Fighting rather than Bargaining

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Abstract

If bargaining is understood to involve the continuous exchange of offers that have a positive chance of being accepted, then virtually all interstate and civil wars involve significant periods in which the combatants simply fight and do not bargain. Why don't they exchange serious offers in order to reduce the costs of war? I consider a model in which a government makes offers to a rebel group, and in which the government cannot commit not to revise its proposal downwards if the rebel group reveals its type by accepting an offer. I show that this "ratchet effect" can undermine the government's ability to screen "weak" types of rebel groups by making peace offers, forcing the government to use fighting to screen out weak types. In the model's equilibrium the government makes non-serious offers that neither type of rebel group will accept for a period of time. If the rebels survive this length of time, the government shifts to an offer that both types will accept and a self-enforcing peace begins.

1 Introduction

Interstate and civil wars can often see months or even years pass without either side making a serious offer for a negotiated settlement (that is, an offer that has a positive probability of being accepted). Since it is natural to think of war as a bargaining process in which the point of conflict is to induce the other side to make an acceptable offer, this fact poses a puzzle. In standard bargaining models, including those developed for the case of war, the parties are always putting serious offers on the table, and the conflict may thus end at any time. By contrast, in a great many if not all actual wars, whether civil or interstate, the leaders on both sides seem to have adopted the position "let's just fight for a while to see if we can win, or demonstrate to the other side that we must ultimately be given better terms."

In some cases, a plausible explanation for the lack of serious bargaining is that the conflict is driven by a commitment problem. The deals that both sides would prefer are for some reason unenforceable. Thus, Acemoglu and Robinson (2001) explain costly revolutions and coups by assuming that the power of rich and poor fluctuates, so 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). In the interstate context, the allies in World War II made no serious offers, instead demanding unconditional surrender from January 1943 forward. In large part this was because they did not believe that deals with Hitler would be enforceable. 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 second Gulf war.[1] In wars of "regime change" like these two interstate wars and many civil wars, bargaining is largely beside the point due to one or both side's conviction that the other can't be trusted.

While compelling for some cases, a difficulty for commitment-problem explanations of protracted conflict is that such conflicts often *do* end with negotiated settlements.[2] Further, it often appears as if this becomes possible because the combatants have learned something about the military or political situation by fighting. In a pure commitment-problem story, conflict ends only when one side defeats the other militarily, or (in principle) something exogenous occurs that renders agreements enforceable, such as third-party intervention.[3] Most interstate wars end with negotiated settlements, however, as do perhaps one third of civil wars, and not all due to third-party

[1]As did, I believe, Saddam Hussein's belief that the access necessary for an inspection regime to satisfy the U.S. administration that he was not developing weapons of mass destruction would necessarily allow the U.S. to undermine his regime, which the U.S. could not commit not to try to do (say, by revealing to his domestic adversaries that in fact he did not have WMD).

[2]The "Troubles" in Northern Ireland are just one example.

[3]But see Leventoglu and Slantchev (2005), discussed in related literature below.

guarantees (Pillar 1983; Walter 2002).

A second possible explanation for extended fighting without bargaining is that conflict occurs when one or both sides have overly optimistic expectations about their odds of winning, for reasons of bounded rationality. Fighting eventually forces expectations into line with reality. In this account, stressed by Blainey (1973), each party thinks its offers are serious while the other side's are not. By contrast, if full rationality is assumed, then parties can update about the true odds of winning based on the other side's bargaining behavior, which is a force for quick convergence and rapid settlement (Powell 2004*a*).

In this paper I show that if bargainers cannot commit not to withdraw or revise their offers after they learn that the other side is willing to accept, then an extended period of fighting without making serious offers can become the best feasible alternative.

If there is no way to commit to long-run implementation of an agreement, then it can be dangerous to accept a proposal because this can reveal that one would be willing to accept an even worse deal rather than return to war. This is called a "ratchet effect" in the literature on buyer-seller bargaining over the terms of a service or other rental good. As shown by Laffont and Tirole (1988) and Hart and Tirole (1988), it can make it impossible for a seller (say) to "screen" types of buyers with a descending series of price offers. In the economic models, the seller's best alternative given the ratchet effect is to offer a low price that will attract all types of buyer, leading to immediate settlement.

In the context of international or civil war bargaining, however, the parties have another option: to "screen" between weak and tough types of opponent *by fighting*. I consider a model in which a government makes offers to a rebel group in successive periods. The rebel group may be a strong type that cannot be eliminated militarily, or a weak type that the government can eliminate with some probability in each period of war. The government would like to be able to screen out the weak type by making a relatively tough offer that the weak type would accept but the strong type would reject. But if the weak type of rebel groups reveals itself by accepting, then the government will exploit its bargaining power and change the deal to the weak type's disadvantage. This ratchet effect turns out to prevent the government from using reactions to peace offers to learn about the rebel group's ability to fight.

However, the government still has the option of making non-serious offers that both types of rebel group will reject, forcing war and thus allowing the government to learn about the rebel group by seeing whether it can be defeated. I show that as the time between (potential) offers approaches zero, the game's pure strategy equilibrium involves the government making non-serious offers while it fights for a positive and potentially quite large amount of time. The longer the rebels manage to survive, the more the government's belief that it faces the strong type increases, rising eventually to the point that it is willing to make an offer that both types of rebel group would accept. Thus the model provides an explanation both for the fact that most or 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 or resolve.

I begin with a discussion of related literature, and then present and analyze the model. The conclusion discusses some empirical implications and possible extensions.

2 Related literature

Schelling (1966, chapter 4) stressed and developed the idea that war is a bargaining process. Wagner (2000) finds the argument in Clausewitz (1832[1976]), and proposes a Rubinstein-like alternating-offer bargaining model in which there is a constant risk that one or the other side will win outright when offers are rejected. Blainey (1973) argued that wars occur when states "disagree on their relative strength" and end when war has revealed the true balance of military power. He seems to suggest that such disagreements occur mainly for reasons of bounded rationality or nationalist emotions. Smith and Stam (2004) formalize this argument, considering a model in which fighting brings convergence in the war estimates of two states who begin with conflicting priors about their odds of success. Goemans (2000) shows how the major combatants in World

War I revised or failed to revise their war aims in light of information about relative strength as revealed on the battlefield.

