War Exhaustion and the Credibility of Arms Treaties

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Abstract

Why do some states agree to arms treaties while others fail to come to terms? I argue that the changing credibility of preventive war is an important determinant of arms treaty stability. If preventive war is never an option, states can reach settlements that both prefer to costly arms construction. However, if preventive war is incredible today but will be credible in the future, a commitment problem results: the state considering investment faces a "window of opportunity" and must build the arms or it will not receive concessions later on. Thus, arms treaties fail under these conditions. I then apply the theoretical findings to the Soviet Union's decision to build nuclear weapons in 1949. War exhaustion made preventive war incredible for the United States immediately following World War II, but lingering concerns about future preventive action caused Moscow to proliferate.

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1 Introduction

Recently, the United States has engaged in negotiations to trade policy concessions for limitations in arms. On the nuclear level, Washington has spent more than a decade trying to convince North Korea and Iran to forgo nuclear development, offering improved diplomatic relations and even food to induce more cooperative relations. On the non-nuclear front, Russia has sought to end a proposed missile defense shield in Eastern Europe and successfully negotiated a pause in development by giving the U.S. access to Russian shipping lanes into Afghanistan.

Arms agreements in this vein, implicit or explicit, are commonplace. Indeed, most states most of the time are not rushing to out militarize most other states. Yet not all agreements last over the long-term, and the failures tend to be most salient. This leads to an important puzzle: why do some states reach arms agreements while others fail?

Such broad a question undoubtedly has many viable answers. This paper focuses on a single mechanism: commitment problems as a result of the changing credibility of preventive war. Immediately after fighting one conflict, states often suffer from war exhaustion. This idea dates back to at least Richardson (1960, 232), who wrote that "a long and severe bout of fighting confers immunity on most of those who have experienced it; so that they no longer join in fights." Many issues might cause the exhaustion, though political reluctance, manpower shortages and limited military resources (Treisman 2004) are particularly problematic.[1] Regardless of the cause, the common thread is that states often find themselves momentarily vulnerable, finding the costs of war intolerably high today but bearable tomorrow.

I argue that fading war exhaustion causes a commitment problem that leads to inefficient arms building. During times of weakness, rivals wish to buy off potential rising states to remove the need for investment in weapons. However, during times of strength, rivals can leverage the threat of preventive war to deter arms building—after all, those rivals will not pay costly carrots when the deterrent stick is comparatively cheaper. Thus, potential rising states have a "window of opportunity" in the waning days of war exhaustion. Building guarantees continued concessions; not building means that rivals will cut concessions. As result, the potential rising states must jump through the window.

To illustrate the theory, I analyze the Soviet Union's decision to proliferate in 1949. Existing studies treat the nuclear outcome as inevitable once Washington and Moscow learned of their divergent preferences. However, as the baseline model will demonstrate, incompatible demands cannot explain the inefficiency puzzle. Put differently, why couldn't the United States and Soviet Union ne-

[1] The exact origins of war exhaustion remain in question, as empirical investigations have yielded mixed results (Levy and Morgan 1986; Pickering 2002; Ostrom and Job 1986; Feaver and Gelpi 2004; Lian and Oneal 1993). However, while failing to reject the null hypothesis that war makes a state less likely to go to war in the near future, Garnham (2002) is careful not to equate large-n aggregate results with individual-level behavior. Case studies clearly demonstrate that war exhaustion exists; the trouble is pinning down its causes.

gotiate a mutually preferable outcome and save on the cost of proliferation? I argue that fading war exhaustion from World War II combined with improving American intelligence rendered any such deal inherently unstable. The Soviet Union thus proliferated to secure the benefits of nuclear power well into the future.

This article speaks to four literatures beyond the works on war exhaustion. First, the literature on arms races and arms agreements has a long history in international relations. The prisoner's dilemma common models the phenomenon. In iterated versions, retaliation strategies such as grim trigger or tit-for-tat promote efficient outcomes under the threat of switching to inefficient equilibria.[2] I show that states can also reach efficient outcomes through conciliatory bargaining strategies. Indeed, the model I develop features only one-sided arming, thereby ensuring that the mechanism is distinct from retaliation strategies. In the process, it casts doubt on whether such retaliatory strategies are credible.

