nature of War'." *Journal of Conflict Resolution* 50(4):607–13.
- Fuchs, William and Andrzej Skrzypacz. 2011. "Bargaining with Deadlines and Private Information." Unpublished manuscript, U.C. Berkeley and Stanford University.
- Fudenberg, Drew, David K. Levine and Jean Tirole. 1985. Infinite-Horizon Models of Bargaining with One-Sided Incomplete Information. In *Game Theoretic Models of Bargaining*, ed. Alvin Roth. New York: Cambridge University Press pp. 73–98.
- Fudenberg, Drew and Jean Tirole. 1991. *Game Theory*. Cambridge, MA: MIT Press.
- Goemans, Hein. 2000. *War and Punishment*. Princeton, NJ: Princeton University Press.
- Gul, Faruk, Hugo Sonnenschein and Robert Wilson. 1986. "Foundations of Dynamic Monopoly and the Coase Conjecture." *Journal of Economic Theory* 39(1):155–190.
- Hart, Oliver D. 1987. "Bargaining and Strikes." Mimeo, MIT.
- Hart, Oliver D. 1989. "Bargaining and Strikes." *Quarterly Journal of Economics* 104(1):25–43.
- Hart, Oliver D. and Jean Tirole. 1988. "Contract Renegotiation and Coasian Dynamics." *Review of Economic Studies* 40:509–40.
- Hess, Gregory D. and Athanasios Orphanides. 1995. "War Politics: An Economic, Rational-Voter Framework." *American Economic Review* 85(4):828–46.
- Hobbes, Thomas. 1651(1985). *Leviathan*. New York: Penguin.
- Iklé, Fred Charles. 1971. *Every War Must End*. New York: Columbia University Press.
- Jackson, Matthew O. and Massimo Morelli. 2011. The Reasons for War: An Updated Survey. In *Handbook on the Political Economy of War*, ed. Christopher J. Coyne and Rachel L. Mathers. Cheltenham, UK: Elgar.
- Kennan, John. 2001. "Repeated Bargaining with Persistent Private Information." *Review of Economic Studies* 68(4):719–55.

- Laffont, Jean-Jacques and Jean Tirole. 1988. "The Dynamics of Incentive Contracts." *Econometrica* 56(5):1153–1175.
- Lake, David A. 2011. "Two Cheers for Bargaining Theory: Assessing Rationalist Explanations of the Iraq War." *International Security* 35(3):7–52.
- Langlois, Jean-Pierre P. and Catherine C. Langlois. 2012. "Does the Principle of Convergence Really Hold? War, Uncertainty, and the Failure of Bargaining." *British Journal of Political Science* 42(3):511–36.
- Leventoglu, Bahar and Branislav Slantchev. 2007. "The Armed Peace: A Punctuated Equilibrium Theory of War." *American Journal of Political Science* 51(4):755–771.
- Myerson, Roger B. 1991. *Game Theory: Analysis of Conflict*. Cambridge, MA: Harvard University Press.
- Petraeus, David H. and James F. Amos. 2006. *Counterinsurgency: Field Manual 3-24*. Washington, DC: Department of the Army.
- Pillar, Paul R. 1983. *Negotiating Peace: War Termination as a Bargaining Process*. Princeton, NJ: Princeton University Press.
- Powell, Robert. 1996a. "Bargaining in the Shadow of Power." *Games and Economic Behavior* 15:255–89.
- Powell, Robert. 1996b. "Stability and the Distribution of Power." *World Politics* 48(2):239–267.
- Powell, Robert. 2002. "Bargaining Theory and International Conflict." *Annual Review of Political Science* 5:1–30.
- Powell, Robert. 2004a. "Bargaining and Learning While Fighting." *American Journal of Political Science* 48(2):344–361.
- Powell, Robert. 2004b. "The Inefficient Use of Power: Costly Conflict with Complete Information." *American Political Science Review* 98(2):231–242.
- Powell, Robert. 2006. "War as a Commitment Problem." *International Organization* 60(1):169–204.
- Powell, Robert. 2012. "Persistent Fighting and Shifting Power." *American Journal of Political Science* 56(3):620.
- Powell, Robert. 2013. "Monopolizing Violence and Consolidating Power." *Quarterly Journal of Economics* 128(2):807.
- Reiter, Dan. 2003. "Exploring the Bargaining Model of War." *Perspectives on Politics* 1(1):27–43.