In Powell (2004*a*), two states have common priors about their resolve or their ability to prevail in battle, which creates the possibility of reactions to offers revealing information about war costs or odds of winning. When the private information concerns costs for fighting, war is avoided when states can make offers rapidly; when it concerns the odds of winning all in a battle, war may occur but will not last long if the time between offers is short. Slantchev (2003) likewise has private information about odds of winning, but fighting in a period results in a finite territorial change rather than stalemate or complete collapse by one side or the other. 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.[4] In these and in Wagner (2000), the parties to conflict always make serious offers when they have a chance. In Smith and Stam (2004), 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 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. The assumption is relaxed in a set of papers that study how shifts in bargaining power may create a commitment problem that can make for costly fights (Fearon 1998; Fearon 2004; Powell 2004*b*; Acemoglu and Robinson 2001). But in this approach there is no private information and thus no role for learning in the course of conflict, which seems empirically relevant in many cases.

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. The model studied here corresponds most closely to their "rental model

[4]Neither Slantchev nor Powell formally consider what happens as the time between offers becomes short in the case of private information about odds of winning.

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 of learning the rebel group's type that is not present in the economic setting.

Muthoo (1990) considered a modification of the Rubinstein bargaining model in which a player is not committed to implement an offer she has made that has been accepted; instead, she can allow play to proceed to the next period with no deal. He shows that this makes for a multiplicity of subgame perfect equilibria supporting any division of the pie as the discount factor approaches 1. The game analyzed here differs in that the players bargain in successive periods over the division of a flow of payoffs, rather than a one-time exchange. In effect, I assume that the government can commit to implement an accepted offer within a single period, but cannot commit not to make (or implement) a different offer later. (However, I also analyze behavior in the models as the time between offers gets very small, which means that the amount of time the government is committed goes to zero.)

Leventoglu and Slantchev (2005) study a complete-information model in which large first-strike advantages at the level of battles prevent states from being able to enforce agreements. Peace may become possible after war has destroyed enough resources that the value of a successful first strike (which is assumed to give a state total victory) is low enough. This model can thus generate negotiated settlements even though a commitment problem drives war, but it makes strong assumptions about the technology of conflict. This kind of model also cannot explain cases where it seems that learning from war helped make a negotiated settlement possible.

3 The model

The government, G, and rebel group, R, interact in successive periods $t = 0, 1, 2, \ldots$. 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 $r > 0$, which is essentially for notational convenience (see footnote 7 below).

Fighting may result in the government eliminating the rebel group completely, in which case the strategic interaction ends. This occurs with probability $1 - b$. If the rebels are crushed, the government's payoff from this period looking forward is thus $g + \delta\pi/(1 - \delta)$, while the rebels get $r + 0 + 0 + \ldots = r$. With probability b the rebels survive and play proceeds to the next period.

At the outset of the game, Nature chooses whether the rebel group is a weak or strong type, where this refers to the group's probability of surviving a period of fighting. The strong type has $b = 1$, whereas the weak type has $b = \beta \in (0, 1)$. The common prior probability that the rebel group is weak is $p \in (0, 1)$. The rebel group is informed of Nature's choice; the government is not.[5]

4 Analysis

4.1 Complete information

Begin by considering the complete information case in which the government knows for sure the rebel group's type. When the rebel group is the strong type that cannot be eliminated, the model is a standard repeated game and there are multiple subgame perfect equilibria when the players are patient enough. Obviously the rebel group cannot get a time-averaged payoff of less than r each period in equilibrium, and the government cannot get less than g. However, for large enough δ we

[5]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 $r = \pi - q - c_2$, where c_i is the per-period cost of fighting. 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.

can support equilibria in which the government offers $x \in [r, \pi - g]$ each period, and on the path the rebels always accept. The trick is to have the rebels expect that if they fail to reject an offer less than x, play will revert to the subgame perfect equilibrium in which the government always offers $x_t = r$, regardless of history, and the rebels always accept any offer of at least r. Thus if the rebels accept an infinitesimally small deviation down from $x > r$, they will get $x + \frac{\delta r}{1-\delta}$ whereas if they reject this and fight for a period they get $r + \delta x/(1-\delta)$. The condition for subgame perfection is that the latter be greater than the former, which reduces to $\delta > 1/2$.

The weak type's (minmax) value for perpetual war is $V_R^{wk} = r + \beta\delta V_R^{wk} = r/(1-\beta\delta)$, and thus the lowest offer the weak type would accept every period is $\underline{x}^{wk} = (1-\delta)V_R^{wk} = (1-\delta)r/(1-\beta\delta)$. Similarly, by offering $x_t = 0$ every period the government can assure itself at least

$$V_G^{wk} = g + (1-\beta)\delta\pi/(1-\delta) + \beta\delta V_G^{wk}.$$

With algebra and an argument similar to that in the last paragraph we find that in the complete information game with the weak rebel group, there exist subgame perfect equilibria supporting any

$$x \in \left[\frac{1-\delta}{1-\beta\delta}r, \frac{1-\delta}{1-\beta\delta}(\pi - g)\right] \equiv [\underline{x}^{wk}, \bar{x}^{wk}]$$

offered every period, provided that $\delta > 1/(1+\beta)$.

Since there are multiple equilibria in both complete information cases, it is not difficult to construct multiple equilibria when there is incomplete information. For example, suppose that the players expect that if either type is revealed, the government and rebel group will coordinate on a subgame perfect equilibrium in which G offers some $x \in [r, \bar{x}^{wk}]$ in every subsequent period.[6] Since the government would then have no incentive to try to use offers or war to distinguish the two types, we can construct a perfect Bayesian equilibria in the incomplete information game that will support accepted offers of any such x in all periods on the path of play.

[6]Assuming parameters are such that $r < \bar{x}^{wk}$.

