Persistent Fighting to Forestall Adverse Shifts in the Distribution of Power*

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Abstract

Three striking features or stylized facts about both interstate and civil war are that (i) there are often periods of persistent fighting, (ii) fighting commonly ends in both negotiated settlements as well as militarily decisive outcomes, and (iii) fighting sometimes recurs. We have few if any models that exhibit all of these features along an essentially unique equilibrium path. This paper presents a simple model of state consolidation in which fighting results from an effort to forestall adverse shifts in the distribution of power. The equilibrium path of the model displays these features, and the analysis links the pattern of fighting to the way that the distribution of power shifts during the consolidation process. Fighting occurs when the underlying distribution of power is shifting rapidly and stops when this shift slows or stops. Fighting resumes if the distribution of power again begins to shift rapidly. The analysis also shows that state consolidation can occur without fighting if the process is sufficiently slow.

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War – be it civil or interstate – poses an "inefficiency puzzle." Fighting typically destroys resources, so the "pie" to be divided after the fighting begins is smaller than it was before the war. As a result, there usually are divisions of the larger pie that would have given each belligerent more than it will have after fighting. Fighting, in other words, leads to Pareto-inferior or inefficient outcomes. Why, then, do states or opposing political factions sometimes fail to reach a Pareto-superior agreement before any fighting begins and thereby avoid war?

In addition to the fact that it occurs, there are at least three other striking features or stylized facts about both interstate and civil war. The first is that fighting sometimes persists for prolonged periods. The mean duration of the 128 civil wars started between 1948 and 1999 was 11 years with a median duration of 7 years. Twenty-five percent of the conflicts lasted at least a decade, and 10% continued for more that 25 years (Fearon 2004). Interstate wars are typically much shorter than civil wars, but they too exhibit cases of prolonged fighting. The mean duration of the 104 wars fought between 1816 and 1991 was 14 months and the median was 5.6 months. Fifteen percent lasted more than 3 years and 5% went on for more than 5 years (Slantchev 2004). Since additional fighting entails additional costs, persistent fighting also poses an inefficiency puzzle. All the more puzzling is the fact that there is often no serious bargaining during these periods (Fearon 2007).

A second feature is that wars commonly end in negotiated outcomes as well as militarily decisive outcomes. About 40% of civil wars started after 1945 ended in some form of negotiated settlement rather than in military defeat for one of the sides (Hartzell and Hoddie 2007). Almost two-thirds of interstate wars ended short of a militarily decisive outcome (Slantchev 2004). How, as Leventoğlu and Slantchev (2007) ask, does fighting resolve the problem that gave rise to it the first place? How does fighting sometimes pave the way to a negotiated settlement?

Third, negotiated settlements frequently breakdown in renewed fighting. Licklider (1995) found that about half of the negotiated civil-war settlements subsequently broke down in renewed fighting. Walter (2004) reports that 22 out of 58 civil wars ending between 1948 and 1996 were followed by another war. About a third of the negotiated power-sharing agreements result in future fighting (Hartzell and Hoddie 2007). Similarly, about a third (22 out of 64 cases) of interstate cease-fires end in further fighting in Fortna's (2004) study. Individual wars and insurgencies also go through periods of quiescence and recurrent fighting. What explains patterns of persistent recurrent conflict?

We now have many studies explaining why states or opposing factions may fail to reach an agreement and decide to fight. However, most of these analyses model war as a game-ending move (e.g., Fearon 1995; Jackson and Morelli 2007; Leventoğlu and Tarar 2008; Powell 1999, 2006; Slantchev 2005) or assume that the fighting lasts only one period even if the game itself does not end (e.g., coups in Acemoglu and Robinson's (2001, 2006) models of political transition or in Padro's (2007) examination of political control in divided societies).[1] We have far fewer "costly process" models which allow for and under some circumstances exhibit persistent inefficient fighting along the equilibrium path. (Those we do have include Fearon 2007, Leventoğlu and Slantchev 2007, and Powell 2004 and are discussed further below.) We have still fewer models in which there can be and sometimes are persistent and recurrent periods of fighting along the equilibrium path. (Fearon 2004 and Yared 2009 are among the very few examples and are also discussed below.)

This paper analyzes a model of state consolidation in which two opposing factions vie for control of the spoils of the state. The essentially unique (Markov perfect) equilibrium path exhibits three broad patterns of conflict depending on the underlying parameters: consolidation without fighting, persistent fighting which may end in either a militarily decisive outcome or a negotiated settlement, and persistent recurrent fighting in which negotiated settlements subsequently breakdown in renewed fighting.

Two key ideas motivate the model. First, state consolidation often leads to a shift in the distribution of power in favor of one faction, usually the faction in control of

[1] Blattman and Miguel (2009), Powell (2002), Reiter (2003), and Walter (2009) survey this work.

the government. This shift creates a commitment problem as the faction in control of the government will be inclined to renege on any previous agreements once the state has consolidated and the now more powerful faction is in a stronger bargaining position (Fearon 1998; Walter 1997, 2002). The second motivating idea is that fighting may destabilize a state and prevent or impede consolidation. This gives an opposing faction an incentive to fight in order to forestall state consolidation and the adverse shift in the distribution of power.

The analysis of a simple stochastic game incorporating these ideas shows that the pattern of fighting is closely linked to way that the underlying distribution of power shifts during the consolidation process. Rapid shifts lead to fighting whereas the factions cut deals and are able to avoid fighting when the distribution of power is stable or shifting slowly. These deals subsequently breakdown in renewed fighting if a stable or slowly changing distribution of power begins to shift rapidly.

This formal result suggests that an important factor in understanding the observed empirical pattern of fighting in different cases is the rate at which the underlying distribution of power is changing. This result offers a theoretical account which may help to explain at least in part the patterns of conflict across different cases. To develop this account further, we highlight three broad patterns of shifting power and the patterns of fighting they induce.

In the first, the consolidation process is characterized by a slowly shifting distribution of power. If this shift is sufficiently slow, the state consolidates without fighting. The declining faction can be bought off and in this sense voluntarily gives up its arms and acquiesces to its decline. In the second, consolidation is associated with a rapid shift which then slowly levels off as the state nears complete consolidation. This pattern leads to persistent fighting which may end in a militarily decisive outcome during the period of rapid change or a negotiated settlement once the shift in power slows. There is moreover no serious bargaining during the fighting phase. Finally, if the rate at which the underlying distribution of power shifts varies during the consolidation process, there may be persistent recurrent fighting. The factions fight during periods when the distribution of power shifts rapidly, and the factions divide the spoils without fighting during periods of stability or when the distribution of power changes slowly. These broad patterns of shifting power and the associated patterns of fighting may provide a framework for empirical investigation.

The next two sections analyze a baseline model in which fighting is sure to prevent consolidation, and it only takes the state one period without fighting to consolidation. Although simple, the baseline model highlights and clarifies some of the crucial intuitions. The subsequent section characterizes the equilibria of a more general model in which fighting only impedes consolidation and complete consolidation takes multiple periods. The fifth section uses the equilibrium results to describe the patterns of fighting induced by the three patterns of consolidation. A final section relates the present analysis to existing work on conflict.

A Baseline Model

The baseline model formalizes in a very simple strategic setting the idea that persistent fighting may result from efforts to forestall state consolidation and the adverse shifts in the distribution of power that accompany it. In this setting, the faction controlling the state consolidates its position in a single period if there is no fighting during that period. Conversely, fighting is sure to prevent consolidation. (The general model relaxes both of these assumptions.)

Formally, consider a two-player, infinite-horizon stochastic game in which the faction in charge of the government, G, and a rival faction, R, vie for the social spoils. The size of the "pie" to be divided in each period is one. The factions share a common discount factor β, and each tries to maximize its sum of discounted spoils.

At the start of period t, G makes a take-it-or-leave-it offer $x_t \in [0, 1]$ which R can either accept or reject by fighting. If R ever accepts an offer and consequently there is no fighting during that period, the state consolidates and there is a once-and-for-all shift in the distribution of power in G's favor.[2]

If R accepts in period t, R and G respectively get x_t and $1 - x_t$ during that round. If the state has already consolidated (i.e., if R has accepted an earlier offer), R's acceptance ends the round and the next begins with G's offering x_{t+1}. If the state has not yet consolidated when R accepts x_t, the state consolidates, the distribution of power shifts in G's favor, the round ends, and the next begins with a new offer from G.

If R rejects an offer and fights, R and G get flow payoffs of $f_R > 0$ and $f_G > 0$ for that period, and the round can end in one of three ways: a militarily decisive outcome in favor of G, a decisive outcome in favor of R, or a stalemate. A decisive outcome ends the game with the victor getting the entire flow of future benefits and the loser getting nothing. If the fighting ends in a stalemate, the round ends with the distribution of power unchanged. An unconsolidated state remains unconsolidated, and a consolidated state remains consolidated. We assume fighting is inefficient, so $f_R + f_G < 1$. The one-period loss due to fighting is $1 - f_R - f_G$.