- Reiter, Dan. 2009. *How Wars End*. Princeton: Princeton University Press.
- Sarkees, Meredith and Frank Wayman. 2010. *Resort to Arms: 1816-2007*. Washington, DC: CQ Press.
- Schmidt, Klaus. 1993. "Commitment through Incomplete Information in a Simple Repeated Bargaining Game." *Journal of Economic Theory* 60:114–139.
- Slantchev, Branislav L. 2003. "The Principle of Convergence in Wartime Negotiations." *American Political Science Review* 97(1):621–32.
- Smith, Alastair and Allan C. Stam. 2004. "Bargaining and the Nature of War." *Journal of Conflict Resolution* 48(6):783–813.
- Smith, James D. 1995. *Stopping Wars: Defining Obstacles to a Cease-Fire*. Boulder, CO: Westview Press.
- Wagner, R. Harrison. 2000. "Bargaining and War." *American Journal of Political Science* 44(3):469–84.
- Walter, Barbara. 2002. *Committing to Peace*. Princeton: Princeton University Press.
- Waltz, Kenneth N. 1979. *Theory of International Politics*. Reading, MA: Addison-Wesley.

## On-line appendix

### Results mentioned in 5.1

Let  $x^w \in [\hat{x}(\beta, r), \bar{x}(\beta, r)]$  where  $\bar{x}(\beta, r) = (\pi - g)(1 - \delta)/(1 - \delta\beta)$ , let  $x^s \in [r, \pi - g]$ , and suppose that  $x^s > x^w$ . Consider PBEs of the incomplete information game with types  $(\beta, r)$  and  $(1, r)$  such that if type  $i = s, w$  is revealed then in the continuation equilibrium it always receives and accepts the offer  $x^i$ .

**Proposition.** *For time between offers close enough to zero, the game with  $x^w$  and  $x^s$  as the complete information bargaining offers has an equilibrium of the same form as in Proposition 7 when the following conditions hold. Let  $p^* \equiv \rho(\pi - g - x^s)/\lambda x^s$  and let  $A = (1 - p)p^*/p(1 - p^*)$ . The conditions are that  $p > p^*$ , and*

$$r \left[ \frac{\rho}{\rho + \lambda} (1 - A^{\frac{\rho}{\lambda} + 1}) + A^{\frac{\rho}{\lambda}} \right] > x^w + x^s A^{\frac{\rho}{\lambda}} (1 - A).$$

*This condition necessarily holds for  $x^w = \hat{x}_w$  and  $x^s = r$ , so it also holds for a range of  $x^w > \hat{x}_w$  and  $x^s > r$ .*

**Proof.** An equilibrium as in Proposition 7 can be supported provided that there is no initial offer  $x_0$  that would be accepted by the weak type and rejected by the strong type if the weak type expected that the alternative to accepting was fighting until the government was willing to pool on  $x_m = x^s$ , with  $m$  as defined in the text. Formally this requires that there be no  $x_0$  such that the strong type would reject, i.e.,

$$x_0 + \frac{\delta \max\{r, x^w\}}{1 - \delta} \leq r \frac{1 - \delta^m}{1 - \delta} + x^s \frac{\delta^m}{1 - \delta},$$

but the weak type would accept, i.e.,

$$x_0 + \frac{\delta x^w}{1 - \delta} \geq r \frac{1 - \delta^m \beta^m}{1 - \delta \beta} + x^s \frac{\delta^m \beta^m}{1 - \delta}.$$

If  $x^w > r$  then there definitely exist  $x_0$  that satisfy both inequalities because the left-hand sides are then the same while the right-hand side of the first is greater than that for the second. So  $x^w < r$  is a condition for the Proposition to hold.<sup>32</sup>

Given  $x^w < r$ , there is no  $x_0$  that satisfies both if

$$r \frac{1 - \delta^m}{1 - \delta} + x^s \frac{\delta^m}{1 - \delta} - \frac{\delta r}{1 - \delta} < r \frac{1 - \delta^m \beta^m}{1 - \delta \beta} + x^s \frac{\delta^m \beta^m}{1 - \delta} - \frac{\delta x^w}{1 - \delta},$$