It seems much more natural, however, to select equilibria in the complete information cases such that *the weak type gets less than the strong type*. This follows, for example, if we apply the Nash bargaining solution to the set of complete information equilibria. This is an average of the upper and lower bounds of the range of feasible x's, and the range shifts down for the weak type. Alternatively, we could consider a version of the model with a finite but very long horizon; this is the approach taken by Hart and Tirole (1988) in their model of rental contracting. Subgame perfection then selects $x_t = r$ in every remaining period if R is known to be that strong type, and an $x_t < r$ in all remaining periods if R is known to be the weak type.

In the analysis that follows, I consider equilibria of the incomplete information game in which the government is assumed to have all the bargaining power whenever a type is revealed.[7]

Assumption 1. If in period t of the game the government believes that it faces the strong (weak) type for sure, then both parties expect to play a subgame perfect equilibrium in the continuation game in which the government offers $x = r$ ($x = \underline{x}^{wk}$) for all subsequent periods.

Define an *A1 equilibrium* to be a perfect Bayesian equilibrium of the game that satisfies assumption A1.

I will restrict attention to A1 equilibria in most of the analysis that follows. In section 5, I consider the extension to the more general case where we assume the players expect coordinate on complete information equilibria with offers of x^w and x^s with $x^w < x^s$, where these are respectively what the weak and strong types would get when type is known.

4.2 Conditions for no separating equilibrium

Now consider the game with incomplete information.

Proposition 1. For $\delta > 1/(1+\beta)$, there is no A1 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.

[7] If $r \leq 0$, then both the weak and strong type have the same minmax value of zero in the complete information game (attainable by accepting any offer in every period), so that giving the government all the bargaining power makes for no difference in their payoffs when types are known.

Proof. If there were such an equilibrium, then starting in the next period the government would offer $\underline{x}^{st} = r$ to the strong and $\underline{x}^{wk}$ to the weak rebel group for ever after. For the weak type to be willing to accept the offer, call it $\hat{x}$, it must prefer $\hat{x} + \delta \underline{x}^{wk}/(1-\delta)$ to what it could get by rejecting the offer and mimicking the strong type. This is $r + \beta\delta r/(1-\delta)$. Algebra leads to the condition that

$$\hat{x} \geq r \left[1 + \frac{\beta\delta}{1-\delta} - \frac{\delta}{1-\beta\delta} \right]. \tag{1}$$

As δ approaches one, the right hand side approaches infinity, so that the offer needed to induce the weak type to separate gets arbitrarily large. The intuition is that if the rebel group puts a very high value on future payoffs – or equivalently, if the amount of fighting it has to do to get to another offer by the government is very small – then it is always worth paying the cost and risk of one period of fighting to have a chance at the better payoffs that the strong type gets.

If the government has a liquidity constraint, this may already make separation infeasible. But leaving liquidity aside, a second condition must also be satisfied: the strong type of rebel group must not want to accept $\hat{x}$ and then go back to war. Note that this constraint does not arise in "one-time" bargaining over a stock, since in that case acceptance of an offer ends the strategic interaction.

Suppose there is an equilibrium in which in period t the weak type accepts $\hat{x}$ and the strong type rejects. If the strong type were to accept instead, the government would conclude that this was the weak type for sure, and offer $\underline{x}^{wk}$ in all subsequent periods, ignoring any subsequent deviations by the rebel group.[8] Thus the strong rebel group's payoff for accepting $\hat{x}$ and subsequently rejecting offers of $\underline{x}^{wk}$ would be $\hat{x} + \delta r/(1-\delta)$ as compared to the payoff it gets for rejecting $\hat{x}$, which is just $r/(1-\delta)$. Clearly the strong type is willing to reject $\hat{x}$ only if

$$\hat{x} \leq r. \tag{2}$$

[8] Somewhat implausibly. However, this is a problem with subgame perfect and/or an insufficiently rich type space.

The right-hand side of condition (1) is greater than r when

$$\delta > \frac{1}{1+\beta}, \text{ or equivalently, } \beta > \frac{1-\delta}{\delta}. \tag{3}$$

Thus when (3) is the case, there is no offer $\hat{x}$ that satisfies both (1) and (2). $\square$

In sum, when δ is large enough the government cannot use the rebel group's reaction to peace offers to "screen" the rebels by their capability to fight, and thus to reach a mutually acceptable deal favorable to the government. An offer that is 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 renege, going back to war.

Separation would be possible if the government could commit not to renege on the initial deal. With such a commitment, by accepting $\hat{x}$ the weak rebel group would get $\hat{x}$ in perpetuity, or $\hat{x}/(1-\delta)$. By rejecting the offer, a weak group gets one period of war followed by $x^{st} = r$ forever, thus $r + \beta\delta r/(1-\delta)$. This latter expression is strictly less than $r/(1-\delta)$, which is what the tough type of rebel group can assure itself by fighting. Thus the strong type has no incentive to accept $\hat{x} = r(1-\delta) + \beta\delta r$, and a separating equilibrium can work.[9] By contrast, when the government cannot commit not to revise its offer down, it can induce the weak type to accept only by making an initial offer that is large enough to attract the strong type as well.

4.3 Conditions for pooling on a high offer

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 in the model. It could be that this simply forces the government to make a peace offer that *both* types would accept (that is, to "pool" them). If supportable, the government would offer $\underline{x}^{st} = r$ in every period, leaving $\pi - r$ for itself.

[9]Of course, the government must prefer not to pool both types by offering x^{st} in every period, but this will be so if the prior that it faces the weak type, p, is below a threshold value.

However the government has another option: to fight in hopes that it can eliminate the rebel group, after which it can have all the revenues for itself. Suppose that, from the first period, the government never makes an offer that either type would accept (or that the government can simply fight without making any offer in each period). Then the government's expected payoff is

$$\begin{aligned} V_G^{war} &= p\left[g + (1-\beta)\frac{\delta\pi}{1-\delta} + \beta\delta V_G^{war}\right] + (1-p)(g + \delta V_G^{war}) \\ V_G^{war} &= \frac{g + p(1-\beta)\frac{\delta\pi}{1-\delta}}{1-\delta+p\delta(1-\beta)}. \end{aligned}$$

The government prefers the war option to pooling if $V_G^{war} > \frac{\pi - r}{1-\delta}$. Algebra shows that this is true whenever

$$p \geq \left(\frac{1-\delta}{1-\beta}\right)\left(\frac{\pi-(g+r)}{\delta r}\right) \equiv p^*. \tag{4}$$

If the initial belief p that the rebels are the weak type is lower than this threshold value, and if condition (3) holds, then the game has a perfect Bayesian equilibrium in which the government offers r in every period, and both weak and strong types always accept offers of at least r.