Let d denote the probability that the fighting ends decisively if the state is unconsolidated. The probability that a decisive outcome favors R is p, and the probability that it favors G is $1 - p$.[3] Take d' and p' to be the analogous probabilities when the state is consolidated.

State consolidation in the baseline model results in a once-and-for-all adverse shift in the distribution of power against R. To formalize this, let F_R and F'_R denote R's payoffs to fighting to the finish if the state is unconsolidated and consolidated. That is, F_R denotes R's continuation value starting from an unconsolidated state and assuming that the factions fight in every round until a decisive outcome. F'_R is R's continuation value starting from a consolidated state.

Since an unconsolidated state remains unconsolidated as long as the fighting continues, F_R satisfies the recursive relation $F_R = f_R + \beta\,[pdV + (1-d)F_R]$ where $V = 1/(1-\beta)$

2 On substantive grounds, both G and R should be able to choose to fight. To keep the model as simple as possible, we instead parameterize the game so that R always rejects an offer of $y = 0$. G therefore can always choose to fight by offering $y = 0$.

3 That is, the conditional probability that R prevails given a decisive outcome is p. The unconditional probability that R prevails is pd and similarly for G.

is the present value of the flow of benefits. The first term on the right is what R obtains in the current period during which the factions are fighting. Fighting ends the game with probability d in which case R prevails and obtains the future flow of benefits V with probability p. R loses and gets nothing with probability $1 - p$. The current round ends in stalemate with probability $1 - d$, the distribution of power remains the same, and play moves on to the next round where the states fight again and R's continuation value is F_R. Solving for F_R yields $F_R = (f_R + \beta p d V)/[1 - \beta(1 - d)]$. Similarly, F'_R satisfies $F'_R = (f_R + \beta p' d' V)/[1 - \beta(1 - d')]$ since a consolidated state remains consolidated.

Taking R's payoff to fighting to the finish as a measure of its *de facto* power (Acemoglu and Robinson 2006), the assumption that the distribution of power shifts against R when the state consolidates means $F_R > F'_R$. More precisely, d, p, d', and p' are assumed to satisfy $F_R > F'_R$.

Before specifying the factions' strategies, it is useful to note two advantages to stylizing fighting in terms of its decisiveness d and the relative distribution of power p rather than in terms of, say, the probability that G prevails π_G, the probability that R prevails π_R, and the probability of a stalemate $1 - \pi_R - \pi_G$. First and foremost, the cost or efficiency loss due to fighting turns out to play a crucial role in the equilibrium analysis, and this cost is directly related to d and independent of p. Formally, the expected length of a fight to the finish is $1/d$, and the expected cost is $(1 - f_R - f_G)/[1 - \beta(1 - d)]$. Thus, the less decisive the fighting, the longer and more costly fighting to the finish is. Moreover, the factions relative strength p has no effect on these costs. Rather, p determines how the distribution of the spoils will be divided (in expectation) in the event of a militarily decisive outcome.

The second advantage of formalizing fighting in terms of d and p is that this specification provides a natural parameterization of the costly-lottery and costly-process models of war used in recent work in international relations theory and comparative politics.[4] Costly-lottery models formalize the initial decision to fight as a game-ending move, e.g.,

[4] Powell (2002, 19-24) surveys these models. Other discussions include Powell (2004), Slantchev (2003), and Wagner (2000).

exercising an outside-option in a bargaining game. Exercising this option ends the game in a lottery where the payoffs and the probability of winning are determined by the cost of fighting and the distribution of power between the belligerents. While such models may help us understand the causes of war, they clearly are moot about intra-war dynamics. By contrast, costly-process models formalize war as a continuation game during which the players repeatedly have to decide whether to continue fighting (e.g., Fearon 2004, 2007; Leventoğlu and Slantchev 2007; Powell 2004; Yared 2009).

In the present model, the decision to fight is a game-ending move when $d = 1$. The baseline model in this case effectively reduces to what Fearon (1998) calls his "toy" model of ethnic conflict and state consolidation. When $d < 1$, the decision to fight in a given round may not end the game and the bargaining may continue in subsequent rounds. Indeed, when D is very small, fighting simply imposes costs and resembles a war of attrition.

Finally, G's strategy specifies its offer in each period as a function of the history preceding that period and whether the state is consolidated or not.[5] R's strategy specifies the offers it will accept and reject in each period as a function of the current state and the history leading up to that state. Formally, let $k = 0$ or 1 respectively denote unconsolidated and consolidated states with (d, p) and (d', p') defining the distributions of *de facto* power in those states. The state of the game at time t is $\sigma_t \in \{0, 1\}$. Also let $\phi_t \in \{0, 1\}$ be one if R fights in round t and zero if R accepts G's offer at time t. It follows that a history leading up to round t is given by $h_t = \{(\sigma_j, x_j, \phi_j)\}_{j=0}^{t-1}$ with $h_0 = \emptyset$.[6] Take H_t to be the set of all possible histories h_t. Then a strategy for G is an infinite sequence of offer functions $\{x_t\}_{t=0}^{\infty}$ such that $x_t : \{0, 1\} \times H_t \to [0, 1]$. R's strategy is an infinite sequence of acceptance functions $\{\alpha_t\}_{t=0}^{\infty}$ such that $\alpha_t(z|\sigma_t, h_t)$ is the probability

[5] At the risk of some minor ambiguity, we refer to the states of the stochastic game as well as the institutions and structures of the government as consolidated and unconsolidated states.

[6] Strictly speaking, we do not need to include the states σ_j in the definition of a history in the baseline game since σ_j is solely a function of the fighting history. That is, $\sigma_j = 0$ if $\phi_i = 1$ for all $i < j$ and $\sigma_j = 1$ otherwise. Including prior states in the history is useful when we generalize the baseline game.

R accepts $z \in [0,1]$ given any state σ_t and any history $h_t \in H_t$.

An Equilibrium with Persistent Fighting

This section does three things. First, it characterizes the Markov Perfect equilibria (MPE) of the baseline game and identifies conditions under which there is persistent fighting along the equilibrium path. Second, the analysis highlights the role and importance of the assumption that fighting forestalls an adverse shift in the distribution of power. Finally, the section examines the relation between persistent fighting and the cost of fighting.

The intuition underlying persistent fighting is straightforward. Since G makes all of the offers, it can either try to buy R off or it can choose to fighting (by making an offer R is sure to reject). In order to buy R off, G will offer just enough to leave R indifferent between fighting or not.

To determine the offers that leave R indifferent in the consolidated and unconsolidated states, observe first that G's offers x_t and R's acceptance functions α_t only depend on the current state and not on the prior history in an MPE. In light of this, let x and x' denote G's respective offers in the unconsolidated and consolidated states. Then the offer that makes R indifferent to fighting or accepting in the consolidated state satisfies $x'/(1-\beta) = F_R'$. The expression on the left is R's payoff to getting x' in every period whereas the expression on the right is R's payoff to fighting to the finish. Solving for x', the offer that is just enough to buy R off in the consolidated state is the time-average of the payoff to fighting to the finish $x' = (1-\beta)F_R'$.

To buy R off in the unconsolidated state, G's offer must satisfy $x + \beta F_R' = F_R$. The expression on the left is R's payoff to accepting x and then moving on to the consolidated state where its continuation payoff is F_R'. The expression on the right is R's continuation payoff to fighting to the finish from the unconsolidated state. Note further that we can write x as $x = F_R - \beta F_R' = F_R - F_R' + x'$. Thus in order to buy R off in the unconsolidated state, G's offer x must be larger than x' by just enough to compensate R for the the adverse shift in the distribution of power that accepting x entails.

Intuition suggests that G always prefers to buy R off rather than fight. Since fighting is costly and R is indifferent between fighting and not, whatever surplus is saved by not fighting must go to G. The prospect of pocketing this surplus makes G strictly prefer buying R off to fighting.

Although G always wants to buy R off, it may not be able to do so because it cannot offer G enough. offer enough to do so. To buy R off in the unconsolidated state, G must offer $x = F_R - \beta F'_R$. But G cannot offer more than all of today's pie ($x = 1$). Hence, R is sure to fight when the adverse shift in R's *de facto* power is too large, i.e., when $F_R - \beta F'_R > 1$. What is more, fighting in the baseline game ensures that the state is unconsolidated in the next round. Hence, G and R find themselves in the same situation in the next round, so R fights again in that round and in the round after that and so on.

Lemma 1 begins to formalize this intuition. The proofs for this and other results are in the appendix.