Second, the paper builds off of a rich research tradition on preventive war. Dating back to Thucydides (1972), the literature has remained popular over the last few decades. Although many researchers add nuance to the motivation for preventive war, the overall concept is that states declining in power relative to another might prefer paying the costs of war to lock-in favorable terms today to making the necessary accommodations later on (Levy 1987, 87).[3] I maintain this common definition. However, the focus here is *not* on the motivations for preventive war. Rather, the model developed below uses the preventive motivation to analyze how those incentives affect whether states successfully negotiate arms treaties.

Third, I build heavily off of formal models of preventive war. Initial treatments of preventive war assumed that the source of power shifts is exogenous (Fearon 1995; Powell 1999; Powell 2006). More recent research has allowed for endogenous (Chadefaux 2011) and costly (Debs and Monteiro 2014) power shifts in the context of explaining preventive war. I maintain these innovations. However, rather than explaining war, I focus how the shadow of war affects the stability of arms treaties. To do so, I allow the parties to negotiate over a bargaining good *before* any arming decisions are made. This means that a state can persuade its rival not to build weapons by endogenously shifting benefits upfront. Indeed, such tactics lead to Pareto improvement.

Lastly, this paper directly engages an empirical debate on the Soviet Union's decision to build nuclear weapons in 1949. Conventional wisdom treats the decision as trivial—the United States could not launch preventive war (Sagan and Waltz 2003, 56-59; Gaddis 1982, 149), so the Soviet Union proliferated to reap the benefits of a nuclear arsenal. However, the baseline model shows that disagreement does not explain costly investment in weapons. Rather, the sides have incentive to negotiate an agreement that would leave both better off than had investment occurred. I instead argue that the United States' inability to credibly commit to concessions over the long term forced the Soviet Union to

[2] Axelrod 1984; Downs, Rocke, and Siverson 1986; Ikle 1961, 214-215. For criticism, see Downs and Rocke 1990.

[3] See Van Evera 1999 and Copeland 2000 for other recent treatments.

proliferate to lock-in a favorable distribution of resources.

This article proceeds as follows. I begin by generating a baseline model of bargaining over weapons. While it is clear why declining states are happy to engage in agreements, the model shows that rising states can credibly commit to status quo arms levels by threatening to invest if the declining state does not cede to its demands. The following section extends the model to cover war exhaustion and the changing credibility of preventive war; the aforementioned commitment problem results. After, I illustrate the model's logic using the Soviet Union's decision to proliferate in 1949. A brief conclusion ends the paper.

2 Why Bargain? Modeling Arms Treaties

To establish the puzzle, I begin with a simple model of bargaining over weapons in the shadow of war. The central argument of this section is that incompatible demands do not explain the production of arms. Indeed, two states in deep disagreement over a bargaining good still have incentive to reach arms treaties, as the costs of weapons and war open up a range of mutually preferable settlements, similar to the bargaining model of war (Fearon 1995).

2.1 The Game

Consider an infinite horizon game between two actors, D (the declining state[4]) and R (the rising state), as illustrated in Figure 1. The game begins before R has invested in new arms. D makes an offer $x_t \in [0, 1]$ to R, where t denotes the period. R accepts, rejects, or builds in response. Rejecting results in game ending war; R receives $p_R \in [0, 1)$ in expectation while D receives $1 - p_R$. These payoffs persist through all future periods, but the states pay respective costs $c_D, c_R > 0$ in each future period regardless.[5]

If R accepts, the period ends. R receives x_t for the period while D receives $1 - x_t$. This process then repeats, with D making another temporary offer x_{t+1}.

If R builds, it forgoes the concession D offered and pays a cost $k > 0$ to begin constructing the new weapons. D sees this and decides whether to initiate a preventive war or advance to bargaining post-power shift. Preventive war ends the game and results in the same terminal payoffs as though R had rejected D's offer x_t. If D advances, the period ends, and R receives x_t for the period while D receives $1 - x_t$.

If R successfully builds, R's outside option of war improves in all future periods. D makes an offer y_{t+1} to R in such a post-shift period. If R accepts, the period ends, R receives y_{t+1} for the period, D receives $1-y_{t+1}$ for the period, and the game repeats the post-shift bargaining period, where D makes another offer y_{t+2}. If R rejects, a game-ending war results. Here, R takes $p'_R \in (p_R, 1]$ in expectation while D receives $1 - p'_R$. That is, R expects to receive more from

[4]One might alternatively conceptualize D as the coalition of states against R.

