War has its own momentum:  
How windows of opportunity prevent negotiated settlements

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Abstract

Why do wars continue even when their original causes are resolved? I offer a rationalist explanation: wars end in a negotiated settlement only when wartime and peacetime balances of power are approximately equal. Since fighting tends to shift the wartime balance of power, war creates its own commitment problems which can preclude a peaceful settlement—even after its initial causes have become irrelevant. In contrast to previous work, I show how these commitment problems arise without any exogenous cause. Aside from the motivating puzzle, this finding accounts for two empirical trends: why costlier wars are shorter and more likely to end peacefully; and why wars are not more likely to end the longer they last, even though more information has been revealed. I then illustrate the model using the Iran-Iraq War. I also derive practical implications for military intervention and military strategy. The article concludes by proving that, for purely rational reasons, a peaceful settlement tends to become less likely the longer a war lasts.

1 Introduction

Bargaining models of war typically address two puzzles. First, they ask why bargaining fails—why states cannot avoid the apparently irrational waste of war. Second, they ask how wars remain limited—how fighting resolves a war’s causes without one side achieving total victory.¹ These puzzles frame what we expect from a complete and coherent model of war, namely, that it must account both for war’s origin and its conclusion (Leventoglu and Slantchev, 2007, 757). Consequently, current models focus on why bargaining initially breaks down and on how fighting facilitates a negotiated settlement. But by focusing solely on war’s

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¹R. Harrison Wagner identifies these as the “two fundamental puzzles about war” (2007, 135). In his review of the bargaining model of war, Dan Reiter offers a similar characterization (2003, 30).
genesis and termination, our models understand war exclusively as solving problems, not creating them; we theorize that conflict only eliminates, and never exacerbates, the reasons for fighting. We thus neglect a third puzzle: how does war itself create new impediments to peace?

Nations often fight for much longer than they intended and for goals very different from those with which they began. As one historian observes,

War once begun has always tended to generate a politics of its own: to create its own momentum, to render obsolete the political purposes for which it was undertaken, and to erect its own political imperatives...war [emerges] not as the servant but as the master of politics (Weigley, 1988, 341).

But how is this possible? Whether in Athens or Vietnam, Rome or the First World War, in every era we witness reasonable statesmen expanding their war aims, making peace increasingly remote. If war helps solve problems, then why do wars last long after everyone has forgotten why they began? And why do wars often end with terms the belligerents once found unacceptable—especially when perceptions remain unchanged?

To these questions I offer an answer which is intuitive yet overlooked. A fundamental obstacle to peace is the disconnect between present and future strength. If one state grows stronger, it might seek to revise the status quo to reflect its newfound power. Because no state can credibly promise not to seek such a revision, the prospect of a future power shift can undermine negotiations in the present. When the shift is severe, diplomacy fails, causing a declining state to initiate a preventive war rather than wait for its position to worsen. This cause of war is most often referred to as a commitment problem, since the rising state cannot credibly commit to honor an agreement once its power has increased. An established and extensive literature dwells on this dynamic, exploring how long-term economic, demographic, and technological shifts can disrupt peace. But this scholarship overlooks a more immediate problem: the same thing can happen during war.

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2 This literature is far too vast even to survey here. For a useful introduction to the essential nature of the problem, see Levy (2011). The mechanism is most comprehensively formalized in Powell (2006). For a more historical treatment, Copeland (2000) argues compellingly for the pervasive importance of the problem.
In this paper, I focus on two essential but understudied elements of conflict: first, fighting tends to alter the balance of power over the course of a war; second, peace tends to reverse these wartime gains to some extent, allowing a losing side to regroup or rebuild. Together, these two elements imply that, by its very nature, war tends to create temporary windows of military superiority. Because they are only temporary, these opportunities will often make militarily successful actors reluctant to negotiate a settlement. A ‘winning’ state has gained an advantage, but this advantage might not persist once the war is over, and so its rival might be tempted to renege on any bargain. Consequently, a winning state might be unable to find an agreement both commensurate with its strengthened position and stable once that position erodes.

In other words, certain series of victories and defeats during war can shift the balance of power so as to create a new commitment problem. After such a shift, states will be incapable of peacefully resolving their differences until the balance shifts again. Therefore, for every conflict there exists a limited range of circumstances in which states can peacefully conclude a war. At any balances of power outside this range, even with complete information and no previous commitment problem states still cannot settle a conflict. This problem can exist after states have resolved the initial causes of a war. It arises endogenously from conflict, and consequently it can cause conflict to persist even when its original causes are moot. In this situation, war gains its own momentum—it expands beyond its original causes to take on a life of its own.

This dynamic allows us to relate the probability of a negotiated settlement to cost and to time. As costs increase, the range of feasible settlements will expand, and this expansion will increase the likelihood one is reached. Costs can thus mitigate the momentum of war, limiting the extent to which temporary superiority can justify continued fighting. By contrast, as time passes, temporary gains tend to accumulate, causing states to draw farther away from the range of feasible settlements and thus making peace more remote. The probability of a

3To clarify: throughout the paper, I employ the phrase ‘negotiated settlement’ to denote an agreement which leaves both actors as intact political units. By contrast, I use the term ‘total victory’ to denote a settlement in which the victor completely dictates the terms of peace and the defeated state accepts them. In Clausewitz’ lexicon, the former is a limited outcome, the latter a decisive or absolute one.
negotiated settlement therefore tends to decline as a war wears on.

The rest of this paper proceeds in five sections. First, I review the relevant parts of the literature on bargaining and war, focusing on the lacunae I intend to fill. Second, I develop a general, formal model and prove the paper’s central claims. Third, I discuss the implications of the model for strategy, military technology, and conflict intervention. Fourth, I use the Iran-Iraq war to illustrate the model’s utility, highlighting the novel facts it explains. A final section concludes.

2 The Importance of Battles to Bargaining

Battles perform three functions: they can capture inherently valuable territory and goods, signal a country’s strength, and shift the balance of military power. Put another way, states can fight to seize goods, leaving their relative power unchanged; they can fight to communicate their relative power; or they can fight to change their relative power. In reality, of course, states fight for combinations of all three reasons, but it is theoretically useful to separate them. The first reason, seizing valuable wealth, is the most immediately apparent: if states cannot agree on a distribution of goods satisfactory to all, then one side or other will simply try to take what it desires. A rival might not willingly yield part of the pie, but a state can still capture through force what it cannot obtain through diplomacy. Models focusing on this function primarily study war as a commitment problem. For instance, because ceding part of the pie can cause a power shift, states might rather fight than peaceably bargain; nevertheless, once states seize some portion of the pie, they can negotiate without impediment.\(^4\) Importantly, since war cannot create additional goods, it can only solve, not complicate, existing commitment problems.

More than commitment problems, however, bargaining models of war predominantly emphasize battles as conduits of information. In this approach, warfare is above all else a signal:

\(^4\)Importantly, Fearon (1996) finds that, so long as these shifts are continuous, they cannot cause a commitment problem. Hence Powell (2006) states the essence of the commitment problem is a sudden, discontinuous shift in power. Besides seizing power-transition causing goods, Leventoglu and Slantchev (2007) show how war, by destroying the goods to be consumed, can eliminate the desire for war by reducing its expected benefits. In addition, if states can consume goods while fighting, then Langlois and Langlois (2006) show that actors might also prefer to fight.
while diplomats lie and politicians cheat, a battlefield is always honest. This honesty enables states to bargain during war in a way impossible in peacetime. In particular, fighting allows states to appraise their enemies’ strength and resolve with increasing accuracy, eventually giving all parties a rough agreement on the true balance of power. Because weak states suffer battlefield defeats more often and because they more quickly accept less generous terms, as wars wear on, all actors gain an increasingly clear picture of their foes.\(^5\) In short, if divergent expectations cause wars to begin, then fighting a war will make it easier to end.

This informational approach drives our current understanding of war. Battles and the bargaining surrounding them convey steadily more information, so that as time passes states draw ever nearer a peaceful settlement. Nevertheless, in order to focus on learning and its relationship with bargaining, most informational models of war neglect the third, military character of battles: that they (temporarily) alter the relative power of states. In this article, I show that including this aspect seriously changes our understanding of war.

The civil war literature has long recognized the difficulty of ending wars, even when information problems have been resolved. Walter (1997) argues that civil wars rarely end in negotiated settlements because, once rebels disarm, a government can punish them with impunity. The government cannot commit not to exploit its future, stronger position. Fearon (2004) likewise argues that an exogenous drop in governmental strength can encourage disaffected citizens to make greater demands upon the government and launch an armed rebellion. Again, the government cannot indefinitely commit to honoring its concessions.\(^6\) Walter suggests such commitment issues are uniquely an intrastate problem, but I show how this commitment problem can exist at any postwar balance of power, regardless the interstate or intrastate nature of a conflict.\(^7\)

\(^5\)The claim’s essential proof is by Slantchev (2003), who shows how states will bribe increasingly strong types to terminate the war. Virtually all information-based models of war exhibit this same screening property, allowing states to settle wars as battles reveal progressively more information.