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<sup>32</sup>It is easy to show that when  $r < x^w + x^s(1 - \beta)$  there is a separating equilibrium when  $p > p^*$ .

which can be rewritten as

$$x^s \delta^m (1 - \beta^m) < r \left[ \frac{1 - \delta}{1 - \delta \beta} (1 - \delta^m \beta^m) + \delta^m - (1 - \delta) \right] - \delta x^w.$$

Using the same approach as for Proposition 3, we find that the threshold value of  $p_t$  such that the government is willing to pool is

$$p^* = \frac{1 - \delta \pi - g - x^s}{1 - \beta} \frac{1}{\delta x^s}.$$

Taking limits as  $\Delta$  approaches zero the limit of  $p^*$  is  $\rho(\pi - g - x^s)/\lambda x^s$ . Let  $A = (1 - p)p^*/p(1 - p^*)$  using this limiting value for  $p^*$ . Using the upper bound  $\ln A/\ln \beta + 1$  for  $m$ , some calculus further shows that

$$\lim_{\Delta \rightarrow 0} \delta^m = A^{\rho/\lambda} \quad \text{and} \quad \lim_{\Delta \rightarrow 0} \beta^m = A.$$

Then taking limits of both sides of the last inequality above yields the condition given in the Proposition. Plugging in  $x^w = \hat{x}_w$  and  $x^s = r$  and manipulating shows that this condition is definitely satisfied in that case (the case of Proposition 7), so it stays satisfied when we increase either  $x^w$  or  $x^s$  a small amount, provided that  $x^w < r$ .

## Results mentioned in 5.2

The restriction to equilibria in which type  $\bar{b}_t$  accepts  $\bar{x}_t$  for sure in period  $t$  implies that  $G$  can guarantee that  $R$  will accept an offer of  $\bar{x}_t$  for sure (lower types of  $R$  must strictly lower their payoff by rejecting, since they reveal that they are a lower type and then cannot do better than the maximum  $\bar{b}'_t$  of the set that rejects would get). The following lemma gives the condition on beliefs in period  $t$  such that  $G$  prefers pooling all types  $B_t$  on the offer  $\bar{x}_t$  to forcing a fight for a period by making a non-serious offer.

**Lemma.** *Suppose that  $G$ 's beliefs about the distribution of  $\beta$  in period  $t$  are described by  $f_t(\beta)$  on  $B_t$ . In an equilibrium,  $G$  prefers to make the pooling offer  $\bar{x}_t$ , which is accepted for sure by all types in  $B_t$ , to making a non-serious offer, when*

$$\pi > g + r \frac{1 - \delta b_{m,t}}{1 - \delta \bar{b}_t}, \quad (6)$$

where  $b_{m,t}$  is the mean of  $\beta$  using  $f_t(\beta)$ .

**Proof of Lemma.** A necessary condition for  $G$  to want to make the pooling offer in all periods from  $t$  on is that  $G$  does not get a higher payoff by deviating for a single period to a non-serious offer that would induce all types of  $R$  in the game at  $t$  to fight. The latter

course gives  $G$  the time-averaged expected payoff

$$g(1 - \delta) + \delta \sum_{\beta \in B_t} \left( (1 - \beta)\pi + \beta \left[ \pi - \frac{r(1 - \delta)}{1 - \delta \bar{b}_t} \right] \right) f_t(\beta).$$

which equals

$$g(1 - \delta) + \delta \pi - \delta \frac{r(1 - \delta)}{1 - \delta \bar{b}_t} b_{m,t},$$

where  $b_{m,t} = \sum_{\beta \in B_t} \beta f_t(\beta)$ . Algebra shows that this is less than  $G$ 's time-averaged payoff to pooling,

$$\pi - \frac{r(1 - \delta)}{1 - \delta \bar{b}_t},$$

when the condition given in the Lemma holds.