LEMMA 1: *The continuation game starting from the consolidated state has a unique MPE. G offers $x' = (1 - \beta)F'_R$, and R accepts all $z \geq x'$ and rejects anything less than x'.*[7]

Lemma 1 pins down what happens in all subgames starting from a consolidated state in any MPE of the baseline game. It follows that there is persistent fighting along the equilibrium path whenever $F_R - \beta F'_R > 1$. By contrast, G offers $x = F_R - \beta F'_R$ and R

[7] This is the only place where the results depend on the MPE assumption. The continuation game starting from the fully consolidated state is essentially a repeated game, and any indiviually rational outcome can be supported in equilibrium when β is sufficiently large and d' is sufficently small. The MPE assumption "selects" one of these equilibria. Once the player's continuation payoffs are defined in the consolidated state, the factions' strategies can be derived from backwards induction without any further use of the MPE assumption.

accepts in the unconsolidated state whenever $F_R - \beta F'_R < 1$.[8]

Proposition 1: *If $F_R - \beta F'_R > 1$, R fights in every round along the equilibrium path in all MPE of the baseline game.*[9] *If $F_R - \beta F'_R < 1$, G offers $x = F_R - \beta F'_R$ in the consolidated state, and R accepts any $z \geq x$ and rejects anything less.*

The condition $F_R - \beta F'_R > 1$ is sure to hold and thus there is sure to be persistent fighting if state consolidation weakens R relative to G ($p > p'$) and if the factions are sufficiently patient. To see that $F_R - \beta F'_R > 1$ holds in the limit, multiplying by $1 - \beta$ and let β go to one to obtain $\lim_{\beta \to 1}(1-\beta)(F_R - \beta F'_R) = p - p' > 0 = \lim_{\beta \to 1}(1-\beta)$.

Corollary 1: *If $p > p'$, then $F_R - \beta F'_R > 1$ and R fights in every round in every MPE if β is sufficiently large.*

Proposition 1 is the central result for the baseline game. But it raises two issues. First, the key idea motivating the baseline model and the analysis more generally is that fighting is more likely when it may forestall adverse shifts in the distribution of power. To show that this is the case, suppose instead that fighting does not forestall the adverse shift in the distribution of power. That is, the game starts out in the unconsolidated state and then consolidates in the second round whether or not R fights. If the shift in *de facto* power is sufficiently large, R still fights in the first round (but not in any subsequent round as Lemma 1 shows). However, the size of the shift needed to induce fighting is much larger than the size of the shift needed when fighting forestalls the adverse shift.

To establish this, let y be the offer that leaves R indifferent between fighting and accepting in the game where state consolidation is sure to occur. In symbols, y satisfies $y + \beta F'_R = f_R + \beta[dpV + (1-d)F'_R]$. The expression on the left is R's payoff to accepting

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[8] The fact that $F_R > F'_R$ ensures that $x > 0$ and is therefore feasible. If $F_R - \beta F'_R = 1$, R may not accept $x = F_R - \beta F'_R$ for sure, and multiple MPE exist. This contrasts with the typical equilibrium behavior in bargaining games (e.g., an ultimatium game) where a bargainer generally must accept an offer for sure even if it is indifferent. If a bargainer in those games rejects an offer with positive probability, then the other bargainer can profitably deviate from that offer by offering slightly more and buying an agreement for sure. That logic does not hold in the baseline game if $F_R - \beta F'_R = 1$ as G cannot offer slightly more than $x = 1$. The condition $F_R - \beta F'_R = 1$ is nongeneric and will be discounted.

[9] Since R is sure to reject every feasible offer, G is indifferent to all of these offers and multiple MPE exist.

y, and the expression on the right is R's payoff to fighting when offered y. Rewriting the expression on the right as $[1 - \beta(1 - d)]F_R + \beta(1 - d)F'_R$ and solving for y gives $y = [1 - \beta(1 - d)]F_R - \beta d F'_R$. Hence, R is sure to fight in the first round if G is unable to offer y, i.e., if $y > 1$ or $\Theta \equiv [1 - \beta(1 - d)]F_R - \beta d F'_R > 1$. Conversely, G buys R off and there is no fighting if $\Theta < 1$.

The requirement that $\Theta > 1$ is more demanding than the requirement needed to ensure fighting when doing so would forestall the adverse shift in the distribution of power. Observe that $F_R - \beta F'_R > \Theta$ since $\Theta = F_R - \beta F'_R - \beta(1 - d)(F_R - F'_R)$. Thus whenever $F_R - \beta F'_R > 1 > \Theta$, the shift in power is large enough to induce fighting if fighting forestalls the adverse shift in the distribution of power but not if consolidation is certain to occur.

The second issue concerns the relative cost of fighting. Note that fighting essentially becomes costless if the factions are very patient. That is, the cost of fighting as a fraction of the value of the flow of benefits goes to zero as β goes to one: $\lim_{\beta \to 1}(1 - f_R - f_G)/[V(1 - \beta(1 - d))] = 0$. Loosely, fighting is almost sure to stop in finite time as the probability that a fight to the finish lasts longer than t rounds is $(1 - d)^t$. But the cost of fighting for any finite number of rounds is negligible if the factions are very patient.

That the cost of fighting becomes vanishingly small as β goes to one raises the possibility that R's decision to fight in Corollary 1 derives from the fact that fighting is almost costless. To see that this is not the case, consider the limit of $F_R - \beta F'_R$ as β goes to one and as d and d' decrease so that R's expected payoffs to a fight to the finish relative to the total benefits, F_R/V and F'_R/V, remain constant. This ensures that the cost of fighting as a share of the total benefits $(V - F_R - F_G)/V$ also remains constant as β goes to one. As will be seen, $F_R - \beta F'_R > 1$ holds in this limit.

To evaluate this limit, let $v_R \equiv F_R/V$, and solve for d as a function of β to obtain $\widetilde{d}(\beta) \equiv [(1 - \beta)/\beta](f_R - v_R)/(v_R - p)$. Define v'_R and $\widetilde{d}'(\beta)$ analogously where $v_R > v'_R$ since $F_R > F'_R$. Now rewrite the fighting condition as $(1 - \beta)(F_R - \beta F'_R) > 1 - \beta$ which is equivalent to $v_R - \beta v'_R > 1 - \beta$. Letting β go to one and d and d' vary according to $\widetilde{d}(\beta)$ and $\widetilde{d}'(\beta)$ give $v_R - v'_R > 0$. Hence, R is sure to fight in all MPE if the factions are sufficiently patient and the relative cost of fighting remains constant.

COROLLARY 2: *Let d and d' vary with β so that F_R/V and F'_R/V remain constant as $\beta \to 1$. Then $F_R - \beta F'_R > 1$ and R fights in every round in every MPE if β is sufficiently large.*

In sum, the baseline model exhibits persistent fighting. But it is a fight to the finish. There is never a negotiated settlement. The next section describes a more general model in which persistent fighting may end in a negotiated settlement.

A More General Model

This section generalizes the baseline model in two ways. Complete consolidation now requires multiple periods without fighting rather than the single period assumed in the baseline model. Fighting in the general model also makes consolidation less likely but is not sure to prevent it. The main result is that the pattern of fighting turns out to be closely linked to the way that the distribution of power shifts during the consolidation process. The factions fight when the distribution of power is shifting rapidly; the factions negotiate agreements and avoid fighting when the distribution of power is either completely stable or slowly changing. These agreements subsequently breakdown in renewed fighting if the distribution of power begins to change rapidly again.

Suppose that there are $N + 1$ states where each state is defined by the decisiveness of fighting and the conditional probability R prevails (d_k, p_k) for $k = 0, .., N$. The game begins in state 0 with G's making a proposal which R can accept or reject by fighting. If R accepts, the next round begins in state 1. If R fights, the game ends with probability d_0. If the game continues, there is some chance that the state will consolidate even though R fought. More precisely, the game remains in state 0 with probability $1 - \varepsilon$ and transitions to state 1 with probability ε.

More generally, if R accepts an offer in $k < N$, the game moves to state $k + 1$ with probability one. If R fights in k, the game ends with probability d_k, moves to $k + 1$ with probability $\varepsilon(1 - d_k)$, and remains in k with probability $(1 - \varepsilon)(1 - d_k)$. Once play reaches N, the state is fully consolidated and the distribution of power remains at (d_N, p_N).

The sequence of states $P = \{(d_k, p_k)\}_{k=0}^{N}$ defines the pattern of shifting power associated with state consolidation. More precisely, P defines the way that the underlying distribution of power would shift if the factions did not fight. The present analysis assumes this to be exogenous. An obvious task for future work is to endogenize it.