Proposition 2. If $p \leq p^*$ and $\delta > 1/(1+\beta)$, then the game has an A1 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. If G deviates by offering $x_t < r$ and R accepts, G believes that R is certainly the weak type and henceforth always offers $\underline{x}^{wk}$, 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 believes that p is still the probability that R is the weak type, so G returns to the equilibrium path offer as just described.

Proof: See the appendix.

This case is familiar from standard bargaining models. If it is likely enough that the other side is the tough type, it is not worth paying the cost of trying to separate the weak from the tough with a low offer that only the weak type would accept. You might as well "pool" both types on the good offer. The only notable difference here is that the alternative to pooling is not making an offer that would separate the tough and weak types of rebel group, but rather making an offer that both would reject, leading to a period of war. War becomes the separating option. If the rebels survive, G can increase its belief that they are strong type. $p \leq p^*$ means that the chance that the rebels can be eliminated is not large enough to make this course worthwhile for the government.

4.4 Separating by fighting

Now consider the more interesting case of $p > p^*$. 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 strong and weak type of rebel group "pool" on a peace offer, then the only remaining pure-strategy possibility is for G to make an offer that both types of rebel group will reject.[10]

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

$$\beta^m \frac{p}{1-p} \leq \frac{p^*}{1-p^*}. \tag{5}$$

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 2.

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 3 establishes that in this case the game has an equilibrium in which the government makes an offer in the first period that both types are *sure to reject*.

[10] 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.

Proposition 3. If conditions 3 and 4 hold and $m = 1$, then the game has an A1 equilibrium in which 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 $\underline{x}^{wk}$, which the weak type would accept and the strong type would reject.

Proof: See the appendix.

Given these parameter conditions, the government starts by making a non-serious offer, accepting war for sure in the first period. If the government fails to defeat the rebels, it makes a serious offer that is sure to be accepted and peace prevails subsequently. The government would be better off, and the rebels no worse off, if the government could commit to implementing its first-period offer in all later periods, since war is then avoided if the rebels are the weak type.[11] In a simple manner, then, this example reflects the common real-world pattern: non-serious offers while the parties fight to learn about relative strengths, followed by serious offers and a negotiated settlement.

4.5 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, $m > 1$). The nub of the problem is that 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. The weak type is willing to separate if the alternative is fighting for several periods, but if the weak type separates then the alternative is in fact one period of fighting followed by getting the good offer! And if this is the alternative then the weak type will not separate at an offer that the strong type would not want to

[11]It is easy to show that the government's payoff under commitment is higher than under no commitment. Both types of rebel groups get the same here, though they would get strictly more under commitment if assumption A1 was not giving all the surplus under complete information to the government.

mimic (that is, separating is impossible).

Suppose both types were to reject 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 easily shown to be

$$r\frac{1-\delta^m\beta^m}{1-\delta\beta} + r\frac{\delta^m\beta^m}{1-\delta}. \tag{6}$$

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, β^m.

R^{wk} prefers to accept the first offer when $x_0 + \delta\underline{x}^{wk}/(1-\delta)$ is greater than (6), 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 behind Proposition 3, 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

$$\beta > \frac{(1-\delta)^{1/m}}{\delta}. \tag{7}$$

From (5), 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 right-hand side of condition (7) is a nonlinear function of m, which is in turn a nonlinear (and discontinuous) function of β and δ through p^*, it is difficult to gain insight about when (7) holds in the general case. However, much insight can be gained by making the natural assumption that nothing stops the government, if it wants to, from making offers in rapid succession – that is, by letting δ approach 1.

Let the time between offers be Δ, and let $\delta = e^{-\rho\Delta}$, where $\rho > 0$ is the discount rate. Let $\beta = e^{-\lambda\Delta}$, where $\lambda > 0$ is the rate at which the weak type of rebel group may be defeated. (Thus, as λ increases it take 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 4. As $\Delta \to 0$, condition (7) 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 A1 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. If the rebel group ever accepts an offer less than r, the government assumes it faces the weak type and offers $\underline{x}^{wk}$ thereafter, which a weak type accepts and a strong type rejects.

Proof: See the Appendix.

So there are two scenarios. In the first ($p \leq p^*$), the government initially thinks the rebel group is likely enough to be the tough type (that is, not militarily defeatable) that it is willing to make a good offer that will be accepted straight off, with no fighting. In this case it is credible that the government will stick by the bargain because the rebel group's acceptance does not communicate weakness.

In the second ($p > p^*$), the government is not initially convinced of the rebel group's military capability, in which case the government makes non-serious offers while the two sides fight it out. 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.

This result may seem puzzling at first. In particular, how can it be that as the time between offers gets small, the weak type of rebel group *necessarily* prefers to fight it out in hopes of surviving to get to 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 renege and give the weak rebel group its reservation value for fighting. So the weak type's choice is really between accepting, which gives a momentary good deal followed by a deal equivalent to its value for fighting, versus rejecting, which gives it its value for fighting for a time plus some positive probability that it will get "the big prize" if it survives long enough. As the time between offers grow small, the government can renege more and more quickly, so that the "momentary good deal" ($\hat{x}$) becomes increasingly momentary and thus worthless. So, from the weak rebel group's perspective, it is better to fight in hopes of surviving long enough to get serious concessions than to accept a deal that is no better than fighting forever with no prospect of larger concessions.