An immediate implication of the lemma is that for any ‘initial’ beliefs  $f_t(\beta)$ , after enough periods of fighting the government will prefer pooling all types of rebel group on the offer  $\bar{x}_t$  to continuing to make non-serious offers that yield fighting for sure. This is because  $b_{m,s}$  converges (in  $s$ ) to  $\bar{b}_t$  from below as fighting proceeds, which implies that the right-hand side of (6) approaches  $g + r$  from above. Since  $\pi > g + r$  by the assumption that fighting is costly, there is a finite time when the government prefers pooling on an offer to pooling on fighting.<sup>33</sup>

**Proposition 8.** *Let  $G$ 's initial beliefs about the distribution of  $\beta$  be described by  $f_0(\beta)$ . If (6) holds for  $b_{m,0}$  then the game has an equilibrium in which, on the path, the government always offers  $\bar{x}_0 = r$  and all types of rebel group accept. If the inequality in (6) is reversed, then for small enough time  $\Delta$  between offers, there exists an equilibrium in which the government makes non-serious offers  $x_t < r$  until it either defeats the rebel group or condition (6) is satisfied, at which time it switches to making the pooling offer  $r$ .*

**Proof of Proposition 8.** Complete the strategy and beliefs description as follows: In any period after any history,  $R$  rejects any  $x_t < r$  and accepts any  $x_t \geq r$ . If  $R$  ever accepts  $x_t < r$ , then  $G$  believes that  $\beta = \beta_0$  with probability one, and subsequently always offers  $x_s = r(1 - \delta)/(1 - \delta\beta_0)$ ,  $s > t$ . In this event,  $R$  always accepts if  $\beta = \beta_0$  and otherwise always rejects. If  $R$  ever gets an offer of  $x_t \geq r$ , then  $G$  assumes that all types behave the same way, so that  $f_{t+1}(\beta) = f_t(\beta)$  if  $R$  accepts and  $f_{t+1}(\beta)$  is updated using Bayes' rule if  $R$  rejects.

Now consider the case where (6) holds for  $b_{m,0}$ . The Lemma shows that  $G$  prefers to

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<sup>33</sup>Because higher types are always more likely to survive a round of fighting than lower types,  $f_s(\beta)$  converges to a ‘spike’ at  $\bar{b}_t$  as  $s$  increases ( $s > t$ ), for any initial distribution  $f_t(\beta)$ . In the particular case where all types fight from period 0 to period  $t$ , using Bayes' rule we can derive that  $f_t(\beta) = \beta^t f_0(\beta) / \sum_{b \in B} b^t f_0(b)$ .

offer  $r$  to making an offer that would induce rejection (and fighting) for sure. But would all types of  $R$  reject a lower offer,  $x_0 < r$ ? Accepting such an offer yields  $x_0 + \delta r / (1 - \delta \beta_i)$  (since subsequent offers will be rejected for all but type  $\beta_0$ ). Rejecting (and sticking with the proposed equilibrium strategy) yields  $r + \delta \beta_i r / (1 - \delta)$ . From algebra, rejecting is strictly better than accepting when

$$\delta r \left( \frac{1}{1 - \delta \beta_i} - \frac{\beta_i}{1 - \delta} \right) < r - x_t.$$

Let  $\delta = e^{-\rho \Delta}$  and  $\beta_i = e^{-\lambda_i \Delta}$ , where the distribution of types of  $R$  is now on a subset of  $\{0 = \lambda_n, \lambda_{n-1}, \dots, \lambda_0\}$ . Making substitutions and taking limits (using l'Hôpital's rule) shows that the left-hand side approaches negative infinity, while the right-hand side is positive since  $r > x_t$ . So in this case pooling on the offer  $r$  is supportable as an equilibrium.

Now consider the alternative case where the inequality (6) is reversed for  $b_{m,0}$ . Let  $t^*$  be the first period such that (6) is satisfied if all types fight in each period  $t = 0, 1, \dots$ , and note that  $t^*$  is a function of  $\Delta$ . For periods  $t \geq t^*$ , we can support pooling on the accepted offer  $x_t = r$  by the same argument as that just given for pooling at time  $t = 0$ . And we know from the Lemma that before  $t^*$ ,  $G$  prefers making an offer that will certainly be rejected to pooling  $R$  on any offer that would be accepted by all types ( $x_t \geq r$ ). But would all types of  $R$  reject a lower offer,  $x_t < r$ ? Accepting such an offer again yields  $x_t + \delta r / (1 - \delta \beta_i)$  (since subsequent offers will be rejected for all but type  $\beta_0$ ). Rejecting gives, from  $t = 0$  (which is when  $R$  would be most tempted to accept, since the “prize” for fighting is farthest away),

$$r \frac{1 - (\delta \beta_i)^{t^*}}{1 - \delta \beta_i} + (\delta \beta_i)^{t^*} \frac{r}{1 - \delta}.$$