[5]The results are the same if costs are only paid in the period of fighting. Moreover, the proof is identical except that c'_i substitutes for c_i, where $c'_i = \frac{c_i}{1-\delta}$.

war with the weapons than without. These payoffs again persist through time, but the sides still pay their respective costs c_D, c_R.[6]

The states share a common discount factor $\delta \in (0, 1)$. Thus, the states discount period t's share of the good and costs paid by δ^{t-1}. The discount factor reflects two underlying parameters. First, as is standard, greater values place greater weight on future payoffs. Second, and common to models of shifting power, δ also represents the time it takes R to successfully develop its new weaponry. Ineffective programs correspond to lower values, as more time must pass before the states renegotiate their terms of settlement.

Note that the model makes a couple of important assumptions In particular, I assume that the decision to arm is public and that D can retract any offer it makes if R decides to build. Both these assumptions make arming look less attractive—the public observation means that R cannot build weapons without facing the direct threat of preventive war, while retractable offers forces R to forgo any gains today if it wishes to have more power tomorrow. A skeptical reader may believe this unfairly stacks the deck in favor of sustainable agreements. In fact, however, agreements succeed even under these harsher circumstances. The reason is interesting and previews the results that follow for the model described. R's decision to build is relatively trivial—it looks at how much it can receive from building and compares it to how much it is currently receiving from the concessions. Consequently, D can strategically manipulate R's decision by making R's stake in the status quo so compelling that *not building strictly dominates building.* Under such conditions, R will not build regardless of whether its build decision is hidden or whether D can retract its offer.

Since such agreements work under these more complicated circumstances, I choose to solve for the simpler bargaining environment because the results are substantially more transparent. Additionally, this paper ultimately aims to show that arms treaties fail when the credibility of preventive war changes over time. Consequently, if arms treaties fail here, they will fail under less optimistic circumstances as well.

2.2 Equilibria

Since this is an extensive form game with complete formation, subgame perfect equilibrium (SPE) is the appropriate solution concept. An SPE is an equilibrium such that the strategies form a Nash equilibrium in every subgame.

Before stating the main results, the following lemma will prove useful:

Lemma 1. *In every SPE, in every post-shift period, D offers* $y_t = p'_R - c_R$*, and R accepts.*

The intuition is a straightforward application of Fearon's seminal bargaining game.[7] Since war creates deadweight loss to the system, D can always offer enough to satisfy R, and the optimal acceptable offer is preferable to war for D

[6] Similar results would obtain if the costs of war changed in post-shift periods.

[7] See the appendix for complete proofs of this lemma and all the propositions. Throughout, I assume $p_R - c_R > 0$ to avoid corner solutions.