As in the baseline model, R's payoff to fighting to the finish plays a critical role in characterizing the MPE. Let F_R^k denote R's payoff in the continuation game starting from state k given that R fights in every round. Since the distribution of power remains constant once play reaches N, the expression for F_R^N parallels that for F_R' in the baseline game and is given by $F_R^N = (f_R + \beta d_N p_N V)/[1 - \beta(1 - d_N)]$. The continuation value F_R^k for $0 \leq k < N$ satisfies the recursive relation $F_R^k = f_R + \beta[d_k p_k V + (1 - d_k)[(1 - \varepsilon)F_R^k + \varepsilon F_R^{k+1}]]$. The expression on the right is the flow payoff from fighting in the current period plus the discounted payoff to prevailing with probability $d_k p_k$ plus the discounted continuation payoff of remaining in state k with probability $(1 - d_k)(1 - \varepsilon)$ plus the discounted continuation value of being in state $k+1$ with probability $\varepsilon(1 - d_k)$. Solving for F_R^k gives

$$F_R^k = \frac{f_R + \beta d_k p_k V + \varepsilon\beta(1 - d_k)F_R^{k+1}}{1 - \beta(1 - d_k)(1 - \varepsilon)}. \tag{1}$$

We assume $F_R^k - \beta F_R^{k+1} > 0$ and $F_R^k - \beta F_R^{k+1} \neq 1$ for all k. As will be seen below, the substantive import of the weak inequality $F_R^k - \beta F_R^{k+1} \geq 0$ is that R is never so much stronger in $k+1$ that it would be willing to pay a tax to G in k in order to avoid fighting in that period. Taking the inequality to be strict ensures that there are feasible offers strictly less than $F_R^k - \beta F_R^{k+1}$ and consequently that G can always choose to fight by offering $y = 0$ (see footnote 2). Excluding the nongeneric situation in which $F_R^k - \beta F_R^{k+1} = 1$ eliminates cases in which R might mix in equilibrium when offered $y = F_R^k - \beta F_R^{k+1}$ (see footnote 8).

Assumption 1: *$F_R^k - \beta F_R^{k+1} > 0$ and $F_R^k - \beta F_R^{k+1} \neq 1$ for all k.*

Lemma 1 holds in the general game as well as in the baseline game. That is, G buys R off and obtains the continuation payoff $V - F_R^N$ in any MPE as soon as play reaches N. In light of this it is useful to define G's payoff to fighting to the finish from k as its payoff to fighting until the consolidation process finishes, i.e., from k until N, at which point G buys R off. This leaves $F_G^N = V - F_R^N$. For $k < N$, $F_G^k = f_G + \beta[d_k(1-p_k)V + (1-d_k)[(1-\varepsilon)F_G^k + \varepsilon F_G^{k+1}]]$ which yields $F_G^k = [f_G + \beta d_k(1-p_k)V + \varepsilon\beta(1-d_k)F_G^{k+1}]/[1-\beta(1-d_k)(1-\varepsilon)]$. Accordingly, $V - F_R^k - F_G^k$ is the total cost of fighting from k until the state fully consolidates at N.

Describing the MPE is now straightforward. Fix an MPE, and let V_R^k and V_G^k denote the factions' equilibrium payoffs conditional on being in k. Define $\widetilde{x}_k$ to be the offer that leaves R indifferent between fighting and accepting. That is, $\widetilde{x}_k$ satisfies $\widetilde{x}_k + \beta V_R^{k+1} = f_R + \beta[d_k p_k V + (1-d_k)[(1-\varepsilon)V_R^k + \varepsilon V_R^{k+1}]]$. Subgame perfection implies that R strictly prefers accepting any $y > \widetilde{x}_k$ and strictly prefers fighting to any $y < \widetilde{x}_k$.

It follows that R's continuation value at k is its payoff to fighting to the finish, i.e., $V_R^k = F_R^k$, which in turn implies that $\widetilde{x}_k = F_R^k - \beta F_R^{k+1}$. The key intuition behind this carries over from the baseline game. In every state k, G either holds R down to its reservation value by offering $\widetilde{x}_k$ or R fights. Either way R gets the same payoff, namely the certainty equivalent of fighting.

To demonstrate this somewhat more formally, suppose play is in state $N-1$. Because R accepts any $y > \widetilde{x}_{N-1}$, G never offers more than $\widetilde{x}_{N-1}$. (If G did propose a $y > \widetilde{x}_{N-1}$ in equilibrium, then G could profitably deviate to the lower offer $(y+\widetilde{x}_{N-1})/2$ which R would also accept.[10]) If G proposes $y < \widetilde{x}_{N-1}$ in equilibrium, R fights. If G proposes $y = \widetilde{x}_{N-1}$, R is indifferent between accepting and fighting. Thus R's equilibrium continuation value satisfies $V_R^{N-1} = f_R + \beta[d_k p_k V + (1-d_k)[(1-\varepsilon)V_R^{N-1} + \varepsilon F_R^N]]$ where, recall, $V_R^N = F_R^N$. Solving for V_R^{N-1} and using Eq (1) gives $V_R^{N-1} = F_R^{N-1}$.

Similarly, G never proposes more than $\widetilde{x}_{N-2}$ in $N-2$. As a result, R's continuation payoff is what it would get if it fought in $N-2$, i.e., $V_R^{N-2} = f_R + \beta[d_k p_k V + (1-d_k)[(1-\varepsilon)V_R^{N-2} + \varepsilon V_R^{N-1}]]$. Solving for V_R^{N-2} using $V_R^{N-1} = F_R^{N-1}$ gives $V_R^{N-2} = F_R^{N-2}$. Repeating this argument leaves $V_R^k = F_R^k$ and, consequently, $\widetilde{x}_k = F_R^k - \beta F_R^{k+1}$.

Now consider G's decision and suppose that $\widetilde{x}_k$ is feasible, i.e., $\widetilde{x}_k \in (0,1)$, so that G

[10] The assumption that $F_R^k - \beta F_R^{k+1} > 0$ ensures that $(y + \widetilde{x}_{N-1})/2 > 0$ and is therefore feasible.

can buy R off if it wants to. As in the baseline game, the surplus saved by not fighting goes to G since R's equilibrium payoff is its reservation value of fighting ($V_R^k = F_R^k$). As a result, G will act at k in the way that minimizes the total cost of fighting and thereby maximizes the surplus.

However, minimizing the losses due to fighting is somewhat more subtle when consolidation takes multiple periods ($N \geq 2$) than in the baseline game where consolidation takes a single period. In the baseline game, minimizing the total cost of fighting meant that G always wanted to buy R off in the unconsolidated state. Doing so would avoid any losses to fighting in that state, and play would then move on to the fully consolidated state where Lemma 1 ensures that there would be no further fighting and no additional losses. Hence buying R off in the unconsolidated state of the baseline game necessarily minimized the total cost of fighting by holding that total down to zero.

By contrast, minimizing the total cost of fighting in the more general game may mean fighting in the current state. Suppose for example that G can buy R off in k and that fighting is very decisive in that state ($d_k \approx 1$). But, assume further that G will not be able to buy R off in $k+1$ because $\widetilde{x}_{k+1} > 1$ and that fighting is quite indecisive there ($d_{k+1} \ll 1$). In these circumstances, G will fight in k in order to minimize the total cost of fighting to the finish. To see why, note that because fighting is very decisive in k, the game is very likely to end if G fights and, consequently, the expected loss to fighting will be close to the cost of fighting for a single period. If by contrast G buys R off in k, play moves on to $k+1$ where G is unable to buy R off. Fighting moreover is now unlikely to be decisive. As a result, the expected losses will be larger than the cost of fighting for a single period. Thus minimizing the total losses due to fighting may mean fighting in the current state if fighting becomes significantly less decisive in future states.

To make this argument more formal, let W_G^k be G's payoff to fighting in k and then playing according to the MPE from $k+1$ on. That is, $W_G^k = f_G + \beta[f_G + d_k(1-p_k)V + (1-d_k)[(1-\varepsilon)W_G^k + \varepsilon V_G^{k+1}]]$. G's payoff to buying R off in k and then playing according to the MPE from $k+1$ on is $1 - \widetilde{x}_k + \beta V_G^{k+1}$. Hence, G prefers to fight rather than buy R off in k when $W_G^k > 1 - \widetilde{x}_k + \beta V_G^{k+1}$ and prefers buying R off when this inequality is reversed.

To see that G acts in the way that minimizes the total cost of fighting, substitute $V = 1/(1-\beta)$ and $\widetilde{x}_k = F_R^k - \beta F_R^{k+1}$ in the previous inequality to obtain $W_G^k > (1-\beta)V - (F_R^k - \beta F_R^{k+1}) + \beta V_G^{k+1}$. Using the fact that $V_R^j = F_R^j$ and rearranging terms now shows that G prefers to fight R off when $\beta(V - V_G^{k+1} - V_R^{k+1}) > V - W_G^k - V_R^k$. The expression on right is the total surplus V less the actors' continuation values if they fighting in k and then play according to the MPE for the rest of the game. Or, equivalently, the expression on the right is the amount destroyed by fighting given that G fights at k and then follows its MPE strategy from $k+1$ on. As for the expression on the left, none of the surplus is destroyed in k if G buys R off. Consequently, the expression on the left is the total surplus destroyed by fighting given that G buys R off in k and then follows its MPE strategy from $k+1$ on. Thus G fights in k when doing so minimizes the total surplus destroyed by fighting and buys R off when that minimizes the total loss.[11]

Note further that the prospect of future fighting makes fighting more likely today. That is, the more fighting there is in the future, the larger the future losses and the less decisive fighting today has to be in order to induce G to fight today. To establish this, use $V_R^j = F_R^j$ and Eq (1) to rewrite the condition ensuring that G fights as $1 - f_R - f_G < \beta[1 - (1-d_k)[\varepsilon + \beta(1-\varepsilon)]]\left(V - V_G^{k+1} - F_R^{k+1}\right)$. The factor in brackets on the right is positive, so the smaller G's future payoff V_G^{k+1}, the larger the expression on the right and the easier it is to satisfy the inequality. And, the more often the factions fight as play moves from $k+1$ to N, the smaller V_G^{k+1}. If, for example, there is no fighting from $k+1$ on then $V_G^{k+1} = V - F_R^{k+1}$. If there is continual fighting, $V_G^{k+1} = F_G^{k+1}$. Hence, the more likely the factions are to fight in the future, the more likely they are to fight today.