Accept is strictly better when

$$x_0 > r \left[ \frac{1 - (\delta \beta_i)^{t^*}}{1 - \delta \beta_i} + \frac{(\delta \beta_i)^{t^*}}{1 - \delta} - \frac{\delta}{1 - \delta \beta_i} \right],$$

which parallels the condition in the two-type case. The expression in brackets is greater than 1 when

$$(\delta \beta_i)^{t^*} > 1 - \delta.$$

Taking the log of both sides and then the limits as  $\Delta \rightarrow 0$ , we find that the left-hand side is  $-t^* \Delta (\rho + \lambda)$  while the right-hand side approaches negative infinity. Since  $t^* \Delta$  is the total time fighting that it takes for  $G$ 's updated beliefs to satisfy (6),  $t^*(\Delta) \Delta$  must approach a finite limit. Therefore for small enough  $\Delta$ , any offer  $x_t < r$  will be rejected by all types for  $t < t^*$ .

So, for sufficiently optimistic initial beliefs by the government, the game with many types has a pooling equilibria exactly parallel to the two-type case, wherein the government

makes non-serious offers and fights to learn if the adversary can be defeated outright. We have not ruled out, however, the possibility that there is also a separating equilibrium in which offers are made that might be accepted or rejected, both with positive probability. The proof of Proposition 9 establishes that this cannot be so if the time between offers is sufficiently small.

**Proposition 9.** *For sufficiently small time between offers  $\Delta$ , the game with type set  $B_0$  does not have a PBE in which in  $G$  never offers more than  $\bar{x}_t$  in period  $t$ , and in which, on the path, an offer has positive probability of being accepted and positive probability of being rejected.*

**Proof of Proposition 9.** By assumption (on the type of PBE we are restricting attention to), type  $\beta_n = 1$  will never receive an offer greater than  $r$ . This implies that in any equilibrium it will always reject any offer less than  $r$ , since it can guarantee  $r$  by fighting and the only reason to accept an offer less than  $r$  would be if this could lead to an offer greater than  $r$  subsequently. Thus  $f_0(\beta_n) > 0$  implies that there is positive probability that  $G$  faces a type that will reject any offer  $x_t < r$ .

Suppose to the contrary of the Proposition that in a PBE, a positive measure of types accepts an offer in a period and a positive measure rejects. There must be a period  $t$  in which the set of types that would reject such an offer contains  $\beta_n = 1$ . Let  $\beta' < 1$  be the highest type that accepts  $x_t$ . By assumption,  $\beta'$  will not receive an offer greater than  $r(1 - \delta)/(1 - \delta\beta')$  subsequently, so its payoff for accepting is  $x_t + \delta r/(1 - \delta\beta')$ . By arguments given for Propositions 4 and 7, this cannot be optimal for small enough  $\Delta$  if there is a finite time  $s > t$  at which  $G$  will offer  $r$  from then on if  $R$  has rejected, fought, and survived up to  $s$ . So we ask now if  $G$  must eventually prefer to pool  $R$  on the offer  $r$  if all previous offers less than  $r$  have been rejected.

If not, then for every  $s \geq t$ , there is an  $s' \geq s$  such that  $G$ 's offer  $x_{s'} < r$  may be accepted or rejected, both with positive probability, after the history where  $R$  has rejected all previous offers less than  $r$ . Since  $B$  is finite, this is clearly impossible in an equilibrium where all types of  $R$  play pure strategies: continual separation of lower  $\beta$  types must lead eventually to only type  $\beta_n = 1$  remaining, at which point  $G$  offers  $r$  from then on. But could this occur in a mixed strategy equilibrium where some types  $\beta_i < 1$  mix between rejecting and accepting?

In such a separating equilibrium, at most one type of  $R$  is indifferent between accepting and rejecting  $x_t$ , which implies that ultimately (after rejections and fighting), there are at most two types remaining,  $\beta_n$  and some  $\beta_i < 1$ . But as seen in the two-type case examined earlier, given enough periods of fighting,  $f_t(\beta_i)$  must be close enough to zero that  $G$  strictly prefers to pool on  $r$ .