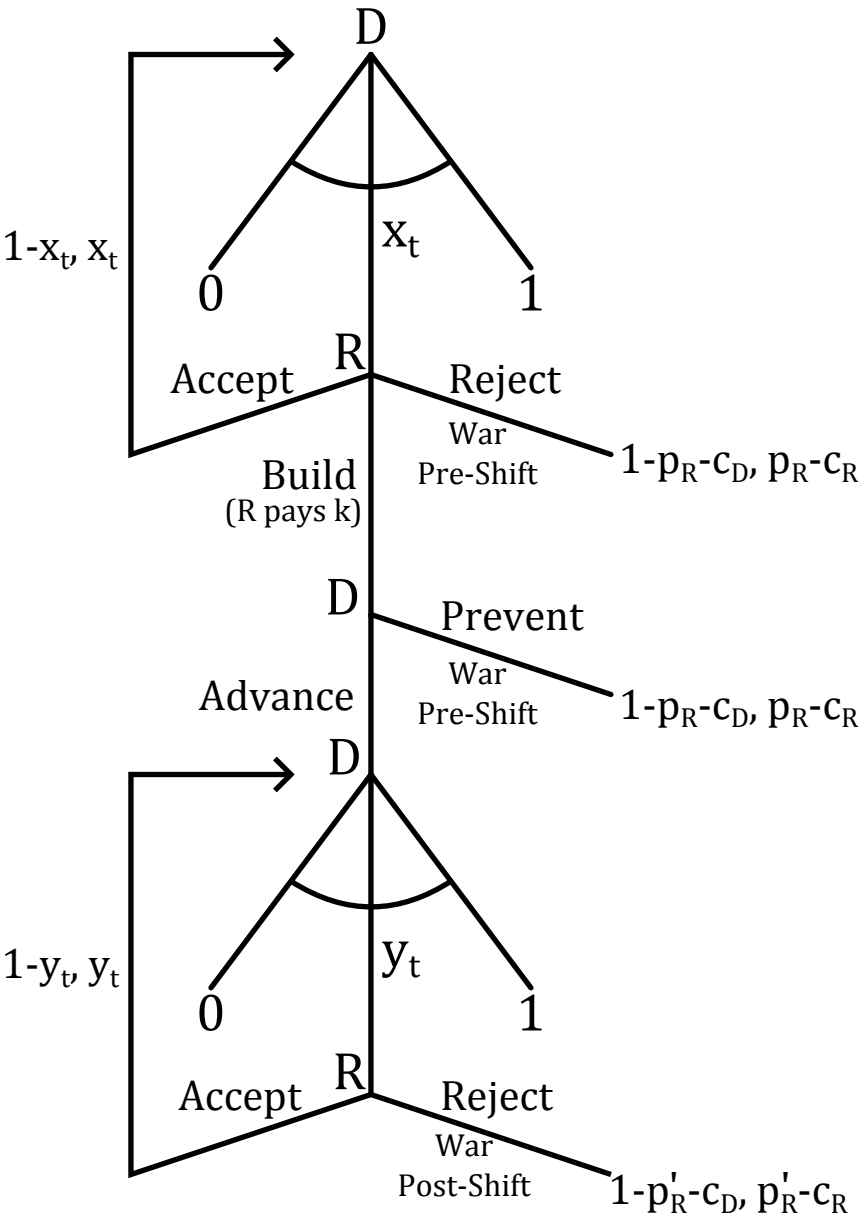

Figure 1: The baseline model. All payoffs listed are for the period, though the war outcomes lock in their respective payoffs every period for the rest of time.

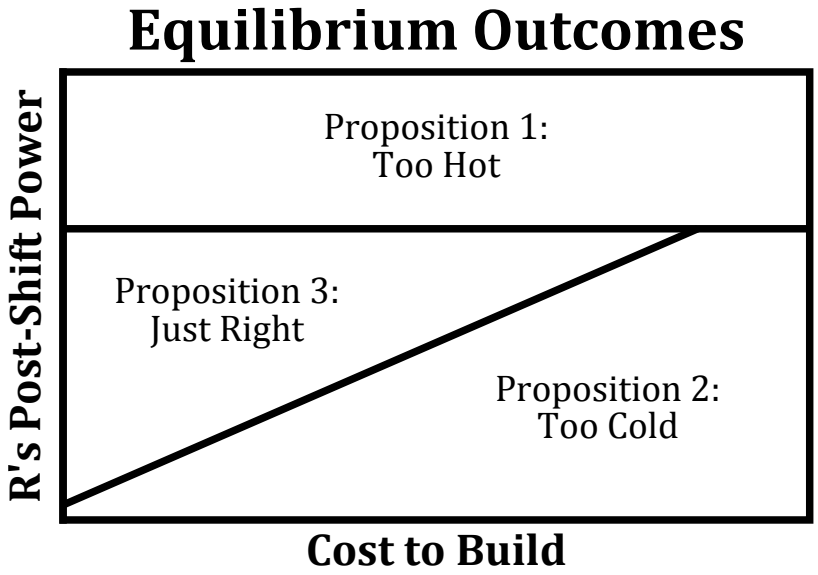

Figure 2: Equilibrium outcomes as a function of p'_R and k. Figure drawn to scale with $p_R = .3$, $c_D = .3$, $c_R = .2$, $k = 1$, $\delta = .9$.

as well. Thus, D offers just enough to induce R to accept. D keeps all of the surplus. In particular, R earns $p'_R - c_R$ and D earns $1 - p'_R + c_R$ for the rest of time. Peace prevails.