Proposition 2 shows that the as long as the losses due to fighting until the state is fully consolidated are weakly larger at k than at $k+1$, then G prefers to buy R off in

[11] To see that G may actually prefer to fight, let $d_k \to 1$. Then, $V - W_G^k - F_R^k$ goes to $1 - f_R - f_G$ whereas $\beta(V - V_G^{k+1} - F_R^{k+1})$ will be larger than this if β is close enough to one, d_{k+1} is sufficiently small, and $k+1 < N$ (since $V - V_G^N - F_R^N = 0$).

k. In symbols, G prefers to buy R off if $V - F_R^k - F_G^k \geq V - F_R^{k+1} - F_G^{k+1}$.[12] When this holds, G's and R's actions at k do not depend on subsequent strategic behavior and can be determined directly from the underlying parameters of the game.

Proposition 2 (The Fighting Constraint): *If $F_R^k - \beta F_R^{k+1} > 1$, R fights in k in all MPE of the game. If $F_R^k - \beta F_R^{k+1} < 1$ and $V - F_R^k - F_G^k \geq V - F_R^{k+1} - F_G^{k+1}$, then G offers $x_k = F_R^k - \beta F_R^{k+1}$ and R accepts.*[13]

An immediate implication of Proposition 2 is that if the cost of fighting until the state is fully consolidated weakly decreases as the state moves toward consolidation (i.e., if $V - F_R^k - F_G^k$ is weakly decreasing in k), then G always strictly prefers to buy R off.

Corollary 3: *If $V - F_R^k - F_G^k$ is weakly decreasing in k, then G offers $x_k = F_R^k - \beta F_R^{k+1}$ and R accepts whenever $F_R^k - \beta F_R^{k+1} < 1$.*

Finally, G's incentive to fight rather than settle seems to result from the possibility that fighting will become much less decisive in the future. Corollary 4 shows that this is the case. G prefers to buy R off as whenever it can as long as d_{k+1} is not too much less than d_k. This follows from Corollary 3 and the fact that $V - F_R^k - F_G^k$ is weakly decreasing as long as $d_{k+1} \geq d_k - \eta$ for all k and a small enough $\eta > 0$. Thus, G prefers to buy R off when the level of decisiveness is increasing, constant, or slowly decreasing (i.e., as long as $\eta \geq d_k - d_{k+1}$).

Corollary 4: *There exists an $\eta > 0$ such that $V - F_R^k - F_G^k$ is weakly decreasing as long as $d_{k+1} \geq d_k - \eta$ for all $k \leq N - 1$.*

In sum, G always wants to buy R off if fighting becomes weakly more decisive during the consolidation process. Nevertheless, the factions fight when the underlying distribution of power defined by (d_k, p_k) shifts rapidly against R. As in the baseline game, there is no serious bargaining during these periods. The factions agree on a division of the current period's spoils and do not fight when the distribution of power stabilizes or shifts more slowly. Note further that Proposition 2 allows for the possibility that R's *de facto* power might increase, albeit not too rapidly, during some phases of the consolidation process.

[12] Algebra shows that $V - F_R^k - F_G^k \geq V - F_R^{k+1} - F_G^{k+1}$ implies $\beta(V - V_G^{k+1} - V_R^{k+1}) > V - W_G^k - V_R^k$ (see the proof of Proposition 2).

[13] Since R fights regardless of what G offers whenever $F_R^k - \beta F_R^{k+1} > 1$, there are multple MPE corresponding to different offers.

That is, the assumption that $F_R^k - \beta F_R^{k+1} > 0$ only requires $F_R^{k+1}/F_R^k \leq 1/\beta$ and hence will still hold if F_R^{k+1} is a little larger than F_R^k.

Three Patterns of Conflict

Proposition 2 links the observed pattern of fighting to the way that the distribution of power shifts during the consolidation process. It provides a theoretical account which may at least partly explain the observed patterns of conflict across different empirical cases. This section develops this account further by highlighting three important stylized patterns of conflict – peaceful consolidation, persistent fighting which can end in a negotiated settlement or a militarily decisive outcome, and persistent recurrent fighting. The analysis shows that very simple patterns of shifting power $P = \{(d_k, p_k)\}_{k=0}^N$ can account for these patterns of fighting. Determining whether they actually do is an important and challenging task for future empirical work.

A useful and simplifying first step is to relate R's payoff to fighting to the finish from state k when fighting is not certain to prevent further consolidation ($\varepsilon > 0$) to R's payoff to fighting to the finish when fighting is sure to prevent any further consolidation ($\varepsilon = 0$). To this end, let $\phi_R(d, p) \equiv [f_R + \beta p d V]/[1 - \beta(1 - d)]$ denote R's payoff to fighting to the finish when decisiveness and the probability that R prevails remain constant at d and p. Consequently, R's payoff to a fight to the finish from state k when fighting is sure to forestall further consolidation is $\phi_R^k \equiv \phi_R(d_k, p_k)$. It follows that we can approximate F_R^k by ϕ_R^k if we also assume ε is sufficiently small. That is, $\lim_{\varepsilon \to 0} F_R^k = \phi_R^k$. Lemma 2 summarizes this result.

LEMMA 2: $\phi_R^N = F_R^N$ *and* $\lim_{\varepsilon \to 0} F_R^k = \phi_R^k$ *for* $0 \leq k < N$.[14]

Peaceful consolidation: The first pattern of fighting is really the absence of fighting. Why or under what circumstances would a faction – whether an insurgent group or warlord – ever willingly give up its arms or power? Under what circumstances might a state consolidate without having to fight and defeat an opposing faction? Proposition

[14] Observe trivally that F_R^{k+1} is bounded and let $\varepsilon \to 0$ in Eq 1.

2 suggests that this occurs when the shift in the distribution of power against R is sufficiently slow and consequently the fighting constraint never binds.

Suppose in particular that the distribution of power continually shifts against R throughout the consolidation process but at a declining rate. Formally, R's *de facto* power F_R^k is decreasing and convex. It follows that if the initial rate of decline is sufficiently small that G can buy R off (i.e., if $F_R^0 - \beta F_R^1 < 1$), G will be able to buy R off in all subsequent periods and the state will consolidate without fighting.

To construct a more concrete example, we use the fact that we can approximate F_R^k by ϕ_R^k if ε is sufficiently small. To keep things simple, assume that fighting becomes more decisive by Δ in each period as the state consolidates and that probability that R prevails remains constant. In symbols, $d_k = d_0 + k\Delta$ and $p_k = p < f_R$ for $0 \leq k \leq N$. The assumption that $p < f_R$ ensures that $\phi_R(d, p)$ is decreasing and convex in d. Hence, $\phi_R^k - \phi_R^{k+1} > \phi_R^{k+1} - \phi_R^{k+2}$ and consequently $\phi_R^k - \beta\phi_R^{k+1} > \phi_R^{k+1} - \beta\phi_R^{k+2}$. Taking Δ sufficiently small ensures that $1 > \phi_R^0 - \beta\phi_R^1$. Lemma 2 then implies that we can choose ε small enough to guarantee that $1 > F_R^0 - \beta F_R^1$ and $F_R^k - \beta F_R^{k+1} > F_R^{k+1} - \beta F_R^{k+2}$. Finally, since d_k is increasing, Corollary 4 guarantees that the total cost of fighting to the finish is decreasing. Hence, G always buys R off with $x_k = F_R^k - \beta F_R^{k+1}$ and there is no fighting along the equilibrium path.

Persistent Fighting and Negotiated Settlement: As observed above, an important empirical feature of both interstate and civil wars is that they often do not end in militarily decisive outcomes. In light of this, Leventoğlu and Slantchev emphasize the need for "complete and coherent theories" (2007, 757), i.e., accounts which explain both why fighting starts and, if it does, why it ever stops short of a decisive military outcome. How in particular does fighting solve the problem that gave rise to it? In the context of informational accounts of war (Fearon 1995), fighting starts because of asymmetric information about, say, resolve or the distribution of power, and it ends because the process of fighting reveals information that narrows the asymmetry (e.g., Powell 2004, Slantchev 2003). But it is less clear, Leventoğlu and Slantchev point out, how fighting arising from a commitment problem solves that problem.

Proposition 2 suggests the factions reach negotiated settlements and stop fighting when the rate of change of the distribution of power slows sufficiently. Building on the example above, suppose again that the distribution of power continually shifts against R throughout the consolidation process at a declining rate. However, the initial rate of decline is faster than in the previous example. In particular, R's *de facto* power approximated by ϕ_R^k is decreasing and convex as above but now with Δ large enough so that $\phi_R^0 - \beta\phi_R^1 > 1$. (See the appendix for the details of the construction.)