\(^6\)Elsewhere, Fearon (1998b) makes a similar argument, where minorities fight rather than join a new state because the majority would grow stronger after consolidating its position. This argument is essentially a special case of the more general 2004 argument.

\(^7\)Walter writes, “The key difference between interstate and civil war negotiations is that adversaries in a civil war cannot retain separate, independent armed forces if they agree to settle their differences” (Walter, 1997, 337). But the distinction here is not one of kind but of degree: intrastate conflicts are more likely to create new commitment problems than interstate ones, but the dynamic exists in both. Indeed, removing the distinction between civil and interstate war actually strengthens Walter’s ability to explain negotiated settlements absent third parties, as I discuss later.
This finding expands on the literature’s recent attention to the effects of commitment problems on war termination. Wolford, Reiter, and Carrubba (2011) find that wars begun by information problems can extend beyond the resolution of uncertainty if states recognize a previously unknown power advantage and seek greater gains. Powell (2012) further argues that states will persist in fighting in order to forestall an adverse post-conflict shift in power. Yet, both Wolford et al. and Powell assume that the current balance of power and its future shifts are exogenous. By contrast, I seek to vastly expand the scope of their insights, and so I allow current and future power to be endogenous to fighting. With this additional complexity, I show how wars create new commitment problems, perpetuating conflict and generating their own momentum. This momentum is an exciting and understudied aspect of war. I therefore hope this paper opens new areas for the study of conflict, and especially new areas for the application of game theory. But first I must show why the character of a future power shift might depend on the current balance of military power.

Military power has two components, strength and depth. Strength reflects an actor’s ability to make military gains. In its simplest form, strength is the ability to win engagements, driving a rival from a particular field of battle. The second component of power is depth. Depth reflects an actor’s ability to absorb defeats. It might be thought of as the distance between an actor’s present military situation and its total defeat. Because strength and depth are not the same, one country might be stronger than its enemy in battle, but its enemy, if it has more depth, might be more powerful. For example, while Napoleon was much stronger on the battlefield than Alexander’s Russia, Russia possessed much more depth than Napoleon—and was thus able to defeat him.

Most models of war do not take depth seriously. They typically conceptualize depth as a series of forts or battlegrounds between players’ capitals. In each battle, players will either win, capturing a fort and moving closer to an enemy’s capital (at which point the enemy will lose the war), or lose, surrendering a fort and falling back closer to their own capital. While a convenient and helpful way to conceptualize war, this approach has unintentionally confined our imaginations. The language of ‘forts’ is tacitly territorial, leading us to think
of war purely as the gain and loss of ground. Consequently, when we think of depth purely in territorial terms, we have no problem assuming that countries’ current positions can be ‘locked in.’ If states make territorial gains during war, then their borders can simply be redrawn to reflect these gains. The gain and loss of territory does not obviously affect actors’ ability to agree on a satisfactory distribution of goods, and so the gain and loss of territory does not obviously change actors’ ability to settle a war.

But depth is more complicated than territory. Territorial gains can be ‘locked in’ with relative ease, since countries can simply draw new borders to reflect the current balance. But other components of power cannot be made permanent so easily. Many components of power, especially those related to psychology and morale, will essentially reset during peacetime; they cannot be restricted to current levels. Other components of power, like industrial potential or population size, may not wholly return to pre-war levels, but they will still recover to some extent. Territory itself is not so straightforward as it appears, since during peacetime states will still increase their power by consolidating their control of a region or levying new taxes. Thus, some components of an actor’s military position are necessarily temporary. One country’s power will decline after a war, even though its territory might remain the same. The very act of agreeing to a ceasefire may strengthen a rival.

To see this, consider an illustration. Imagine two different kinds of war. In the first kind, in every battle each country tries to seize some of its enemy’s territory. In the second kind, in every battle each country tries not only to seize some of its enemy’s territory but also to bomb some of its enemy’s cities. In the first, the countries might end a war simply by agreeing to a ceasefire reflecting their current territorial control. But in the second, agreeing to a ceasefire along the current territorial lines is insufficient. A country’s power reflects not just its current territorial gains but also its gains behind enemy lines—its destruction of industries, weakening of governance, and disruption of supplies. Its overall power is more (or less) than its present share of territory. Finding a way to preserve this present balance of power into the future will prove difficult, perhaps impossible, especially since an actor
cannot commit to keep its cities at their current level of devastation. Because the present balance of power will differ from that in the future, states might face a commitment problem. A future expansion of a rival’s power will tempt that rival to overturn any settlement which reflects the present distribution of power. Thus, while that rival might want to come to terms reflecting its current position, it cannot commit to honor those terms when circumstances change.

Current theories all model war as the first kind of conflict—one wherein actors can without difficulty ‘lock in’ their gains. Actors are able to divide the pie along the present distribution of power, and no post-war power shift will occur. But this approach radically simplifies the difficulties confronting wartime diplomacy, especially the difficulty states have of perpetuating their current power. Appreciating this problem is essential to our understanding of war. Besides explaining how wars can outlast their initial causes, it also helps explain two undertheorized trends in the study of conflict: why the probability of war termination correlates positively with its ongoing costs, and why the probability of war termination does not correlate positively with its age (which current models predict).

Intuitively, many scholars recognize that altering the relative cost of war should alter the probability of peace. If states act at least somewhat rationally, then changing their incentives should change their decisions. But while extensive empirical work shows a strong and positive relationship between the cost of war and its termination, theoretical accounts of this relationship remain underdeveloped. Most commonly, political scientists posit that as “costs increase, pressure to settle the conflict will increase as well” (Balch-Lindsay and Enterline, 2000, 624). How this pressure arises, or the mechanism by which costs increase it, is left obscure. Others maintain that the costs of war might diminish to a point where war becomes more profitable than peace, arguing that natural resources and looting tend to enrich insurgents. Nonetheless, though states may expect to gain from conflict, this

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8For evidence of the relationship, see for instance Balch-Lindsay and Enterline (2000), Collier and Hoeffler (2004), Cunningham, Skrede Gleditsch, and Salehyan (2009), Fearon (2004), and Hegre (2004). Collier and Hoeffler (1998) find that increasing the payoff from victory (and thus decreasing the relative costs of war) increases the duration of civil wars, with further empirical support in Collier and Hoeffler (2004), but their findings are disputed by Fearon (2005).

9Ross (2006). Note that he connects natural resources to civil war duration through three mechanisms: increasing the capabilities of the weaker side, prolonging war; creating wartime opportunities for profit, encouraging war; and creating peacetime opportunities for profit, encouraging peace. The first does not relate to the costs and benefits of conflict; the last two I subsume
expectation does not mean that war is somehow not inefficient: the central tenet of the bargaining model is that in almost all cases a mutually preferred, peaceful bargain must exist. Thus, these explanations only obscure the puzzle: already war is inefficient; making it more inefficient does not obviously address the problems which cause it to persist.

The costliness of war creates a range of settlements which a state will accept given its perception of the balance of power. When the ranges of two states overlap, then a bargaining window exists, and they can avoid war; when they do not, they cannot. Increasing the costliness of war widens these ranges, in some sense making them more likely to overlap, and thus making peace more likely. Nevertheless, if costs are relatively constant, then absent some other effect on the bargaining window costlier wars are not more likely to end sooner or more peacefully, for the ranges remain constant, and thus whether they overlap does not change. Hence, wars with increasing marginal costs should terminate more quickly and peaceably than wars with constant marginal costs, even if the latter costs are always higher. Similarly, if the costs of war rise but then remain constant, the increase in costs should only affect the probability of an immediate settlement (either it does or does not open a bargaining window), with no long-term consequences. And yet, neither are what the literature finds, nor what, intuitively, we think is true.

More plausibly, some accounts link the role of cost with that of information. As the belligerents gain information through costly fighting, they should learn more about their relative capabilities and resolve and realize the costs of further fighting. As the projected costs of continued fighting increases, so should the likelihood of reaching a negotiated settlement. But most civil wars are very long, more than long enough for both sides to accurately appraise their relative power. As James Fearon asks, “what prevents negotiated settlements to long-running, destructive civil wars for which conflicting military expectations are an implausible explanation?” In such wars, the effect of cost should disappear, but it does not.  

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In short, according to our present theories, once informational problems resolve, more costly wars should be just as likely as any others to end—but they are not.\textsuperscript{13}

The opposite is true of time. Time, almost all our theories suggest, should help wars end. Several bargaining models predict that war should be duration dependent: if uncertainty causes war, and if battles reveal information, then the longer a war lasts, the more information it reveals, and so the more likely it should end.\textsuperscript{14} Yet the effect of time is persistently ambiguous.\textsuperscript{15} In this paper, I show that, while time may solve informational problems, it also creates commitment problems, making the net expected effect of time on war termination unpredictable. Thus, I argue that the problems relating both to war costs and duration share the same solution as the opening puzzle. Namely, battles not only reveal the balance of power, but they change it as well.