Overall, Lemma 1 shows that R has great incentive to build—additional weapons mean greater coercive power, forcing D to offer more concessions to maintain the peace. Consequently, it is not remarkable that declining states want rising states to commit to non-armament agreements. What is surprising is that rising states can credibly abide to such deals.

Before stating the propositions, Figure 2 previews the results. When the power shift is great (relative to the other parameters), D finds a power shift "too hot" to allow. Internalizing this, R does not build and avoids wasting the cost of investment. On the other end of the spectrum, when the power shift is too small relative to the cost of building, R finds the investment "too cold" to be worthwhile. Again, treaties prevail. In the middle case—a situation appearing "just right" for arms control failure—the parties strike an agreement.

Proposition 1. *If* $p'_R > \frac{p_R + c_D}{\delta} + c_R$*, D offers* $x_t = p_R - c_R$ *in the unique SPE. R accepts these offers and never builds.*

Note that the left side of the inequality (in part) measures the extent of the power shift, while the right side contains the inefficiency of war. When the shift is sufficiently greater than war's inefficiency, the power shift is "too hot." If R were to build, D would respond with preventive war. As a result, the credible threat to fight makes R's threat to build incredible. In turn, D can treat the bargaining problem as though R cannot build. Consequently, D

offers $x_t = p_R - c_R$ (the amount R would receive in a static bargaining game), R accepts, and the states avoid war.[8]

Thus, bargaining succeeds here. However, the offers are trivial—R receives exactly what it would earn in a static game that did not feature a power shift. In turn, if R is to coerce concessions out of D, preventive war must first not deter R from attempting to build weapons. The next proposition therefore looks at when the potential power shift is relatively small:

Proposition 2. *If $p'_R < \frac{p_R+(1-\delta)(k-c_R)}{\delta}$, D offers $x_t = p_R - c_R$ in the unique SPE. R accepts these offers and never builds.*

Note the right side of the inequality (in part) reflects the time-adjusted cost of building. When the magnitude of the shift is too small relative to that cost, the power shift is "too cold" for R to find investment worthwhile. D observes that R does not have a credible threat to build and therefore offers the same concessions it would offer if power were static. As a result, though for different reasons, the observable outcome for these parameters are the same as the outcome for Proposition 1's parameters.

Bargaining again succeeds here, though the reason remains trivial—R would not want to build under any circumstances and thus receives the same amount as it would in a game with static power. As such, if R would ever develop weapons it must be in the "just right" region in which D would not want to prevent yet R finds investment worthwhile. Nevertheless, as the next proposition shows, bargaining supersedes the need to engage in inefficient investment:

Proposition 3. *If $\frac{p_R+(1-\delta)(k-c_R)}{\delta} < p'_R < \frac{p_R+c_D}{\delta} + c_R$, D offers $x_t = \delta(p'_R - c_R) - (1-\delta)k$ in all pre-shift periods in the unique SPE; R accepts and never builds.*

Why does bargaining succeed here? R views arms building as investment in future coercive power. If it were to ever make such an investment, it would reap the rewards $(p'_R - c_R)$ in accordance with Lemma 1. However, D anticipates this and recognizes that R will shift power if its offers are insufficient. Rather than inducing R to go down that route, D benefits by immediately offering most of the concessions R would receive in the future. R has no need to invest at that point, while D benefits by extracting the potential investment cost k.

Note that R's decision to not build is a dominant strategy.[9] This is because building generates $\delta(p'_R - c_R) - (1-\delta)k$ forever, while accepting gives that amount today and *at least* that amount in the future, since R can always build later. As a result, similar agreements work even if the model assumes non-retractible offers or hidden arming decisions.

Before moving on, it is worth highlighting two important insights of the basic model. First, arms construction is not an inherently irreconcilable issue.

[8] The fact that preventive war does not occur here should be unsurprising since the game has complete information and power shift is observable and endogenous (Chadefaux 2011).

[9] If $x_t > p_R - c_R$, it is strictly dominant. If $x_t = p_R - c_R$, it is weakly dominant.

Why states find weapons programs attractive is clear: additional strength favorably shifts the balance of power. In contrast, it is not clear states fail reach agreements that reflect that potential power and override the need to invest in inefficient weapons programs.