It is not difficult to show that if the government could commit to implement any offer that the rebels accept, the amount of delay (i.e., war) in the screening equilibrium approaches zero as the government is able to make offers more and more rapidly. By contrast, with this "ratchet effect" commitment problem there can be a long and inefficient war even though there is no restriction on the rate of offers. The combination of a commitment problem and a signaling problem in this model can thus make for considerable inefficiency, as discussed a greater length below.

In more standard bargaining models of conflict, the parties are assumed to be committed to enforce any deal that they manage to agree on. In the anarchy of interstate or government-rebel relations where is no higher authority that can enforce contracts between them, this assumption is suspect. It is quite striking that weakening the assumption leads directly to the result that screening through peace offers becomes impossible, so that the parties must screen through fighting rather than bargaining. Although there may be other mechanisms at work empirically, such as irrational mutual optimism, the empirical pattern is certainly consistent with behavior in the game's equilibrium.

4.6 Comparative statics

War is avoided altogether when the government's initial belief that the rebels can be defeated in war is less than the threshold value p^*, which in effect measures how tempting it is for the government to try for a military victory (higher p^*, less tempting). Since $p^* = \rho\sigma/\lambda r$ in the continuous-time case, the government is more likely to prefer to settle at the outset

- the harder it is expected to be to eliminate the rebels by battle (smaller λ).
- the more the government discounts future payoffs (larger ρ). This is because the only reason the government fights is to gain a chance of eliminating the rebels and thus getting the whole pie at some point in the future. If the government is highly impatient, it would rather just settle right away.
- the greater the costs of fighting relative to surplus available from peace (larger σ).
- and the smaller the difference between what the government gets for eliminating the rebel group and paying them off (smaller r).

War occurs in the model when $p > p^*$, and has a maximum duration of $m\Delta$, which is approximately equal to $\Delta \ln A / \ln \beta$. Taking the limit as the time between offers approaches zero yields a maximum duration of

$$\frac{1}{\lambda} \ln \left(\frac{p}{1-p} \frac{1-p^*}{p^*} \right) = \frac{1}{\lambda} \ln \left(\frac{p}{1-p} \frac{1-\rho\sigma/\lambda r}{\rho\sigma/\lambda r} \right).$$

Expected war duration weights the maximum duration by the probability of facing a tough type, and adds the probability of facing a weak type times the expected duration against a weak type. Probability theory leads to the conclusion that the expected duration of war against a weak type is

$$\frac{1}{\lambda} \left(1 - \frac{1-p}{p} \frac{p^*}{1-p^*} \right) = \frac{1}{\lambda} \frac{p-p^*}{p(1-p^*)},$$

where $p \geq p^* = \rho\sigma/\lambda r$. Thus the ex ante expected duration of fighting is

$$(1-p)\frac{1}{\lambda} \ln \left(\frac{p}{1-p} \frac{1-p^*}{p^*} \right) + \frac{1}{\lambda} \frac{p-p^*}{1-p^*}.$$

To interpret this expression, consider first the case in which the government initially believes that the rebel group is almost certainly a weak type who can be defeated militarily ($p \approx 1$). Then the expected duration of the war is approximately $1/\lambda$, and the process follows (almost) an exponential distribution. The government and rebels fight a true "war of attrition" in which there is a constant probability that the rebel group will be defeated by military means. If the rate at which the rebels lose all (λ) is small and $p^* < 1$ because the players are very patient or have low costs for conflict, then the expected duration can be very long. The maximum duration can also be very long, but eventually, if it is reached the government will "concede" by making a serious offer that both types of rebel group would accept.

When $p \approx 1$, the game is "very close" to the complete information game in which the rebel group is known to be the weak type, and in which the unique A1 equilibrium has no war and implementation of the offer $x = \underline{x}^{wk}$ in every period. Adding an "epsilon" possibility of a strong type causes a radical change in the set of pure-strategy A1 equilibria, as we shift to a state of affairs with an extended war of attrition and considerable inefficiency.[12] The inefficiency arises from the weak type's incentive to mimic a strong type by fighting, and the inability of the government to screen out the weak type by a peace offer due to the ratchet effect.

Returning the to general case, expected war duration will tend to be longer the larger the initial gap between p, the initial belief that the rebel group is a weak type, and p^*, the threshold belief such that the government is willing to concede. The bigger this gap, the more war is needed to get to a negotiated settlement because the government's beliefs have farther to go. This gap is larger when the per-period costs of fighting are smaller, as may be the case with small peripheral insurgencies or terrorist campaigns. It is also larger if the government values future payoffs more highly (ρ smaller). And of course it is smaller if the government starts with a stronger expectation that the rebel group is defeatable.

[12] I believe the same would be true of the sets of subgame perfect and perfect Bayesian equilibria if we were to study the game with a finite but very large horizon. In that case the complete information game's unique SGPNE has the A1 form.

The comparative statics on λ, which is roughly the per-period probability that a weak rebel group can be defeated, are more complex. As λ decreases towards zero while holding the other parameters constant, the threshold belief increases and eventually equals and exceeds p. This implies that for smaller λ, either the government prefers to avoid war by conceding right at the outset, or that war will not last long because the government will quickly reach the point where it is willing to concede. Why fight if it may take a very long time to win or to learn if winning is even possible?

On the other hand, if the per-period probability of defeating a weak rebel group is high (large λ), then expected war duration is short for different reason – the government is likely to crush the rebel group militarily in short order. Other things equal, longer conflicts are most likely in the model when the per-period probability that rebels are defeated is neither very low (in which case the government concedes quickly) or very high (in which case the government probably wins at war quickly).

5 Extensions: Rebel bargaining power and mixed strategies

The analysis so far has restricted attention to equilibria in which the government is assumed to have all the bargaining power if and when the rebels' type is revealed. In this section I briefly consider the more general case, and also (what turns out to be) the related question of what equilibrium looks like when no pure-strategy equilibrium exists.

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 $x^w \in [\underline{x}^{wk}, \bar{x}^{wk}]$ and the rebels always accept on the path of play. Likewise, if the government believes it faces the strong type for sure, 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 $x^s > x^w$.

Proposition 5. 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.

Proof. See the Appendix.