\section{A Model of Bargaining During War}

This section develops a general model of bargaining during war. Because each claim will require progressively more limiting assumptions, I introduce them as they become necessary. I advance three propositions. First, I argue that war can end only when the postwar balance of power approximates the wartime balance of power, with the latitude of this approximation increasing in the costs of war. Second, I show that costlier wars are shorter and more likely to end in negotiated settlements. Finally, and most surprisingly, I show that wars become more difficult to end the longer they last. The propositions hinge on two premises whose innovation lies not in their novelty—both already underpin various bargaining models of conflict—but in their combination, as both have never before appeared together in the formal literature on war.

First, I assume that absolute war ends at a culminating point of victory. Though obvious, much of the most important work on bargaining and war omits this essential assumption.

\textsuperscript{13}An important exception might be Slantchev (2003), who shows that decreased costs can lead to inefficient equilibria (war), but he stops short of relating the changing costs of war to the course of conflict.

\textsuperscript{14}This prediction is universal in informational theories of war, including Slantchev (2003) and Filson and Werner (2002, 827).

\textsuperscript{15}See Bennett and Stam III (1996) and Reiter (2003).
In many theories of conflict each actor has a constant probability of collapse, with war ending when this probability is realized for one player. In these models, fighting a battle does not shift the balance of power, and so victories do not culminate.\textsuperscript{16} While useful for modeling certain problems, this approach limits our understanding of conflict and of war in particular, since battles by their nature tend to move war toward a conclusion. This movement necessarily entails changing a state’s ultimate probability of victory.\textsuperscript{17}

Second, I assume that some shifts in the balance of military power are temporary. This assumption reflects the transitory nature of opportunities, whether for individual units or international coalitions. At the tactical level, the offense succeeds only when it destroys the coherence of the defense, and it halts when a defender restores this coherence; in between, any unit on the offensive enjoys a vanishing strength it must exploit to the utmost.\textsuperscript{18} At the level of grand strategy, a winning state may enjoy an advantage that will evaporate during peacetime, when economies can recover, fortresses can be rebuilt, and peoples can be rearmed.\textsuperscript{19} In all cases, the strength a state presently commands will probably differ from the strength it will have in the future, for better or for worse.\textsuperscript{20}

In the model, two actors, A and B, are bargaining over a pie of size 1. This pie is independent of military power—that is, the components of military power (territory, industry, etc) are assumed to have no intrinsic value. While implausible, this assumption is common in bargaining models because it allows us to isolate certain causes of war. (If the components

\textsuperscript{16}Even such seminal pieces as Leventoğlu and Slantchev (2007) and Powell (2004) adopt this approach, though elsewhere Powell 2002, 21 remarks upon the utility of such models as that of Smith and Stam which allow gains to accumulate. The assumption of non-culminating victory is useful and underused when studying the origins of war (see Leventoğlu and Slantchev (2007)) or long-term rivalries (see Langlois and Langlois (2006)). But to understand how war itself impedes peace, our models must approximate war more carefully, and for that, we must allow battles to culminate in victory.

\textsuperscript{17}Clausewitz articulates two views of war, both of which he argues are indispensable: in the first, battles matter “only in their relation to the whole;” in the second, battles matter as individual games in a larger match, each with “minor advantages [pursued] for their own sake” (Clausewitz, 1976, 582-3). In both the effects of battles must culminate in victory, whether as part of a grand design in the first view, or in the second as individual points of a larger score.

\textsuperscript{18}The army field manual notes, “large gains are achieved by destroying the coherence of the defense, fragmenting and isolating enemy units in the zone of attack, and driving deep to secure operationally decisive objectives” (Hea, N.d., 4). Hence also why Clausewitz stresses speed and the need to pursue victories: because defense is the stronger form of war, any advantage the attacker enjoys is necessarily fleeting; thus, “so long as the aim is the enemy’s defeat, the attack must not be interrupted” (Clausewitz, 1976, 626).

\textsuperscript{19}Clausewitz cautions that a conquering state must be aware of its future ability to retain territory, especially since this territory will tend to weaken a state from its present strength; see Clausewitz (1976, 611-2, 615).

\textsuperscript{20}This assumption is surprisingly uncommon in the bargaining literature. Typically, models either assume binding settlements, as in Filson and Werner (2002) and Slantchev (2003)—and hence no potential shift can create a commitment problem—or that power remains constant during peacetime, as in Leventoğlu and Slantchev (2007) or Smith and Stam (2004). Where it does appear, as in Fearon (2004), there is no culmination of military power.
of military power are also valuable, a commitment problem can emerge—see Fearon (1996) and Powell (2006).)

In the previous section I argued that the oversimplification of depth has blinded us to crucial dynamics of war. Therefore, the model I present deviates from previous work in the way it approaches depth. Most models of war assume a series of $N$ forts, with a player defeating its opponent after accumulating some $k$ number of victories more than its rival. Unfortunately, these discrete models suffer two major constraints: players must fight at the same forts, thus limiting the possible balances of power during war, and the military balance can shift by only one fort at a time, thus limiting the possible ways the balance of power can change during war. Together, these constraints obscure the crucial role of cost and time to the likelihood of a negotiated settlement.\textsuperscript{21} By contrast, I replace the notion of $N$ battlefields with a continuum of possible military balances $\mu$, with $\mu \in \mathbb{R}$. After each battle, $\mu$ shifts from $\mu_{t-1}$ to $\mu_t$ according to a function $f$, where $t$ denotes the number of battles the warring states have fought. If ever this military balance shifts beyond a state’s culminating point of victory, that state decisively and permanently defeats its enemy.

While I leave the interpretation of $\mu$ deliberately abstract, it readily lends itself to at least three. First and most obviously, $\mu$ might represent territory, with the culminating points marking states’ capitals separated by the area their armies must contest. But more than territory, $\mu$ can capture other elements of power, as well. Hence, $\mu$ might also represent the difference in military forces, shifting as the relative size of armies fluctuates. Or again, $\mu$ might represent strategic depth, with the distance from the culminating points of victory representing the magnitude of military setbacks a government can absorb before collapsing. The term will encompass any and all of these, and I leave the optimal interpretation to the imagination of the reader.

\textsuperscript{21}For cost, increasing the costs of war will increase the set of points at which states can settle a war. We might then intuit that the greater the costs of war the greater is the probability of peace, yet in the discrete model this intuition does not hold: once uncertainty resolves, the number of such points is immaterial to the probability of a settlement in future rounds. Because the set of forts where states can settle a war contains all points between its minimum and maximum, having more elements does not matter because the probability of ever reaching those elements is necessarily zero. A similar problem bedevils time. Because of the artificial way in which the balance of power shifts during war, it might be the case that wars can end peacefully in only odd- or even-indexed rounds, depending on $N$. Thus, general statements relating time and the probability of a settlement are unnecessarily convoluted, a product of the game’s peculiar setup. To escape these problems, I deviate from the typical approach of the literature to offer instead a model where the balance of military power is not discrete but continuous.
I assign the values of zero and one as the culminating points of victory for B and A, respectively. These points capture the Clausewitzian notion of a decisive battle or objective. If one side can move the military balance beyond such a point, it can decisively defeat its opponent, rendering him “incapable of further resistance.” For instance, if players A and B are France and Russia in 1812, the value $\mu = 0$ would represent Napoleon’s capture and $\mu = 1$ would represent controlling Moscow. Note that the choice of zero and one are purely for ease and intuition; throughout the paper these values could be replaced with any other real numbers without altering the argument.

We can conceive of power as a state’s ability to win a war decisively, given the present situation. Let $p$ denote A’s power, i.e. the probability that the military balance $\mu_t$ exceeds 1 before it falls below 0. A’s power $p$ is thus essentially its expectation of ultimate victory were it to fight a war to the bitter end; we may write this power recursively as

$$p(\mu_t) = \int_1^\infty f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_0^1 f(\mu_{t+1}; \mu_t) p(\mu_{t+1}) d\mu_{t+1}$$

Note that this interpretation of power inherently incorporates both strength and depth. First, states have more or less battlefield strength, captured by the distribution of battlefield outcomes $f$. This strength uses a state’s current military position, for instance its current share of territory, to predict what will happen should it fight another battle. Second, states have more or less strategic depth, captured by the distance between $\mu$ and the culminating points of victory, i.e. the distance between $\mu$ and 0 or 1. (Again, depth represents the current resilience of a state, i.e. the extent of military setbacks it can sustain before collapsing.)