If the distribution of power shifts in this way, there will be a period of fighting which may end in either a militarily decisive outcome or a negotiated settlement. The latter occurs when the rate at which the distribution of power slows enough that G can buy R off. Moreover, the resolution of the fighting is stable in the sense that it does not break down in further fighting.

Recurrent Fighting: Negotiated settlements to stop fighting frequently break down in renewed fighting. Proposition 2 points to a possible explanation in terms variations in the rate at which the distribution of power shifts. Most simply, suppose that the distribution of power shifts rapidly against R, stabilizes for a while, and then begins another period of rapid change before finally stabilizing. This will induce an initial period of fighting followed by a period during which the factions agree on a division and there is no fighting. But this phase ultimately breaks down in further fighting when the distribution of power begins to change rapidly.

More specifically, suppose that the shift in decisiveness Δ in the examples above varies so that $\phi_R^k - \beta\phi_R^k$ is initially greater than 1 for $k < m$, less than one for $m \leq k < n$, and again greater than one for $n \leq k < s$, before stabilizing for $k \geq s$. (See the appendix for the details of the construction.) Then the factions fight in states $k \leq m$; agree on $x_k = F_R^k - \beta F_R^{k+1} < 1$ for $m < k < n$; fight again in states n through s, and stop fighting thereafter.

In brief, relatively simple patterns of change in (d_k, p_k) can induce important and frequently observed patterns of fighting.

	Persistent Fighting	Negotiated Settlements	Militarily Decisive Outcomes	Recurrent Fighting
Information Problems				
Powell (2004)	X	X	X	
Fearon (2007)	X	X	X	
Yared (2009)	X	X		X
Commitment Problems				
Fearon (2004)	X		X	X
Leventoglu and Slantchev (2007)	X	X	X	

Figure 1: Related work.

Related Work

Existing work on war generally explains persistent inefficient fighting in terms of either information problems (Fearon 2007, Powell 2004, Yared 2009) or commitment problems (Fearon 2004 and Leventoğlu and Slantchev 2007). As Figure 1 suggests, no model explains persistent and recurrent periods of fighting along the equilibrium path which sometimes end in negotiated settlements as well as in decisive military outcomes.

In Powell's model, an uniformed satisfied state makes a series of offers to a dissatisfied state which has private information about its cost of fighting or about the distribution of power. The dissatisfied state can accept the offer or reject it by fighting. The latter may end the game in a decisive outcome or a stalemate in which case play moves on to the next round. The standard screening result obtains and there is persistent fighting along the equilibrium path. But there is also serious bargaining, i.e., the satisfied state never makes an offer that is sure to be rejected.

As in the models here, the government and a rebel group are trying to divide a flow of pies in Fearon (2007). In each period, the government makes a take-it-or-leave-it offer which the rebel group can accept or reject by fighting. The rebel group also has private information about its probability of prevailing. Fearon shows that the government cannot use its offers to screen the rebel group because a weak rebel group would reveal that it is weak if it ever accepted an offer. The government would then use this information in subsequent rounds and make lower offers to the rebels. Anticipating this, a weak rebel group never accepts an offer. Unable to screen with its offers, government in effect resorts to screening by fighting which reveals information about the rebels' strength. That is, the longer the rebels go without collapsing, the more confident the government becomes that it is actually facing a strong rebel group. Eventually the government becomes sufficiently confident that the rebel group is strong that the government offers enough to buy off a strong rebel group. This setup thus leads to persistent fighting along the equilibrium path and no serious bargaining during the fighting phase. Moreover, the fighting can end either in a negotiated settlement or a militarily decisive outcome.

However, fighting never recurs in Powell's or Fearon's analyses. Once enough information is revealed, the bargainers cut a deal and the fighting stops. More generally, it is hard to see how asymmetric information could lead to recurrent fighting unless new asymmetries come into play as the game progresses.

This is what happens in Yared (2009). In each of infinitely many rounds, country *1* makes an offer to *2* which the latter can either accept or reject by fighting. Country *1* is unsure of *2*'s reservation value which *2* learns at the start of each round and which is independent of *2*'s reservation value in other rounds. In effect, there is a new information shock in each period. Yared characterizes the set of Pareto undominated equilibria and shows that many entail periods of persistent recurrent fighting. However, periods of fighting never end in a decisive military outcome. Either the fighting lasts forever or it ends in a negotiated settlement.

Information problems seem likely to play an important role in explaining why fighting starts. Although asymmetric information also leads to persistent fighting in some models, it is less clear that asymmetric information provides a good account of persistent fighting in actual cases. "[I]t strains credulity," Fearon (2004, 290) observes,"to imagine that the parties to a war that has been going on for many years, and that looks very much the same from year to year, can hold any significant private information about their capabilities or resolve."[15] He then goes on to specify a model in which a government and rebel group are bargaining over regional autonomy for the latter. Large, exogenous shocks to the distribution of power lead to fighting, and there are periods of persistent recurrent fighting along the equilibrium path. But fighting once it begins never ends in a negotiated settlement. Either the rebels win and the game ends, or the government wins and play in effect restarts, i.e., the players enter a subgame which is identical to the game itself.

Leventoğlu and Slantchev (2007) study a model which emphasizes first-strike advantages and the fact that fighting destroys a state's resources. The effect of the latter is twofold. First, fighting takes resources, so a smaller resource base limits how long a state can hold on in a fight to the finish. Second, the value of winning and thereby capturing the other's resources also declines as the fighting continues. Deciding not to fight and thereby ceding the first-strike advantage to the other state is akin to a shift in the distribution of power (see Powell 2006) and leads to fighting if the prize is sufficiently large. As the fighting continues, it destroys resources and reduces the value of the prize, i.e., of capturing the other state's resources. At some point the shift in power coupled with the smaller stakes is too small to induce fighting, and the states settle. This setup leads to persistent fighting which may end in either a decisive military outcome or a stable negotiated settlement. But fighting does not recur along the equilibrium path.

Conclusion

The model of state consolidation developed here is based on two key ideas. First, consolidation as Fearon has emphasized creates a commitment problem as the faction in control of the government cannot commit to not exploiting the stronger bargaining

[15] See Powell (2006) for a discussion of the limitations of informational accounts of inefficient fighting.

position it will have once it consolidates its power. Second, fighting may prevent or impede these adverse shifts. The equilibrium links the pattern of fighting to the way that the underlying distribution of power changes during the consolidation process. The factions cut deals and avoid fighting when the underlying distribution of power is stable or shifting slowly. Rapid shifts lead to fighting.

The link between the pattern of fighting and the way that the distribution of power shifts has been developed in the context of a model of state consolidation. However, the two key ideas motivating the model would also seem to hold between countries in the international system as well as between factions in weak states where the central government lacks an effective monopoly on the use of force. That is, a rising state cannot commit to not exploiting a future stronger bargaining position, and fighting may impede these changes in the underlying distribution of power. This suggests that the link between fighting and shifting power analyzed here may hold more generally and apply to interstate conflict as well.

Finally, the distribution of power and the way that it shifts, $P = \{(d_k, p_k)\}_{k=0}^{N}$, are exogenously specified parameters in the model. But surely the distribution of power in many settings is at least to some extent endogenous, perhaps depending on how much effort a faction devotes to fighting or raising the resources to fight in the future. An important task for future work is to try to endogenize the distribution of power.

Appendix

Proof of Lemma 1: Let $(x', \alpha'(z))$ be an MPE of the game starting from the consolidated state. Let V'_R denote R's continuation payoff and let $\widetilde{x}'$ be the offer that leaves R indifferent between accepting and fighting. That is, $\widetilde{x}'$ satisfies $\widetilde{x}' + \beta F'_R = f_R + \beta[p'd'V + (1-d')F'_R]$, or, more simply, $\widetilde{x}' + \beta F'_R = F'_R$. This leaves $\widetilde{x}' = (1-\beta)F'_R$. Subgame perfection in turn implies $\alpha'(z) = 1$ whenever $z > \widetilde{x}'$ and $\alpha'(z) = 0$ for $z < \widetilde{x}'$.

It follows that $\alpha(\widetilde{x}') = 1$. Suppose the contrary and note that $\widetilde{x}' \in (0,1)$ since $F_R \leq F'_R < V$. If $\alpha'(\widetilde{x}') < 1$, G can profitably deviate to $\widetilde{x}' + \gamma$ for a γ sufficiently small. This contradiction leaves $\alpha'(\widetilde{x}) = 1$, and G's unique best response to α' is to offer $x' = \widetilde{x}'$. ■

Proof of Proposition 1: Let $\{(x, \alpha(z)), (x', \alpha'(z))\}$ be an MPE with continuation values V_R, V_G, V'_R, and V'_G. Lemma 1 implies $V'_R = F'_R$ and $V'_G = V - F'_R$. Define $\widetilde{x}$ to be the offer which leaves R indifferent between fighting and accepting, i.e., $\widetilde{x}$ satisfies $\widetilde{x} + \beta F'_R = f_R + \beta[pdV + (1-d)V_R]$. Subgame perfection again implies that $\alpha(z) = 1$ for any $z > x$ and $\alpha(z) = 0$ for any $z < x$.