Proposition 5 indicates that increasing the (complete information) bargaining power of either the strong type or the weak type may restore the possibility of screening through peace offers, other things equal. The better the deal for the weak type if it reveals itself (that is, higher x^w), the less it needs to be "paid" upfront to compensate it for the loss of bargaining power that will come from revealing its type. This favors screening because the tough type will then be less tempted to mimic the weak type and return to war. On the other hand, the better the deal expected by the strong type (higher x^s), the more tempted are both weak and strong to reject the first period offer. Because the weak type has a $1-\beta$ chance of being eliminated by fighting, it is relatively less tempted than the strong type, and thus higher x^s favors screening here.

As the time between offers approaches zero, the condition in Proposition 5 is definitely violated whenever $r > x^w$.[13] So as before (but now provided that the weak type's bargaining power is not "too" large, $r > x^w$), screening is rendered problematic by the ratchet effect. The question remains whether we can obtain a limit result similar to Proposition 4. If we drop assumption A1, when does the game have a unique equilibrium of the form of the equilibrium in Proposition 4, wherein government and rebels fight with no serious offers until the rebels are eliminated or the government decides to concede?

Proposition 6. 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 4 when the conditions stated below hold. Let $p^* \equiv \rho(\pi - g - x^s)/\lambda x^s$ and let $A = (1-p)p^*/p(1-p^*)$.

[13]Because $\beta = e^{-\lambda\Delta}$ approaches one as Δ approaches zero, and the fixed terms r, x^w, and x^s all approach zero at the same rate as flow payoffs.

The conditions are that $p > p^*$, and

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

Proof. See the Appendix.

It is not difficult to check that if one substitutes $x^s = r$ and $x^w = \rho r/(\rho+\lambda)$ (which is the limiting value of $\underline{x}^{wk}$) into the complicated inequality, it is necessarily true – this is the case considered in Proposition 4 above, using assumption A1. Nor is it difficult to see that increasing the weak type's bargaining power x^w makes it less likely the inequality will hold. It can also be shown that if we fix x^w at its lower bound of $\rho r/(\rho+\lambda)$, the inequality is satisfied for $x^s = r$ but as one increases x^s above r, it will eventually be violated (note that A depends on x^s through p^*).

So the conclusion is that the Proposition 4 equilibrium in which the rebels and government fight while the government makes non-serious offers from $t = 0$ exists if the government's bargaining power in the complete information game is sufficiently great.

It remains, however, to answer the question of what happens in the game when the complicated inequality in Proposition 6 fails (which means that there is no "pure fighting" equilibrium) but so does the inequality in Proposition 5 (which means that there is no separating equilibrium). Here the equilibrium must be in mixed strategies, and these are rather complicated even for the simple case that I now briefly describe.

Return to the assumptions of section 4, where we restricted attention to A1 equilibria (that is, the government has all the bargaining power in the repeated game once types are revealed). And suppose that parameters are such that the weak type would be willing to accept an initial offer of $x_0 = \hat{x} < r$ if the alternative was to fight for $m = 2$ periods in hopes of getting good offer. This offer is defined by

$$\hat{x} = r\left[\frac{1-\delta^2\beta^2}{1-\delta\beta} + \frac{\delta^2\beta^2}{1-\delta} - \frac{\delta}{1-\delta\beta}\right] < r,$$

and the condition on δ and β for this to hold is $\delta^2\beta^2 < 1-\delta$. Then we can construct a mixed strategy equilibrium with the following features.

The weak type of rebel group mixes in response to any $x_0 \in [\hat{x}, r)$, putting probability

$$s^* = \frac{1}{\beta}\frac{1-p}{p}\frac{p^*}{1-p^*}$$

on rejecting the offer and $1 - s^*$ on accepting. An offer greater than r would be accepted and an offer less than $\hat{x}$ would be rejected. s^* is chosen so that if the rebel group survives battle in period $t = 0$, the government's belief that it faces the weak type in $t = 1$ is p^*. This means that the government will be indifferent between pooling on $x_1 = r$ and making a non-serious offer $x_1 < r$ to induce fighting in the second period, and so is willing to mix on offering $x_1 = r$ and offering some $x_1 < r$. Let $f(x_0)$ be the probability that the government offers $x_1 < r$ such that the weak rebel group is indifferent in period $t = 0$ between accepting x_0 and rejecting.[14] The strong type rejects any offer less than r, and accepts otherwise.

On the path of play, the government offers $\hat{x}$ in $t = 0$, the weak rebel group rejects this with probability s^*, and in the next period the government offers $x_1 < r$, which both types of rebel group reject. Starting in $t = 2$ (if the offer in $t = 0$ was rejected) the government always makes the good offer $x_t = r$. So there is some chance of initial settlement followed by a period with fighting and a non-serious offer. Off the path of play, if the government offers an $x_0 > \hat{x}$ but less than r, the weak rebel group still mixes with probability s^* on rejecting, and is willing to do so because it expects that the government will concede the good offer with a certain probability in the next round. The greater the first period offer, the greater the expectation of concession in the next round. Since the government's expected payoff in the second round is independent of x_0, it does best to choose the lowest x_0 that gains a chance of acceptance in the first round, which is $\hat{x}$.

In sum, in this intermediate "zone" between separating on peace offers and separating purely by fighting, there may parameter values such that the only equilibrium involves partial separation by an initial offer followed by separation by fighting. The government makes an initial offer that may or may not be accepted by the weak type of rebel group; if it is rejected, the parties fight for one period and then settle on the good offer if the rebels survive.

[14] $f(x_0)$ is a complicated expression found by setting $x_0 + \delta \underline{x}^{wk}/(1-\delta)$ equal to the weak type's expected payoff if it rejects x_0 in the first round.

6 Discussion

Fearon (1995) drew a sharp distinction between rationalist explanations for war that rely on a commitment problem, and explanations that rely on some information asymmetry. In that paper and in Powell (1996), war was formally represented as a costly lottery on victory and defeat, an outcome that results if two states fail to agree on a peaceful division of territory. Wagner (2000) criticized this formulation, making the following observation about information-based explanations for costly conflict: It is not "war" in the standard sense unless the fighting lasts some length of time. But if states start fighting because one thought the other might have been bluffing in pre-war bargaining, then why doesn't the conflict end just as soon as it is clear that the other is actually willing to use force? If it did there would not be a "war" in the usual sense.