The probability that B could win a decisive victory can be similarly defined and con-
structured as $\rho(\mu_t)$. To make things simpler, I assume that the game almost certainly ends, and so $p(\mu_t) = 1 - \rho(\mu_t).^{22}$

Because war inefficiently consumes resources, we want to include its costs in the model. After each battle, a state $i$ incurs a cost according to the schedule $C_i : t \rightarrow [0, \bar{c}]$, where $\bar{c} \in (0, \infty)$ is simply an upper bound on the per-battle costs of war. $C_i$ thus captures the ongoing or marginal costs of war to a country $i$, which can vary with time—for instance, if the costs of war rise over time in a democracy because of public discontent.\footnote{Relaxing this assumption has fascinating implications. If the game does not almost surely end, then some values of $\mu$ cause war to shift (almost) endlessly around the same few values. In this instance, actors have an incentive to settle a war just to escape the trap of its never ending (or lasting for a very long time)—even if one actor becomes more likely to lose the war. This might help explain how long wars of attrition end. Nonetheless, for the tractability of the propositions at hand, I set aside this possibility.} From these ongoing costs, we can calculate an actor’s expected future costs $c_i$ from fighting a war until one side achieves a decisive victory. This expected cost will depend on the age of the war $t$ and the present military balance $\mu_t$; these costs are given by

$$c_i(\mu_t, t) = \sum_{k=t}^{\infty} [P(\mu_k \in [0, 1]) \ast C_i(k)]$$

The game is structured to reflect both wartime bargaining and bargaining during a ceasefire. Its key invention will be to allow power to shift during a ceasefire, so that the shadow of this power shift lies across bargaining during war. Each round proceeds as follows. First, a bargaining process (left unspecified) produces some offer $(x_A, x_B)$, with $x_A, x_B \in [0, 1]$ and $x_A + x_B \leq 1$. Next, both players decide simultaneously whether to accept or reject the offer. If at least one player rejects, then states fight a battle. If a battle was fought in the previous round, then $\mu_{t+1}$ is simply chosen according to $f(\mu_{t+1}; \mu_t)$. If a battle was not fought in the previous round, then $\mu_{t+1}$ is chosen as described in the next paragraph. If both players accept the offer, then one of two things happens: if players fought a battle in the previous round, then the game proceeds to the next round, and $\mu_{t+1}$ is $\mu_t$ (I refer to such a round

\footnote{Importantly, while costs accrue each round a battle is fought, states do not reap any benefits until the war is over. This is to avoid the dynamic, shown by Langlois and Langlois (2006), that consuming goods during a war can incentivize one country not to agree to a settlement.}
as a ceasefire); if players did not fight in the previous round (i.e. the previous round was a ceasefire), then the game terminates and players receive their share of the round’s offer. The latter option captures the idea that a bargain is permanent and war is avoided henceforth.

I argue that temporary, wartime advantages can create commitment problems which prevent a peaceful settlement. Assume that during a ceasefire (a round in which no battle was fought in the previous round), if A chooses to fight when B does not, then $\mu_{t+1}$ shifts according to $f(\mu_{t+1}; a(\mu_t))$, where $a : \mu_t \to \mathbb{R}$. Similarly, if B fights when A does not, $\mu_{t+1}$ is given by $f(\mu_{t+1}; b(\mu_t))$, where $b : \mu_t \to \mathbb{R}$. If both choose to fight, then $\mu_{t+1}$ is simply chosen according to $f(\mu_{t+1}; \mu_t)$. As with $\mu$, I leave the interpretation of $a$ and $b$ deliberately ambiguous, though several are plausible: they could capture returns to surprise attack, the benefits of regrouping/rebuilding an army, the long-term effects of losing key industrial sites, etc. Thus, in contrast to the simple game, this general model makes future balances of power endogenous to previous balances.

Finally, I want to show that, for whatever reasons war begins, it can continue purely from its own momentum. I remain agnostic about a given war’s origins: wars result for many reasons, but whatever their causes, they can all create internal commitment problems. Therefore, I assume that some cause exists exogenously to a war, that this cause resolves after $T$ rounds, and that while this cause persists (while $t < T$), states must continue fighting. Once $t \geq T$, states operate under perfect information for the remainder of the game and can bargain unimpeded. For instance, a war might begin because of uncertainty about relative power, but after a few battles, actors learn enough about each other that this uncertainty is no longer a problem. My goal will be to show that, while actors were fighting to resolve this uncertainty, they may have created a new problem, and this new problem will prevent peace.

The game thus outlined will suffice to prove the first proposition.

**Proposition 1.** *In any subgame perfect Nash equilibrium (SPNE), if states peacefully settle* 

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24 As with $f$, I will impose constraints on these functions for the later propositions, but for now I leave them also unrestricted.
a war, then the following must hold:

\[ p(a(\mu_t)) - p(\mu_t) \leq c_A(t, a(\mu_t)) + c_B(t, \mu_t) \]  \hspace{1cm} (1)

\[ p(\mu_t) - p(b(\mu_t)) \leq c_A(t, \mu_t) + c_B(t, b(\mu_t)) \]  \hspace{1cm} (2)

\[ p(a(\mu_t)) - p(b(\mu_t)) \leq c_A(t, a(\mu_t)) + c_B(t, b(\mu_t)) \]  \hspace{1cm} (3)

The proposition establishes that conflict can end only when the wartime balance of power approximates the balance during peace. Importantly, the latitude of this approximation increases in the expected costs of war. (That is, the difference between the wartime and peacetime distributions of power must be less than the sum of states’ expected costs of war.) The proposition can also be helpfully stated in terms of the war aims of states, denoted \( w_i \), which we can conceptualize as the minimum distribution of goods which might induce a player to remain at peace. As already shown, these must equal the maximum they could obtain either from continuing the present war or from violating a future ceasefire; thus,

\[ w_A(t, \mu_t) = \max [p(\mu_t) - c_A(t, \mu_t), \ p(a(\mu_t)) - c_A(t, a(\mu_t))] \]

\[ w_B(t, \mu_t) = \max [1 - p(\mu_t) - c_B(t, \mu_t), \ 1 - p(b(\mu_t)) - c_B(t, b(\mu_t))] \]

\[ w(t, \mu_t) \equiv w_A(t, \mu_t) + w_B(t, \mu_t) \]

With these terms in hand, we can conveniently restate the proposition thus:

**Corollary 1.1.** If states settle a war, then \( w(t, \mu_t) \leq 1 \).

Since we defined the war aims of states as the minimum bargain they could credibly accept, then obviously if peace is reached the sum of these terms cannot exceed the total goods to be divided. Importantly, this proposition holds regardless of the bargaining protocol, which I have left unspecified; it also serves only as a necessary and not a sufficient condition for peace, as the peculiarities of the negotiating process or of players’ strategies can further limit their ability to settle a war.

For the rest of the paper, I consider only subgame perfect equilibria and bargaining
processes in which the probability of peace is maximized. That is, given $\mu_0$, $f$, and $C_i$, then for any SPNE and bargaining process, I consider that equilibrium and bargaining process if and only if no other SPNE or bargaining process exists in which the probability states reach a negotiated settlement is strictly greater. Given this restriction, it will be helpful to articulate a generic equilibrium that always maximizes peace for a given game. Predictably, this equilibrium uses variants of classic grim trigger strategies. It works as follows. During the negotiation phase, the bargaining process is controlled by Nature. If $w(t, \mu_t) > 1$, then Nature offers $(x_A, x_B) = (0, 1)$. If $w(t, \mu_t) \leq 1$, and if a battle was fought in the previous round, then Nature offers $(x_A, x_B) = (w_A(t, \mu_t), w_B(t, \mu_t))$; if $w(t, \mu_t) \leq 1$ but no battle was fought in the previous round, then Nature offers an $(x_A, x_B)$ equal to the previous round’s offer. Players A and B then play unforgiving grim trigger strategies where a player $i$ accepts an offer $x_i$ if and only if $x_i \geq w_i(t, \mu_t)$ and no player $j$ has ever rejected an $x_j \geq w_j(t, \mu_t)$ when $t \geq T$. That is, players accept offers only when no player has ever rejected an offer which satisfies its war aims.\textsuperscript{25} In the equilibrium, a bargain is always accepted as soon as the conditions of proposition one are satisfied, which means that it must maximize the probability of peace in the game.

Thus, players never have an incentive to continue fighting a war in the hopes of extracting a larger part of the surplus, whether this would accrue through rents as the proposer or through some other mechanism. Moreover, the bargaining protocol will not prevent players from reaching a settlement when they might otherwise be willing. Clearly, since war is costly, states will never fight at these points. This equilibrium has the additional benefit that the necessary conditions from proposition 1 become sufficient conditions to guarantee a peaceful settlement. It will be helpful to describe the set of such points at any given time $t$ as a