Observe further that $\widetilde{x} > 0$. This follows from rewriting the previous expression as $\widetilde{x} = f_R + \beta pdV + \beta(1-d)F_R + \beta(1-d)(V_R - F_R) - \beta F'_R = F_R - \beta F'_R + \beta(1-d)(V_R - F_R)$. Since R can always obtain F_R by fighting to the finish in the unconsolidated state, $V_R \geq F_R$ and, by assumption, $F_R > F'_R$. Hence, $\widetilde{x} > 0$. There are now three cases to consider.

Case 1: $\widetilde{x} < 1$. Since $\alpha(z) > 1$ for all $z > \widetilde{x}$, G will never offer any $y > \widetilde{x}$ with positive probability as G could profitably deviate to the lower offer $(y + \widetilde{x})/2$.

Nor will G ever provoke a war by offering something less than $\widetilde{x}$ with positive probability. This follows from two observations. First, G's payoff to agreeing to $\widetilde{x}$ is strictly greater than its payoff to fighting: $1 - \widetilde{x} + \beta(V - F'_R) > f_G + \beta[(1-p)dV + (1-d)V_G]$. To establish this, substitute for $\widetilde{x}$ and rewrite the previous inequality to obtain $1 - f_R - f_G + \beta(1-d)(V - V_R - V_G) > 0$ which holds because fighting is inefficient. Observe second that G can obtain a payoff arbitrarily close to $1 - \widetilde{x} + \beta(V - F'_R)$ by offering a z larger than but arbitrarily close to $\widetilde{x}$. These two observations imply that if G provoked a war with positive probability in equilibrium, then G could profitably deviate to some $z > \widetilde{x}$.

Hence, G offers $\widetilde{x}$ in equilibrium. The assumption that $\widetilde{x} < 1$ now implies that R must accept $\widetilde{x}$ for sure ($\alpha(\widetilde{x}) = 1$). Otherwise G could profitably deviate to a $z > \widetilde{x}$.

R's indifference between accepting and rejecting $\widetilde{x}$ also implies that its value in the unconsolidated state state satisfies $V_R = [f_R + \beta pdV]/[1 - \beta(1-d)]$ which leaves $V_R = F_R$ and $\widetilde{x} = F_R - \beta F'_R$.

Case 2: $\widetilde{x} > 1$. Trivially, R's payoff to accepting any $z \in [0,1]$ is less than its payoff to fighting. Hence, R fights as claimed in the proposition. The fact that R fights in the unconsolidated state means that its continuation value in this state satisfies $V_R = f_G + \beta[pdV + (1-d)V_R]$. This leaves $V_R = F_R$, and the condition that $\widetilde{x} > 1$ now reduces to $F_R - \beta F'_R > 1$.

Case 3: $\widetilde{x} = 1$. R is indifferent between accepting an offer of $\widetilde{x}$ and rejects anything less. Hence its continuation value in the unconsolidated state satisfies $V_R = f_G + \beta[pdV + (1-d)V_R]$. This again gives $V_R = F_R$ and $\widetilde{x} = 1$ then means $F_R - \beta F'_R = 1$. ■

Proof of Corollary 2: Defining $v \equiv F_R/V$ and $v' = F'_R/V$ and solving these equalities for d and d' gives $d(\beta) \equiv [(1-\beta)/\beta][(f_R - v)/(v-p)]$ and similarly for $d'(\beta)$. Rewriting $F_R - \beta F'_R > 1$ as $v - \beta v' > 1 - \beta$ and taking the limit as β goes to one yields $v - v' > 0$ which is sure to hold since $F_R > F'_R$. ■

Proof of Proposition 2: Let $\{(x_j, \alpha_j(z))\}_{j=0}^N$ denote an MPE and take V_j^k to be j's continuation value in this equilibrium starting in state k. Lemma 1 ensures that $x_N = (1-\beta)F_R^N$ and $\alpha_N(z) = 1$ whenever $z \geq x_N$ and $\alpha_N(z) = 0$ otherwise.

Now define $\widetilde{x}_k$ to be the amount that renders R indifferent between accepting and fighting in k, i.e., $\widetilde{x}_k$ solves $\widetilde{x}_k + \beta V_R^{k+1} = f_R + \beta[d_k p_k V + (1-d_k)[(1-\varepsilon)V_R^k + \varepsilon V_R^{k+1}]]$ for $k < N$. Subgame perfection implies that $\alpha_k(z) > 1$ when $z > \widetilde{x}_k$ and $\alpha_k(z) = 0$ when $z < \widetilde{x}_k$.

To show that R fights whenever $F_R^k - \beta F_R^{k+1} > 1$, it suffices to establish that $V_R^k = F_R^k$ for all k and hence that $\widetilde{x}_k = F_R^k - \beta F_R^{k+1}$. Arguing by induction, Lemma 1 establishes $V_R^k = F_R^k$ for $k = N$. To show that $V_R^k = F_R^k$ given $V_R^{k+1} = F_R^{k+1}$, suppose that $\widetilde{x}_k > 1$. Then R rejects any offer and is sure to fight in k. Hence, its equilibrium continuation value in k is $V_R^k = f_R + \beta[d_k p_k V + (1-d_k)[(1-\varepsilon)V_R^k + \varepsilon V_R^{k+1}]]$. Using $V_R^{k+1} = F_R^{k+1}$, solving for V_R^k, and comparing the result to the expression in Eq. (1) gives $V_R^k = F_R^k$.

Now suppose $\widetilde{x}_k < 1$. G will never offer any $y > \widetilde{x}_k$ in equilibrium as it could profitably deviate to the lower offer $(y + \widetilde{x}_k)/2$ which R would accept. But R's payoff to any offer $y \leq \widetilde{x}_k$ is its payoff to fighting either because it actually does fight or because it accepts its certainty equivalent of fighting. Hence, R's continuation value in k again satisfies $V_R^k = f_R + \beta[d_k p_k V + (1 - d_k)[(1 - \varepsilon)V_R^k + \varepsilon V_R^{k+1}]]$ which implies $V_R^k = F_R^k$.

Finally, assume $\widetilde{x}_k = 1$. R either fights if G offers less than $\widetilde{x}_k$ or possibly agrees to its certainly equivalent of fighting if G proposes $\widetilde{x}_k$. Either way R's continuation payoff V_R^k is its payoff to fighting. Repeating the argument in the previous paragraph gives $\widetilde{x}_k = F_R^k - \beta F_R^{k+1}$. But $F_R^k - \beta F_R^{k+1} \neq 1$ by assumption, so this case is moot.

Now assume that $V - F_R^k - F_G^k \geq V - F_R^{k+1} - F_G^{k+1}$ and $\widetilde{x}_k = F_R^k - \beta F_R^{k+1} < 1$. To demonstrate that G buys R off, we show first that G never offers any $y < \widetilde{x}_k$. This along with the fact that G never offers any $y > \widetilde{x}_k$ implies G offers $\widetilde{x}_k$. We then show that R is sure to accept this offer.

Arguing by contradiction, suppose G does offer a $y < \widetilde{x}_k$ with positive probability. Then G could profitably deviate to something slightly above $\widetilde{x}_k$. To establish this note that since R fights when offered $y < \widetilde{x}_k$, G's equilibrium continuation payoff conditional on proposing y in state k is $V_G^k(y) = f_G + \beta[d_k(1 - p_k)V + (1 - d_k)[(1 - \varepsilon)V_G^k + \varepsilon V_G^{k+1}]]$. Because G offers y with positive probability in k, its payoff to proposing k must be equal to anything else it proposes with positive probability in k. Consequently, G's equilibrium continuation value conditional on y is simply its unconditional equilibrium continuation value at k. That is, $V_G^k(y) = V_G^k$, so $V_G^k = [f_G + \beta d_k(1 - p_k)V + \beta\varepsilon(1 - d_k)V_G^{k+1}]/[1 - \beta(1 - d_k)(1 - \varepsilon)]$.

Now observe that since $\widetilde{x}_k < 1$, G can obtain a payoff arbitrarily close to $1 - \widetilde{x}_k + \beta V_G^{k+1}$ by offering $\widetilde{x}_k + \gamma$ for an arbitrarily small $\gamma > 0$ and then reverting to its equilibrium strategy from state $k+1$ on. It follows that G can profitably deviate from y and therefore that we have a contradiction if $1 - \widetilde{x}_k + \beta V_G^{k+1} > V_G^k$.