This is a good question. It may be extended to arguments that see fighting as explained by states' possession of private information about their ability to win, where the idea is that battles reveal this information and so allow the parties to converge on common beliefs about relative power (Blainey 1973; Goemans 2000; Slantchev 2003). Why don't we observe intense bargaining, serious offers, and a high probability of settlement after the first and each subsequent battle, since each battle should provide new information and a new basis for offers and possible settlement? Indeed, why are battles even necessary? If fighting would be driven by one or both sides having private information about its odds of winning, why can't offers in bargaining short of actual war reveal this information?

Economists will note that this same question appears in the theory of buyer-seller bargaining. The "Coase conjecture" asserts, roughly, that even if one party has private information about his or her value for the good, if the players are able to make offers very quickly, then trade will take place very quickly despite the private information.

Coasian dynamics arise from a subtle interaction between an asymmetry of information and a particular commitment problem. In Rubinstein-like economic bargaining models, including those developed for case of interstate war (Wagner 2000; Slantchev 2003; Powell 2004*a*), it is assumed that the bargainers (a) can commit to implement an agreement they reach on the "price," but that (b) they cannot commit not to make a new offer quickly after an offer is rejected. The latter undermines the bargaining power of the side making an offer, because a weak type receiving an offer pays almost no cost for mimicking a strong type by saying No. It also makes for rapid settlement, as weak or "high valuation" types are quickly screened out by increasingly generous offers.

Typically the party making an offer would like to be able to commit to make only one offer and not change it for some length of time. This would allow her to extract "surplus" from a weak type, though at the risk of costly delay (or having to fight) if the other player is a tough type. The expected outcome is then better for the party making the offer, but is inefficient compared to the case where this party cannot commit to refrain from making a new offer immediately after a previous offer is rejected (Coasian dynamics).[15]

In the international or civil war context, assumption (b) above seems plausible, though not incontestable. That is, a government is not be able to commit itself against making a new offer after a battle, or after an older offer is rejected.[16] In anarchical contexts assumption (a) seems implausible, however. It is implausible to assume that the parties can perfectly commit to implement a settlement that they agree on at a certain time.

The analysis in section 4 shows that if we drop the assumption that the parties are committed to long-run implementation of a deal simply by virtue of agreeing to it, then we rather immediately get equilibrium behavior consistent with the empirical observations of fighting rather than bargaining, and learning about the balance of power as a necessary prelude to a self-enforcing negotiated settlement. The ratchet effect short-circuits Coasian dynamics by making it impossible for the gov-

[15]The more general principle is that things that confer bargaining power on an uninformed player tend to make for inefficiency, as the uninformed player is tempted to extract rents from high valuation types by reducing the consumption of low-valuation types of informed player. See for example Bolton and Dewatripont (2005).

[16]Not incontestable because states could have reputation for honesty to protect, which might allow them to claim credibly that "we will fight till ... no matter what." (See Sartori (2005) on reputation as a way of making cheap talk informative in international disputes.) Another possibility is that leaders need to mobilize their publics for war, and that to do this effectively they need to commit themselves domestically to achieve certain war aims.

ernment to screen out weak types using a peace offer. The offer necessary to compensate a weak type for the change in the deal that will follow acceptance is large enough to attract the strong type as well, undermining screening.

In the buyer-seller context, the story ends here, with the seller's inability to commit not to change the deal reducing his bargaining power and making for an efficient outcome. The story is quite different in the international context, where states have the option of using force in hopes of unilaterally obtaining a better deal if the other side is a type that can be defeated militarily. This option can be more attractive for one side than making an offer that strong and weak types of the other side would accept, even though the war that ensues may be highly inefficient.

It should be evident from this discussion that whether and how information asymmetries give rise to costly conflict depends in subtle ways on what commitment (or contracting) technologies are available to states or governments and rebel groups. So it is not right to draw too sharp a distinction between information- and commitment-based explanations for war.

7 Conclusion

This paper proposes an explanation for two important empirical features of interstate and civil war. First, there is a nearly universal tendency for states at war and parties to civil conflict to simply fight for extended periods of time without making serious offers for a negotiated settlement. That is, it is typical to find that the announced war aims are completely incompatible and that no one sees any chance that either will accept the other's demands in the next week, or month, or even year of fighting (unless one side is militarily defeated).

Second, Blainey (1973) and many other analysts of particular wars have the strong impression that fighting reveals information to the combatants about the true balance of power or resolve, and that learning about this balance is what may ultimately make a stable negotiated settlement feasible. Most interstate wars end with negotiated settlements rather than the complete military collapse of one side, as do a much smaller proportion of civil wars.

Both facts are puzzling from the vantage point of received bargaining theory in a "full rationality" (i.e., common prior assumption) setting: Why make non-serious offers, and why can't negotiations during war reveal information about the balance of power or resolve quickly and efficiently, avoiding protracted conflict?

The explanation proposed here is that states or rebel groups can reasonably fear that accepting a deal will lead the other side to conclude that they can pushed even further in the near future. 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.

I do not claim that this explanation for fighting rather than bargaining has more empirical purchase than the other two developed arguments that can speak to the puzzle of war. These are the idea that protracted fighting without serious offers is driven by pure commitment problems (e.g., Fearon 1998, 2004; Powell 2005), and the idea that war occurs when the complexity of the task of making military estimates allows two boundedly rational leaderships to be mutually optimistic about their odds of winning (Blainey 1973, Wagner 2007, Smith and Stam 2004). These are both plausible as accounts of particular cases, and there is no reason why in reality the three different mechanisms might not appear in some mixture in the same case. Nonetheless, it might be possible to extract testable implications about expected war duration from the model here, if one could identify measures for some of the exogenous parameters.