\textsuperscript{25}This strategy stops a player from fighting a war to strengthen its postwar position, e.g. player A fighting another battle when $p(a(\mu_{t+1})) - c_A(t+1, \mu_{t+1}) - c_A(t) > p(a(\mu_{t})) - c_A(t, \mu_t)$ in order to increase its share of the bargain. The imposition of grim trigger strategies is not unprecedented, as Fearon (1998a) also used it to simplify his calculations. A fitting metaphor for the restriction is courtship: if one lover told another that, while he was quite satisfied with their relationship, he wanted to wait and see if someone better happened to come along, his beloved would abandon him with swift and deserved disdain. Similarly, there is no reason we should expect a state to tolerate its enemy’s delay when both know the present agreement is satisfactory to all.
settlement zone $S$, where

$$S(t) \equiv \{ \mu_t \in [0,1] : w(t, \mu_t) \leq 1 \}$$

It will also be helpful to introduce a term $R$ to denote the points where the game will not terminate, a term $\phi$ to capture the probability of a peaceful settlement, a term $\psi$ to capture the probability of a decisive victory, and a term $\tau$ to capture the expected duration of a war. Since the game almost surely ends, then these terms can be written thus:

$$R(t) \equiv [0,1] \setminus S(t)$$

$$\phi(t, \mu_t) = \begin{cases} 0 & : \mu_t \not\in [0,1] \\ 1 & : \mu_t \in S(t) \\ \int_{-\infty}^{\infty} \phi(t+1, \mu_{t+1})f(\mu_{t+1}, \mu_t)d\mu_{t+1} & : \mu_t \in R(t) \end{cases}$$

$$\psi(t, \mu_t) = 1 - \phi(t, \mu_t)$$

$$\tau(t, \mu_t) = \begin{cases} t & : \mu_t \not\in R(t) \\ \int_{-\infty}^{\infty} \tau(t+1, \mu_{t+1})f(\mu_{t+1}; \mu_t)d\mu_{t+1} & : \mu_t \in R(t) \end{cases}$$

Now, consider two identical games, save that in one costs accrue according to $C_i$ and in the other according to $\hat{C}_i$. Let the terms in the second game which depend on this altered cost function be denoted with a hat, e.g. $\hat{\phi}(t, \mu_t)$. The second proposition is as follows:

**Proposition 2.** On average, costlier wars are shorter and more likely to end peacefully, i.e. for each player $i$, if $C_i(t) \geq \hat{C}_i(t)$ $\forall t \geq T$, then for any $t \geq T$ and $\mu_t$,

$$\phi(t, \mu_t) \geq \hat{\phi}(t, \mu_t)$$

$$\tau(t, \mu_t) \leq \hat{\tau}(t, \mu_t)$$

These claims follow obviously from the first proposition. The first proposition allows us to identify a range of military positions at which a war can (or cannot) be settled. This
range does not exist in current models of war. Once we construct this range, it immediately follows that the range’s size depends on the costs of war. Thus, as costs increase, the range of points at which states can settle a war expands, and so the probability of reaching such a point must expand, as well.

An interesting corollary follows from the second proposition: if the costs of war are steadily increasing, then over time at the same balances of power a peaceful settlement becomes more likely.\(^\text{26}\) That is,

**Corollary 2.1.** For both players \(i\), if for some \(t^* \geq T c_i(t)\) is monotonically and weakly decreasing (increasing) \(\forall t \geq t^*\), then for a given \(\mu_t\), it follows that \(\phi(t, \mu_t)\) is also monotonically decreasing (increasing) \(\forall t \geq t^*\).

A crucial implication follows: if we suppose that wars have large up-front costs, we should expect the probability of peace to wane as wars continue. The bargaining range before a war might be larger than the range afterward. For instance, if an expanding empire must pay large initial costs to transport troops and establish a presence in a region, but its ongoing costs of maintaining such a presence are comparatively low, then the probability of peace will decline after it has established such a presence; indeed, in this scenario, war will be far easier to prevent than to end, and a miscalculated invasion might be almost impossible to undo. This conclusion foreshadows the final proposition, which shows that as a war continues, the expected probability it will end peacefully necessarily declines.

**Proposition 3.** If costs are constant, then in expectation the likelihood of a peaceful settlement declines with time: \(\forall t' > t > T, E[\phi(t', \mu_{t'}); \mu_{t'-1} \in R, \ldots] \leq E[\phi(t, \mu_t); \mu_{t-1} \in R, \ldots]\)

The intuition behind this proposition requires explanation. Each round, the balance of military power shifts to points where the odds of a peaceful settlement are either more likely or less likely. Over time, given that states have not reached a peaceful settlement, then in all probability the balance of power must have shifted to points which make peace less likely. The longer war goes without reaching a peaceful settlement, then, in all probability, the less

\(^{26}\)Unfortunately, because of the confounding effects of time (shown in proposition three, below), this corollary does not suffice to claim that peace becomes more likely as costs increase.
likely a peaceful settlement has become.

Consider a simple example drawing on the First World War. In particular, suppose that there are four battlefields at which Germany must win in order to defeat France—namely, Belgium, the French border, the Marne, and Paris. If Germany captures Paris, then France will fall. Suppose also that Germany and France are only willing to settle the war near the *status quo ante* (this will be the settlement zone). The diagram below represents these different locations the western front might take. Let us assume that, because of the July crisis, Germany initiates the war, but it is free to settle the war after only one round ($T = 1$).

If the probability of a German victory in any given battle is much more than one-half, then clearly over time the balance of power will move rapidly away from the *status quo ante* and thus away from the points at which Germany and France can peacefully negotiate an end to the war.\textsuperscript{27} As it was, because of the technology of the time and the overwhelming strength of the defense, Germany and France were roughly evenly matched on the battlefield. Therefore, assume that the German probability of victory in any battle is .5. The following tables capture the odds of a peaceful settlement (as opposed to a decisive, ultimate victory):

\begin{table}
\begin{tabular}{c|c|c|c|c}
\hline
\textbf{location} & Belgium & France & Marne & Paris \\
\hline
$\phi()$ & $\frac{12}{15}$ & $\frac{9}{15}$ & $\frac{6}{15}$ & $\frac{3}{15}$ \\
\hline
\end{tabular}
\end{table}

\begin{table}
\begin{tabular}{c|c|c|c|c|c|c}
\hline
$t$ & E[location] & $E[\phi();...]$ & $t$ & E[location] & $E[\phi();...]$ \\
\hline
1 & Belgium & .8 & 2 & $\frac{1}{2}$settle, $\frac{1}{2}$France & .8 \\
3 & $\frac{1}{2}$Belgium, $\frac{1}{2}$Marne & .6 & 4 & $\frac{1}{2}$settle, $\frac{1}{2}$France, $\frac{1}{2}$ Paris & .71 \\
5 & $\frac{1}{2}$Belgium, $\frac{1}{2}$Marne, $\frac{1}{2}$conquest & .47 & 6 & $\frac{1}{2}$settle, $\frac{1}{2}$France, $\frac{3}{10}$ Paris & .66 \\
\hline
\end{tabular}
\end{table}

Clearly, the longer war wears on the farther the front moves from the *status quo ante* (in all \textsuperscript{27}For instance, if the probability Germany wins a given battle is .8, then the probability of a peaceful settlement after one battle is about .29, after two .29, after three .11, after four .11, after five .04, &c. Naturally, the same holds true if France is stronger, though for that case, it would be more profitable to examine the points between the status quo and Berlin.)
probability). In fact, if Germany and France are roughly evenly matched, the front stabilizes somewhere between the Marne and the French border, vacillating between the two. If the war does not end quickly—for instance, after two battles—then Germany must have won enough initial victories to move the front significantly away from its starting point but not enough to move it sufficiently close to Paris to achieve victory.

In games with a continuum of military balances, the result is even more pronounced.\(^{28}\) As an example, consider a game where \( S = \left[ \frac{4}{10}, \frac{6}{10} \right] \) and \( \mu_{t+1} \) shifts normally about \( \mu_t \) with a standard deviation of \( \frac{1}{10} \). The following histograms simulate ten million wars after one battle, three battles, and five battles (only ongoing wars are displayed).

![Histograms simulating ten million wars](image)

The shift away from the settlement window is obvious, with \( \mu \) drifting toward a truncated normal distribution on each side of the settlement zone. While some of these wars will draw nearer a settlement, in the aggregate the trend is always away from peace. This trend holds in a broad class of cases. In the appendix, I identify a series of plausible assumptions which suffice for the proposition to hold and offer a general proof.

### 4 Implications

The three propositions I advance answer the motivating puzzles. The first shows how wars can continue and war aims can expand even absent their original causes. The second clearly relates cost to the likelihood of peace and the duration of war; it also shows why the overall magnitude of the ongoing costs of war remain more significant than changes in their rela-

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\(^{28}\) As can be seen from the WWI example, when forts are discrete, then the value of \( p \) oscillates up and down between even- and odd-numbered rounds. In a continuous game, this oscillation disappears.
tive magnitudes, an importance inexplicable without examining the intrawar power shifts I emphasize. The third proposition answers why the effect of time is ambiguous: in line with the work of Wolford, Reiter, and Carrubba (2011), I show how, while the process of fighting a war tends to resolve its causes, the very same process tends to create new problems, producing an uncertain net effect. Indeed, the third proposition shows that, absent some other influence, the probability of a peaceful settlement tends to decline with time. Beyond these primary propositions, I highlight a few additional implications of the model.