To demonstrate that this strict inequality holds, substitute the expression for V_G^k in the previous inequality to obtain

$$0 \;<\; 1-\widetilde{x}_k+\beta V_G^{k+1}-\frac{f_G+\beta d_k(1-p_k)V+\beta\varepsilon(1-d_k)V_G^{k+1}}{1-\beta(1-d_k)(1-\varepsilon)]}$$

$$0 \;<\; 1-\widetilde{x}_k-\frac{f_G+\beta d_k(1-p_k)V-\beta[1-(1-d_k)[\varepsilon+\beta(1-\varepsilon)]]V_G^{k+1}}{1-\beta(1-d_k)(1-\varepsilon)]}. \qquad \text{(A1)}$$

Note that the expression on the right is increasing in V_G^{k+1}. Observe further that $V_G^{k+1} \geq F_G^{k+1}$ since G can always obtain the latter by offering $x_j = 0$ (which R by construction is sure to reject) in states $j = k+1, ..., N-1$ and then buying R off in N with $x_N = (1-\beta)F_R^N$. Hence, A1 is sure to hold if

$$0 < 1-\widetilde{x}_k-\frac{f_G+\beta d_k(1-p_k)V-\beta[1-(1-d_k)[\varepsilon+\beta(1-\varepsilon)]]F_G^{k+1}}{1-\beta(1-d_k)(1-\varepsilon)]}.$$

To see that this relation does hold use $F_G^k = [f_G+\beta d_k(1-p_k)V+\beta\varepsilon(1-d_k)F_G^{k+1}]/[1-\beta(1-d_k)(1-\varepsilon)]$ to rewrite the previous inequality as $1-\widetilde{x}_k+\beta F_G^{k+1} > F_G^k$. Recalling that $(1-\beta)V = 1$ and $\widetilde{x}_k = F_R^k - \beta F_R^{k+1}$ leaves $V - F_R^k - F_G^k > \beta(V - F_R^{k+1} - F_G^{k+1})$. This in turn is certain to hold since $V - F_R^k - F_G^k \geq V - F_R^{k+1} - F_G^{k+1}$ by assumption.

That $\alpha_k(\widetilde{x}_k) = 1$ follows directly from the assumption that $\widetilde{x}_k < 1$. Were $\alpha_k(\widetilde{x}_k) < 1$, G could profitably deviate to a y slightly larger than $\widetilde{x}_k$ which R would be sure to accept.■

Proof of Corollary 4: The cost of fighting to the finish is defined recursively by

$$V-F_R^k-F_G^k = \frac{1-f_R-f_G+\beta\varepsilon(1-d_k)(V-F_R^{k+1}-F_G^{k+1})}{1-\beta(1-d_k)(1-\varepsilon)}$$

and the initial condition $V - F_R^N - F_G^N = 0$. Let $M_k \equiv \beta\varepsilon(1-d_k)$, $D_k \equiv 1-\beta\varepsilon(1-d_k)(1-\varepsilon)$, and

$$\Lambda_k \equiv \frac{1}{D_k}+\frac{M_k}{D_kD_{k+1}}+\cdots+\frac{M_k\cdots M_{N-2}}{D_k\cdots D_{N-1}}$$

for $0 \leq k \leq N-1$. Then $V - F_R^k - F_G^k = \Lambda_k(1-f_R-f_G)$ for $0 \leq k \leq N-1$.

Since $V - F_R^N - F_G^N = 0$ and $V - F_R^{N-1} - F_G^{N-1} = (1-f_R-f_G)/[1-\beta(1-d_{N-1})(1-\varepsilon)] > 0$, we have $V - F_R^{N-1} - F_G^{N-1} \geq V - F_R^N - F_G^N$ for any d_{N-1} and hence for any η.

To establish that $V - F_R^k - F_G^k \geq V - F_R^{k+1} - F_G^{k+1}$ for the other cases, it suffices to show that $\Lambda_k - \Lambda_{k+1} \geq 0$ for all $k \leq N-2$ and some $\eta > 0$. To this end, we demonstrate below that $\lim_{\eta \to 0}(\Lambda_k - \Lambda_{k+1}) > 0$ for any $k \leq N-2$. Hence, there exists an $\eta_k > 0$ such that $\Lambda_k - \Lambda_{k+1} > 0$ for all $\eta \leq \eta_k$. Taking $\eta \leq \min\{\eta_0, .., \eta_{N-2}\}$ proves the claim in the corollary.

Algebra gives

$$\Lambda_k - \Lambda_{k+1} \equiv \frac{1}{D_k} + \left(\frac{M_k}{D_k} - 1\right)\frac{1}{D_{k+1}} + \cdots + \left(\frac{M_k}{D_k} - 1\right)\frac{M_{k+1}\cdots M_{N-2}}{D_{k+1}\cdots D_{N-1}}.$$

Noting that M_j/D_j is decreasing in d_j, D_j is increasing in d_j, and $M_k/D_k - 1 = -\beta(1-d_k) < 0$, let $\underline{d}_k \equiv \min\{d_k, d_{k+1}, ..., d_N\}$, $\underline{D}_k \equiv 1 - \beta(1-\underline{d}_k)(1-\varepsilon)$, and $\overline{M}_k \equiv \beta\varepsilon(1-\underline{d}_k)$. Then

$$\begin{aligned}\Lambda_k - \Lambda_{k+1} &\geq \frac{1}{D_k} - \left(1 - \frac{M_k}{D_k}\right)\frac{1}{\underline{D}_k} - \cdots - \left(1 - \frac{M_k}{D_k}\right)\left(\frac{\overline{M}_k}{\underline{D}_k}\right)^{N-k-2}\frac{1}{\underline{D}_k} \\ &\geq \frac{1}{D_k}\left[1 - \left(\frac{D_k - M_k}{\underline{D}_k}\right)\frac{1-(\overline{M}_k/\underline{D}_k)^{N-k-1}}{1-(\overline{M}_k/\underline{D}_k)}\right]. \end{aligned} \qquad (2)$$

Since $d_k < d_{k+1} - \eta$ for all k, it follows that $d_k < d_{k+j} - j\eta$ for $j = 1, .., N-k$. Consequently, $d_k \leq \lim_{\eta\to 0}(d_{k+j} - j\eta) = d_{k+j}$ which in turn implies $\lim_{\eta \to 0} \underline{d}_k = d_k$, $\lim_{\eta\to 0} \underline{D}_k = D_k$, and $\lim_{\eta\to 0} \overline{M}_k = M_k$. Taking the limit of inequality (2) gives $\lim_{\eta\to 0}(\Lambda_k - \Lambda_{k+1}) \geq M_k^{N-k-1}/D_k^{N-k} > 0$. ■

Construction 1: An example of Negotiated Settlement. As in the example of peaceful consolidation, let $d_k = d_0 + k\Delta$ and $p_k = p < f_R$ for $0 \leq k \leq N$. Define Δ_k to be the size of the shift in power that satisfies $\phi_R(d_k, p) - \beta\phi_R(d_k + \Delta_k, p) = 1$.[16] Then $\phi_R^k - \beta\phi_R^{k+1} > 1$ when $\Delta > \Delta_k$, and $\phi_R^k - \beta\phi_R^{k+1} < 1$ when $\Delta < \Delta_k$. Taking ε small enough ensures that F_R^k satisfy these relations. G, therefore, buys R off in k when $\Delta < \Delta_k$, and the factions fight when $\Delta > \Delta_k$.

Observe further that Δ_k is increasing in k since ϕ_R is decreasing and convex in d. The fact that the initial rate of decline satisfies $\phi_R^0 - \beta\phi_R^1 > 1$ then implies that $\Delta_0 < \Delta_1 < \cdots < \Delta_m < \Delta$ for some largest $m \geq 0$. As a result, the factions will fight in $k \leq m$ and

[16] More precisely, $\Delta_k = [(1-\beta)/\beta][1 - \phi_R^k/V]/[\beta(1-p) - 1 + \phi_R^k/V]$ with $\Delta_k > 0$ as long as $f_R - p > (1-p)[1-\beta(1-d_k)]$.

agree on $x_k = F_R^k - \beta F_R^{k+1}$ in subsequent states.

Construction 2: An example of Recurrent Fighting. Building on the previous examples, suppose that fighting rapidly becomes more decisive in the in initial phase of the consolidation process, then stabilizes before beginning another period of rapid change. In symbols, let $p_k = p < f_R$ for all k and

$$d_k = \begin{cases} d_0 + k\Delta & \text{for } k \leq m+1 \\ d_{m+1} & \text{for } m+1 \leq k < n \\ d_{m+1} + (k-n)\Delta' & \text{for } n < k \end{cases}$$

with with $\Delta > \Delta_m$ where recall Δ_m satisfies $\phi_R(d_m, p) - \beta(d_m + \Delta_m, p) = 1$ and $\Delta_s < \Delta'$ for some largest s. These assumptions ensure $\phi_R^k - \beta\phi_R^{k+1}$ is initially greater than one, less than one for k between m and n, larger than one for k between n and s, and then less than one thereafter. Taking ε sufficiently small ensures that F_R^k follows this pattern as well. Hence, the factions fight in states $k \leq m$; agree on $x_k = F_R^k - \beta F_R^{k+1} < 1$ for $m < k < n$; fight again in states n through s, and stop fighting thereafter.

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