Further, from a normative perspective it would 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. If the problem is mutual optimism, then 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 intervention may be third-party efforts to guarantee and enforce a negotiated deal.[17]

In terms of the theoretical development, one obvious next step is to try to analyze the model with a richer set of types, to see if this affects any of the main conclusions. If we start simply, adding a third type with $\beta = 0$ to the game analyzed in section 4 (that is, a type that is sure to be crushed if it tries fighting), then it is not hard to show that the government can screen this type out in the first period with an offer of $x_0 = r(1-\delta)$ and $x_t = r(1-\delta)$ subsequently if R accepts. If the first-period offer is rejected, play follows the same trajectory as described in Proposition 4 above. This suggests that with a continuum of types (e.g., $\beta \sim F[0,1]$) we might find that there is an initial period of serious offers and possible settlement followed by an extended period of fighting if no settlement was reached. But this is just a conjecture concerning work in progress.

[17] See, for example, Walter (2002) on third-party guarantees as an important component of civil war settlements. Of course, there may be other empirically important explanations for protracted conflict besides these three.

8 Appendix

Proof of Proposition 2

It is easy to show that when (4) 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 4). If offered $x_t < r$, condition (3) guarantees that R^{wk} prefers to mimic the strong type by rejecting the offer rather than saying yes, in which case it would get $\underline{x}^{wk}$ 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 $\underline{x}^{wk}$ 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 3

The strong type of rebel group assures itself r in any period in which it fights, and by G's strategy it will never be offered more than r. So it cannot be sequentially rational for R^{st} to accept any offer less than r, and there is never any reason for R^{st} to reject an offer greater than r.

If the weak type receives the offer $x_t < r$ in any period (including of course $t = 0$), its payoff for accepting would be $x_t + \delta \underline{x}^{wk}/(1-\delta)$. By condition (3), this is less than what it gets by fighting for one period and then getting the good offer r forever after.

Regarding the government, its belief that it faces the weak type in the first period, p, is large enough that it prefers fighting to pooling on r. In the second period, $p_1 \leq p^*$, so G is willing to play the pooling equilibrium described in Proposition 2, as are both types of R.

Proof of Proposition 4

Since the right hand side of condition 7 is increasing in m, if it holds for m' equal to the least upper bound of the interval that defines m, it certainly holds for m. Rewriting the condition we have

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

Using $\beta = e^{-\lambda\Delta}$ and $\delta = e^{-\rho\Delta}$ and taking logs, this can be rewritten as

$$\rho + \lambda < \frac{\ln(1-e^{-\rho\Delta})}{\ln A/\lambda - \Delta}. \tag{8}$$

The term A also depends on Δ through p^*:

$$A = \frac{1-p}{p}\frac{p^*}{1-p^*} \text{ where}$$

$$p^* = \frac{1-e^{-\rho\Delta}}{1-e^{-\lambda\Delta}}\frac{\sigma}{e^{-\rho\Delta}r} = \frac{e^{\rho\Delta}-1}{1-e^{-\lambda\Delta}}\frac{\sigma}{r}.$$

Applying l'Hôpital's rule and taking the limit of p^* as $\Delta \to 0$ yields

$$\lim_{\Delta\to 0} p^* = \frac{\rho\sigma}{\lambda r}.$$

Differentiating p^* in Δ shows that p^* decreases as Δ gets smaller, so p^* approaches its limit from above.

If $p \leq \rho\sigma/\lambda r$, then $p < p^*$ and the government is happy to play the pooling equilibrium of Proposition 2 from $t = 0$ onwards. If not, then $p > p^*$ for small enough Δ, and thus the limit of A is a positive number less than 1.

Returning to (8), notice that the numerator of the right-hand side approaches negative infinity as Δ approaches zero, while the denominator approaches a negative number since $\ln A < 0$. Thus the right-hand side approaches positive infinity, and the condition is surely satisfied for small enough Δ.

This condition guarantees that the weak type prefers to reject any offer less than r in $t = 0$, rather than the alternative of accepting and subsequently getting $\underline{x}^{wk}$. Since the weak type's payoff for waiting till period m increases as period m draws closer, it follows that for small enough Δ, the weak type prefers to reject any offer less than r in every period $t < m$. G is then willing 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 to separate through fighting to pooling on a peace offer.

Proof of Proposition 5

If there is a separating equilibrium of this form then it must be that the weak type is willing to accept an initial offer of $\hat{x}$, which is the case when

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

The strong type prefers to reject $\hat{x}$ when

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

If $x^w > r$ then the left-hand sides of both conditions are the same while the right hand side of the second condition is clearly greater than the right-hand side of the first. This implies that when $x^w > r$ there is always a range for $\hat{x}$ such that the strong type will reject it and the weak type accept. The government's best choice is

$$\hat{x} = r + \frac{\beta \delta x^s}{1-\delta} - \frac{\delta x^w}{1-\delta}.$$

If $r > x^w$ then from algebra it follows that there are $\hat{x}$'s that satisfies both conditions when $r - x^w < x^s(1-\beta)$. When this condition holds the optimal $\hat{x}$ is the same as before.

The remaining question is whether the government prefers to make the separating offer to "pooling" both types on the offer $x_t = x^s$ for all t. Calculating G's expected payoff for separating and comparing it the payoff for pooling, $(\pi - x^s)/(1-\delta)$, yields the condition

$$p > p^* \equiv \frac{\pi - g - x^s}{\pi - g - r + \frac{\delta x^s(1-\beta)}{1-\delta}}.$$

Proof of Proposition 6

An equilibrium as in Proposition 4 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 for any x_0 such that the strong type would reject, i.e.,

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

so would the weak type, i.e.,

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

The left-hand side of the first of these inequalities assumes that $r > x^w$. If this is not the case then the left-hand side of the first inequality would be the same as that of the second, since then the strong type would want to accept $x^w > r$ each period once the government mistakenly believed that it was the weak type. In that case ($x^w > r$), as shown in Proposition 5, there is always a separating equilibrium on peace offers.

Given $x^w < r$, the latter inequality will hold for all x_0 such that the first holds if and only if

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

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

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

Taking limits as Δ approaches zero we find that 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

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

Then taking limits of both sides of the last inequality above yields the condition given in Proposition 6.

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