The first proposition helps explain how different methods of war relate to peace. Military tactics and strategies whose gains are not easily ‘locked in’ tend to prolong war by making a bargain infeasible. This finding might help explain why unconventional wars often prove difficult to end: unlike more conventional, territorial wars, civil and especially guerrilla conflicts involve many advantages and opportunities that can only be secured by a total victory of one side. The insecurity of these gains compels the belligerents to continue fighting, even though all might prefer peace to war. In line with the research of Kalyvas and Balcells (2010), the three propositions thus offer a theoretical justification relating the changing nature of military technology to changes in civil war duration and settlement patterns. The same dynamic applies to cyberwarfare. As in other forms of nontraditional warfare, cyber attacks by their nature tend to involve temporary gains. In an important article, Erik Gartzke (2013) argues that this property of cyberwar compels actors either to follow up their attacks with more conventional warfare or to refrain from their use entirely. In other words, the use of cyberwarfare tends to necessitate the use of additional military force. The possibility of a settlement thus importantly depends on the character of military tactics and technology.

The reverse also holds true: when choosing tactics and strategies, policymakers need to consider the character of the war they expect to fight. If a leader expects to fight an absolute war, then military gains that yield only temporary returns will have the greatest benefit; by contrast, if a leader expects to fight a limited conflict, with the hope it will soon end in a truce, then military gains with permanent and long-lasting value should be
pursued. Thus, the closer wars come to decisive victory, the more leaders will seek temporary advantages instead of objectives with long term value. For policymakers, the implication is clear: during limited wars, states should seek to seize valuable industrial resources and territory of great strategic benefit, while the destruction of supply lines, demoralization of the enemy population, or the defeat of easily replenished armies will prove much less beneficial; the opposite advice holds when leaders expect to fight wars to their decisive conclusions. The militarily valuable goals of policymakers may thus depend importantly on the scope of their political aims. Moreover, if unwise policymakers pursue military objectives inappropriate to their aims, then they may find that their execution of the war has compelled the war to expand.

The second proposition provides a general tool to relate escalation to the possibility of peace. Most simply, the mutual escalation of a conflict that does not substantially alter the relative power of the combatants will make a peaceful settlement more likely and will shorten the expected time to reach such a settlement. While perhaps counterintuitive, the argument is straightforward: mutual escalation increases the costs of war, expanding the range of settlements states are willing to accept and thus the likelihood one is reached. So long as this escalation does not alter the military balance, then its effect is unambiguously pacific. This prediction accords with early bargaining models of war, which suspected—albeit without a firm theoretical foundation—that de-escalation of a conflict can actually make peace less likely (Pillar, 1983).

We can also consider types of one-sided escalation. For this purpose, we can introduce the idea of a winning state, i.e. a state that is closer to victory than when the war began, and a losing state, i.e. a state which is farther from victory than when the war began. If a losing state can escalate a war by making itself more difficult to defeat, for instance by mobilizing its domestic population to fight against an invasion, then it will make a negotiated settlement more likely (in the model, this would alter its enemy’s culminating point of victory). By contrast, if a winning state can make its enemy easier to defeat, say through technological breakthroughs, then a negotiated peace will become less likely, since the settlement zone will
contract. Similar results follow if a losing or winning state can improve its military position.

A general rule emerges: one-sided escalation favors a negotiated peace when and only when a losing state escalates; escalation by a winning state will have at best an ambiguous effect on the odds of a settlement. As an interesting corollary, if a leader seeks “peace through escalation,” then the statement entails one of two logical possibilities: either the leader’s country is losing the war, or the leader is pursuing an absolute victory. In all these explanations, the idea of a settlement zone whose breadth depends on the expected costs of war offers a new tool to relate escalation and peace.

The second proposition also helps relate the nature of third party interventions to the likelihood of peace. Most immediately, humanitarian interventions—interventions which do not alter the military power of the combatants—will prolong war by decreasing its expected costs. Since the alleviation of suffering and provision of necessary services reduces the toll of war on populations and governments, the range of acceptable settlements will narrow, and the probability that the balance of power shifts within this range diminishes. This unambiguous result does not hold for military interventions. Here, the effect more closely tracks that of one-sided escalations: military interventions which strengthen the losing side, whether by shifting the balance of power or by making it more difficult to defeat, will tend to encourage a negotiated settlement. The opposite holds for interventions favoring the winning side. The effect of military interventions on both sides, if of roughly equal magnitude, will have the same effect as mutual escalation: since mutual intervention makes absolute victory more difficult to achieve and increases the expected costs of war, it expands the range of acceptable settlements. In short, if third parties desire a peaceful end to a war, then escalation and military intervention are more appropriate tools than humanitarian assistance.

With these propositions and implications in mind, I now turn to a historical case to highlight their relevance.
5 The Iran-Iraq War

The Iran-Iraq War was one of the longest and deadliest wars of the twentieth century. Lasting from 1980 to 1988, its total casualties surpassed one million, with nearly 400,000 killed in battle, and over one trillion dollars were lost in war damages (Hiro, 1991, 250-1). Yet, despite the war’s longevity and devastation, it ended in a stalemate with the status quo ante unchanged—an arrangement Iraqi President Saddam Hussein first proposed in June 1982, less than two years after the war began.\(^{29}\) What explains the war’s long, costly duration yet status quo outcome?

I suggest that shifting windows of military opportunity during the war best explain its expansion and outcome. Iraq invaded Iran in September 1980 after witnessing the internal tumult wrought by the Iranian Revolution. Military purges had fragmented and weakened Iran, offering Iraq a window for militant opportunism.\(^{30}\) But after suffering a series of catastrophic defeats that united Iran and left Iraq weak, in June 1982 Baghdad announced that it would accept international calls for a ceasefire and return to the status quo ante.\(^{31}\) Tehran, however, rejected any ceasefire, choosing instead to press its advantage. The war would last for another six years.

Historians primarily identify four factors that convinced Tehran to accept the status quo ante: Iraq’s use of chemical weapons,\(^{32}\) Iraqi military gains, Iraqi development of long-range ballistic missiles, and active US military involvement against Iran in the Persian Gulf. The first fits comfortably with extant models of bargaining and war, but the other three are best understood using the model I articulate: each strengthened Iraq’s position and increased

\(^{29}\)Hiro (1991, 63); O’Ballance (1988, xiii).

\(^{30}\)According to Iraqi General Ra’ad Hamdani, Saddam “saw this as the perfect moment, which Iraq needed to seize, because the Iranians were not well equipped, trained, or capable of fighting, and so he could eliminate the Iranian threat” (Kevin Woods and Elkhamri, 2009, 27), and he intended to claim as much territory as his forces could conquer; see Abdulghani (1984, 202-8); Hiro (1991, 39,46); O’Ballance (1988, 19-24); and Ward (2009, 228-30,243-54). More tempting still, Iran had alienated the United States, its long-time military patron, and much of the international community during the recent embassy hostage crisis, leaving it largely friendless abroad (Pollack, 2005, 152-74).

\(^{31}\)Iraq might have succeeded had it not launched “one of the most incompetent military operations of the twentieth century,” resulting in a string of Iraqi defeats (Pollack, 2005, 186). The invasion also stoked Iranian nationalism, uniting the fractured country, and helped reconcile Shah-era military officers with the Khomeini regime; see Axworthy (2012, 197-202,217-221); Ward (2009, 245-7); Hiro (1991, 63); and O’Ballance (1988, 86).

\(^{32}\)Tehran knew of Iraq’s chemical weapon stockpiles, but Baghdad had not before demonstrated a resolve to use them. Both Iraqi use of the weapons and the absence of international condemnation surprised Tehran (James Blight and Tirman, 2012, 178-81). Nevertheless, Iraq began using chemical weapons in 1983, years before the war ended; learning about Iraqi resolve did not alter Iranian determination, and so informational models of war have only limited utility in explaining this case. See Axworthy (2012, 238-40); Hiro (1991, 102,105-6); O’Ballance (1988, 149-50); Ward (2009, 274-6).
Iran’s expected costs of war, eventually driving Iran to negotiate. Moreover, unlike Iraq’s use of chemical weapons, which began in 1983, the last three factors all occurred in 1987 or 1988, just prior to the war’s end.\footnote{They resulted from Iran’s conquest of the al-Fao (al-Faw) peninsula in early 1986, which put Iranian forces in reach of Basra, Iraq’s largest Shi’a city; see (James Blight and Tirman, 2012, 157-9); Hiro (1991, 167-172); O’Ballance (1988, 173-8); Pollack (2005, 219-20); and Kevin Woods and Elkhamri (2009, 12-13,70-5). This threat convinced Saddam to invest heavily in military modernization, to expand his elite Republican Guard, and to better coordinate his use of conventional and chemical weaponry.} In April 1988, as Iraqi forces were retaking al-Fao, the US launched Operation Praying Mantis after a US frigate was struck by an Iranian mine. US forces targeted Iranian oil platforms and naval vessels in the Gulf, dealing a crippling blow to Iran’s naval capacity.\footnote{Hiro (1991, 204-5); Pollack (2005, 229-31); Ward (2009, 287-9)} The final breaking point for Iran came in July, when the USS Vincennes shot down an Iranian airbus, which it mistook for an F-14, killing 290 passengers. Though the US ultimately admitted its error, it refused to offer a formal apology. America’s involvement and obstinacy convinced Tehran that the US was fully committed to preventing an Iranian victory, meaning that further efforts would require confronting both the US and a revitalized Iraq.\footnote{Axworthy (2012, 275-7); James Blight and Tirman (2012, 161-4); Hiro (1991, 211-2); Pollack (2005, 231-3); Ward (2009, 294-5).} Although Iran’s capitulation initially encouraged Iraq to expand its war aims, under Saudi and American pressure Saddam accepted the ceasefire.\footnote{Baghdad put forward additional conditions for a cease-fire and secretly approached Washington to “just give us till October” to inflict a serious military defeat on Iranian forces inside Iran (James Blight and Tirman, 2012, 211-2). Iraq launched three offensives into northern, central, and southern Iran, all of which were defeated by Iranian forces, who were emboldened by the unprovoked Iraqi aggression. See Axworthy (2012, 282-3); Hiro (1991, 248); Kevin Woods and Elkhamri (2009, 89-90). Iraq also received pressure from Saudi Arabia, its leading financial supporter, to accept the cease-fire without preconditions. Given its military losses and threat of withdrawn support, Baghdad relented; see James Blight and Tirman (2012, 205-6); Hiro (1991, 248).} Ultimately, Iraqi gains, along with the mutual threat of continued third party intervention—or, for Iraq, the threat of its withdrawal—altered the balance of power and increased the prospective costs of war enough to drive the belligerent states to end the near-decade long war.

The general outline of the war is thus unambiguous. Iraq, tempted by Iranian weakness after the Islamic revolution, invaded in an attempt to conquer and permanently weaken its longtime rival as much as possible before the new state could consolidate. The origins of the war thus exemplify a classic commitment problem, where one state attempts to exploit its present but declining power. But beyond its origin, current models fail to account for the war. The Iraqi offensive failed, and the Iranian regime united to repulse the threat. Within the war’s first two years, the original impetus for conflict had disappeared, and yet the war
continued. The next six years were not spent learning, for by 1983 both sides understood thoroughly the capabilities and resolve of the other. Neither were they spent destroying disputed resources or to satisfy pride, bloodlust, or domestic politics. Rather, early Iranian gains led the country to exploit its military advantage, as did its later conquests. Only when Iraqi victories reversed many of these gains, while technological advances and third party interventions significantly increased the future costs of war, did the war end. In short, temporary military advantages, of the kind the model describes, drove the war’s persistence; the war at last ended when enough of these advantages evaporated and when mounting costs made the \textit{status quo ante} an acceptable bargain to all parties. Thus, though its original causes vanished by June 1982, the war lasted until the military balance again came within the settlement window.

6 Conclusion

The Iran-Iraq War poses a wrenching puzzle: why would two countries fight, wasting billions upon billions of dollars, devastating their economies, sacrificing hundreds of thousands of lives, and massacring civilians with the ghastliest of weapons, only to end the war exactly where it began? Indeed, only to end the war exactly where it might have ended six years before? Political scientists have long recognized the puzzle of war’s inefficiency, but rarely have we considered its momentum, how war can sweep up countries and drive them to fight for reasons far beyond their initial motives. We would like to think that war, while destructive, at least solves problems. We forget that war has its own momentum, that it has almost a will of its own. “Cry havoc and let slip the dogs of war.”

Besides studying how war resolves the reasons for fighting, we must begin to recognize how it creates new impediments to peace. As a first step, I have shown how temporary changes in military power during war create new commitment problems where they did not before exist, making war difficult to end even after the belligerents have settled its original causes. This tendency springs neither from domestic politics nor from the vagaries of human
psychology, though both exacerbate it. Rather, the very character of war causes conflict to persist.

This momentum should worry every citizen and every leader. Sobriety will not undo mistakes made in fits of national passion. Even if begun for the most foolish of reasons, wars may be impossible to end; though after a year of fighting a war might seem absurd, and though everyone might regard the conflict with cool and detached reason, still leaders may have no rational choice but to continue fighting. The cost of error is thus extreme, and before undertaking any venture, we should recognize that our mistakes can commit us to fight wars we would shudder to contemplate.

I conclude with my central claim and its most troubling implication. Wars cannot end at any balance of power, and sometimes a successful negotiation is beyond the skill of even the deftest diplomacy. Worse still, though as citizens we grow angry and judge our leaders incompetent if after many years a war seems no nearer a conclusion, in fact we should expect precisely this result. Wars are easiest to end when first begun, and the longer they last the more difficult to conclude they become. By its very nature, war makes peace ever more impossible.
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7 Appendix - Proofs

State A’s power $p$ for a given $\mu_t$ is given by

$$p(\mu_t) = \begin{cases} 
0 & : \mu_t < 0 \\
1 & : \mu_t > 1 \\
f_{-\infty}^{\infty} f(\mu_{t+1}; \mu_t) p(\mu_{t+1}) d\mu_{t+1} & : \mu_t \in [0, 1]
\end{cases}$$

$$= \int_{1}^{\infty} f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_{0}^{1} f(\mu_{t+1}; \mu_t) p(\mu_{t+1}) d\mu_{t+1}$$

$$= \int_{1}^{\infty} f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_{0}^{1} \int_{1}^{\infty} f(\mu_{t+1}; \mu_t) f(\mu_{t+2}; \mu_{t+1}) d\mu_{t+2} d\mu_{t+1} + \int_{0}^{1} \int_{0}^{1} \int_{1}^{\infty} \ldots$$

By assumption, state B’s power $\rho$ is $1 - p$. In addition, each actor $i$’s expected future costs from fighting a war to its conclusion, $c_i$, are given by

$$c_i(\mu_t, t) = \sum_{k=t}^{\infty} [P(\mu_k \in [0, 1]) \ast C_i(k)]$$

$$= C_i(t) + C_i(t+1) \int_{0}^{1} f(\mu_{t+1}, \mu_t) d\mu_{t+1} + C_i(t+2) \int_{0}^{1} \int_{0}^{1} \ldots$$

Proposition 1: In any subgame perfect Nash equilibrium (SPNE), if states peacefully
settle a war, then the following must hold:

\[\begin{align*}
    p(a(\mu_t)) - p(\mu_t) &\leq c_A(t, a(\mu_t)) + c_B(t, \mu_t) \\
p(\mu_t) - p(b(\mu_t)) &\leq c_A(t, \mu_t) + c_B(t, b(\mu_t)) \\
p(a(\mu_t)) - p(b(\mu_t)) &\leq c_A(t, a(\mu_t)) + c_B(t, b(\mu_t))
\end{align*}\]

The proof for the first proposition is straightforward. Suppose that states peacefully settle a war, i.e. that after some \(t\) battles both players choose not to fight in two consecutive rounds. In the final round of the game, each state must calculate that its final share of \((x_A, x_B)\) is less than its expected share if it deviated and fought in this round. Now, clearly a state’s expected share can never be less than it could obtain from fighting a war to its conclusion, since if it were it could profitably deviate. For state A, then, it must be true that \(x_A \geq p(a(\mu_t)) - c_A(t, a(\mu_t))\). Similarly, knowing this, in the previous round, for B to choose not to fight, it must be true that \(x_B \geq 1 - p(\mu_t) - c_B(t, \mu_t)\). Thus, since \(x_A + x_B \leq 1\), the extent to which the present balance of power can differ from that in the future, \(p(a(\mu_t)) - p(\mu_t)\), must be less than the costs of war, \(c_A(t, a(\mu_t)) + c_B(t, \mu_t)\). The second claim follows from a similar logic. As the third simply restates the resource constraint and the familiar commitment problem when there are returns to striking first, this completes the proof.

Corollary 1.1 follows obviously from the definitions of \(w_i(t, \mu_t)\) and \(w(t, \mu_t)\).

**Proposition 2:** On average, costlier wars are shorter and more likely to end peacefully, i.e. for each player \(i\), if \(C_i(t) \geq \hat{C}_i(t) \ \forall t \geq T\), then for any \(t \geq T\) and \(\mu_t\),

\[\begin{align*}
    \phi(t, \mu_t) &\geq \hat{\phi}(t, \mu_t) \\
\tau(t, \mu_t) &\leq \hat{\tau}(t, \mu_t)
\end{align*}\]

The second proposition follows obviously from the first. Intuitively, if \(\phi(t, \mu_t) < \hat{\phi}(t, \mu_t)\), then it must be because the ability in the second game to transition to some \(\mu_t \in S(t)\) without a peaceful settlement makes peace more likely. But this is absurd. Since \(R(t) \subseteq \hat{R}(t)\) for all \(t\),
if \( \mu_t \in R(t) \), we can see that

\[
\psi(t, \mu_t) = \int_{-\infty}^{0} f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_{-\infty}^{0} \int_{R(t+1)} f(\mu_{t+2}; \mu_{t+1}) f(\mu_{t+1}; \mu_t) d\mu_{t+2} d\mu_{t+1} + \ldots
\]

\[
\leq \int_{-\infty}^{0} f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_{-\infty}^{0} \int_{R(t+1)} f(\mu_{t+2}; \mu_{t+1}) f(\mu_{t+1}; \mu_t) d\mu_{t+2} d\mu_{t+1} + \ldots
\]

\[= \hat{\psi}(t, \mu_t)\]

Since \( \phi(t, \mu_t) = 1 - \psi(t, \mu_t) \), then \( \phi(t, \mu_t) \geq \hat{\phi}(t, \mu_t) \). Similarly, given that a game has reached time \( t \) and \( \mu_t \in R(t) \), we can see that

\[
\tau(t, \mu_t) = t + \int_{R(t+1)} f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_{R(t+1)} \int_{R(t+2)} f(\mu_{t+2}; \mu_{t+1}) f(\mu_{t+1}; \mu_t) d\mu_{t+2} d\mu_{t+1} + \ldots
\]

\[\leq t + \int_{R(t+1)} f(\mu_{t+1}; \mu_t) d\mu_{t+1} + \int_{R(t+1)} \int_{R(t+2)} \ldots
\]

\[= \hat{\tau}(t, \mu_t),\]

which proves the proposition.

**Proposition 3:** If costs are constant, then in expectation the likelihood of a peaceful settlement declines with time: \( \forall t' > t > T, \ E[\phi(t', \mu_t); \mu_{t-1} \in R, \ldots] \leq E[\phi(t, \mu_t); \mu_{t-1} \in R, \ldots] \)

Propositions one and two hold with minimal assumptions. In fact, while I have couched the proofs in terms of real numbers for their intuitive appeal, both propositions will follow when \( \mu_t \) is any object, even, for instance, the set \{Lee wins, Jackson is shot\}. But while the third proposition holds in a wide variety of cases, it is possible to construct \( f, a, \) and \( b \) in such a way that it does not. I therefore identify a set of assumptions which will suffice (but are not necessary) to guarantee the proposition. I have tried to make these assumptions as general and plausible as possible. These assumptions are four.

First, \( a \) and \( b \) must each be non-decreasing (so that neither A nor B could ever do better in a future war by doing worse in a present one) and either linear or, if not linear, then \( a \)
must be convex and greater than $\frac{1}{2}$ for all $\mu_t$ and $b$ must be concave and less than $\frac{1}{2}$. In other words, the postwar returns to additional territory for an actor must be constant, or, if they are not constant, then they must be increasing. The most obvious examples satisfying these constraints would be a fixed border $a(\mu_t) = k$, in which case all gains are temporary, or a proportional return to additional territory $b(\mu_t) = k\mu_t + z$, where $k, z \in [0, 1]$, in which case all gains are the same proportion of temporary and permanent. I find the latter obviously plausible, and it follows immediately if one assumes that battlefield tactics do not change greatly as one side draws nearer to victory. I further assume that no state can ever win a war through surprise attack (though it can come very close), and so the codomain of $a$ and of $b$ I restrict to $[0, 1]$.

Second, $f$ must satisfy three constraints: (i) one state’s victories do not vary more than another’s, i.e. $f(\mu_t; \mu_{t-1})$ is symmetric about its mean; (ii) stunning victories are less likely than less stunning ones, i.e. $f(\mu_t; \mu_{t-1})$ weakly increases to its mean; and (iii) the character of battlefield outcomes does not depend on how near defeat a state has become, i.e. $f(\mu_t; \mu_{t-1}) = f(\mu_t + \delta, \mu_{t-1} + \delta) \forall \delta$. In addition, for its convenient properties, I assume that battle outcomes are a martingale, i.e. that $E[\mu_{t+1}; \mu_t] = \mu_t$. Some readers may feel this set of restrictions, especially the martingale requirement, holds only when two states are about evenly matched on the battlefield (but not necessarily in overall power), and thus proposition three is unlikely to hold for asymmetric conflicts, though it will still hold for unconventional ones if the belligerents are about evenly matched. If so, then the concern implies an additional scope condition for the model.

Third, given the possible confounding effects of cost from proposition 2, I hold it constant. Thus, $\forall t', t \geq T, S(t) = S(t')$, and so it will be convenient to refer to the settlement zone in any round simply as $S$; naturally, I assume that $\mu_0 \in S$, since to suppose otherwise would presume that war was ongoing before it began, which is absurd.

Fourth and finally, I impose a non-Reversal Constraint, so that no matter how great a state’s victory during war, it cannot cause a losing state to begin winning and also exclude the possibility of peace, i.e. if $\mu_t > \sup(S)$, then $\forall \mu_{t+1} < \inf(S), f(\mu_{t+1}; \mu_t) = 0$, and
similarly if $\mu_t < \inf(S)$. (Note that this assumption is implicit in all existing accounts of bargaining during war which assume discrete balances of power, since in these models the balance of power can shift by only one fort at a time, and so necessarily cannot overlap the settlement zone.)

These assumptions suffice for the proposition. I begin by proving that the set of points at which states can settle war must be convex; in other words, if states can settle the war at a point $x$ and a point $y$, they must be able to settle the war at any points in between.

**Lemma 3.1.** $S$ is convex.

Two features establish this claim: the convexity of the power differentials between war and peace and the concavity of the combined cost functions. I demonstrate each in turn.

To begin, note that $p(\mu_t)$ is a linear function of $\mu_t$; this is obvious when we recognize that $p(\mu_t)$ is concave if $E[\mu_t; \mu_{t-1}] \geq \mu_{t-1}$ and convex if $E[\mu_t; \mu_{t-1}] \leq \mu_{t-1}$. It follows that $p(a(\mu_t)) - p(\mu_t)$ is a convex function. Similarly, $p(\mu_t) - p(b(\mu_t))$ is also convex. Since costs are constant, we may regard $c_i(t, \mu_t)$ as a function of $\mu_t$. Because $f$ is symmetric about $\mu_t$ and weakly increasing to its mean, $c_i(t, \mu_t)$ must be concave with a maximum at $\mu_t = \frac{1}{2}$. Therefore, $c_i(t, a(\mu_t))$ is also concave. Thus, since both are concave, $c_A(t, a(\mu_t)) + c_B(t, \mu_t)$ must be concave; a similar reasoning also establishes the concavity of $c_B(t, b(\mu_t)) + c_A(t, \mu_t)$ and $c_A(t, a(\mu_t)) + c_B(t, b(\mu_t))$.

Given these facts, we can characterize $S$, the set of points where the three conditions of proposition one are satisfied. Since $p(a(\mu_t)) - p(\mu_t)$ is convex, and since $c_A(a(\mu_t)) + c_B(\mu_t)$ is concave, then the points at which $p(a(\mu_t)) - p(\mu_t) \leq c_A(a(\mu_t)) + c_B(\mu_t)$ (the first condition of proposition 1) must be a convex subset of $[0, 1]$. Similarly for the second and third conditions. Because $S$ is the intersection of these three sets, then $S$ itself must be convex, which proves the lemma.

The rest of the proposition follows from lemma 3.1 and the constraints on $f$. The intuition is simple: in expectation, $\mu_t$ will shift away from $S$, and because in expectation it never overshoots the midpoints between $S$ and the culminating points of victory, this shift, while diminishing, will continue forever. Because $f$ is symmetric and a martingale, for any $\mu_t$, if
it is closer to $S$ than it is to 0 or 1, then the probability of a peaceful settlement must be greater than the probability of a decisive victory in that round (and vice versa if it is farther from $S$). Thus, for a $\mu_t$ closer to $S$ than 0 or 1, if there is neither a settlement nor a decisive victory at time $t+1$, then in expectation $\mu_{t+1}$ must have moved away from $S$. Since $\mu_0 \in S$, and because $S$ is convex, then $\mu_t$ is probably closer to $S$ than to 0 or 1.

If we assume without loss of generality that $\mu_T \geq \mu_0$, then we can prove the proposition thus. Since $\mu_0 \in S$, $S$ is convex, and $f$ is a symmetric martingale increasing to its mean and bounded according to the non-Reversal constraint, it must be true that, in expectation,

$$E[\mu_t; \mu_t \in R, \mu_{t-1} \in R, \ldots] \geq E[\mu_t; \mu_t \notin R, \mu_{t-1} \in R, \ldots]$$

$$E[\mu_t; \mu_t \in R, \ldots] \geq E[\mu_t; \ldots]$$

Since $f$ is a martingale, then

$$E[\mu_{t+1}; \mu_t \in R, \ldots] = E[\mu_t; \mu_t \in R, \ldots]$$

And so we can see that

$$E[\mu_{t+1}; \mu_{t+1} \in R, \ldots] \geq E[\mu_t; \ldots]$$

Again, because $f$ is a symmetric martingale, and because $S$ is convex, $\phi(t, \mu_t)$ must be a linear function, just as $p(\mu_t)$ was linear. This implies that $\phi(t, E[\mu_t; \ldots]) = E[\phi(t, \mu_t); \ldots]$. Since $\phi(t, \mu_t)$ is decreasing as $\mu_t$ moves away from $S$ toward 1, then $\forall t' > t \geq T$

$$E[\phi(t, \mu_t)] \geq E[\phi(t', \mu_t')]$$

As the logic for $\mu_T \leq \mu_0$ is identical, this proves the proposition.