Second, the basic retaliatory explanation for why states adopt similar weapons programs fails. This is critical for the case study developed below. One might conclude, for example, that the Soviet Union chose to develop a nuclear weapon because the United States had them. However, the model says nothing about whether the declining state has nuclear weapons at the start of the interaction. Regardless, the states should reach a negotiated agreement that would mutually preferable to a proliferation outcome. Consequently, if negotiated agreements leave everyone better off, it is not immediately clear why the Soviet Union (or any other state) would want to proliferate in response to another state's nuclear acquisition. Bargaining failure must result from a different mechanism.[10]

3 How Bargaining Can Fail

The baseline model generates a simple result: incompatible demands do not explain why states invest in major arms programs. This explains why most states are not maximizing military power most of the time. Of course, exceptions to the rule exist. Similar to the baseline model in Fearon 1995, this does *not* imply that weapons development is irrational. Rather, the model presents a puzzle: if arms deals could leave both sides better off, why does bargaining sometimes fail?

Although many explanations surely exist, this section develops one of them: the changing credibility of preventive war. To preview the results, if the costs of preventive war vary greatly over time, R eventually faces a "window of opportunity" that amounts to a now-or-never chance to develop the weaponry. If R chooses to do so, it receives great concessions in the future as Lemma 1 indicates. If R fails to build, it receives its reservation value for war without the additional power as the "too hot" parameters of Proposition 1 dictate. The difference in value forces R to pay for the inefficient arms since any promise from D to continue concessions into the future is inherently incredible.

3.1 The Modified Game

The overall structure remains the same—D bargains with R over an infinite horizon, R can choose to invest in an arms program in pre-shift periods, and R receives a greater payoff from war in post-shift periods. However, D's cost of war now varies over time. Explicitly, D's cost of war is $c_D(t)$, where $c_D(t) > 0$ for all t. Note that this extension nests the original model, with $c_D(t) = c_D$.

[10] That is not to say that retaliatory arms building is irrational. Indeed, if arms construction occurs due to bargaining failure, it stands to reason that the same source of the bargaining failure might compel both parties to develop the weapons.

To focus on instances where D finds preventive war more attractive as time passes, suppose $c_D(t) > c_D(t+1)$ for all $t = 1, ..., \bar{t}$ and equals some strictly positive constant for all $t > \bar{t}$.[11] Intuitively, this means that D's war exhaustion wears away through the first $\bar{t}$ periods and disappears entirely at period $\bar{t}+1$ and forward. In turn, war becomes increasingly attractive for D as time progresses up until a particular point.[12]

3.2 Inefficient Equilibria

The interaction remains an extensive form game with complete information, so I still search for SPE. Efficient equilibria remain possible under particular circumstances. However, I focus on a particular parameter space where tensions are greatest. Specifically, I impose the following restrictions:

Condition 1. *(Changing Credibility of Preventive War) A period $t^* \geq 2$ exists such that $p'_R > \frac{p_R + c_D(t)}{\delta} + c_R$ for all $t \geq t^*$ and $p'_R < \frac{p_R + c_D(t)}{\delta} + c_R$ for all $t < t^*$.*

The rationale is that all other cases are uninteresting, follow straight from propositions found in the previous section, and render D's changing war exhaustion inconsequential. If no such critical period t^* existed, then either D's threat to prevent would be credible throughout the interaction or D's threat to prevent would be incredible throughout the interaction. In the first case, Proposition 1 states the equilibrium strategies; D's threat to intervene compels R not to build. Intuitively, if D is *very* willing to prevent, then marginal additions to the cost of preventive war do not alter the credibility of intervention. In the second case, the remainder of previous propositions contain the solution; R receives concessions if and only if the cost to build is sufficiently cheap. Intuitively, if D is *very* unwilling to prevent, then any minor change to the cost of war will have no effect on the incredibility of prevention. Either way, war exhaustion has no substantive impact on the game's outcomes. Thus, this section restricts the discussion to the middle cases the assumption describes.

Also, note that t^* simply represents the first period in which D can credibly threaten preventive war. Thus, it must be that $t^* \geq 2$; if $t^* = 1$, then D can always credibly threaten preventive war.

Condition 2. *(Large, Rapid Shifts) Let $\delta(p'_R - c_R) - (1-\delta)k > 1 - \delta + \delta(p_R - c_R)$.*

This condition is critical to generating the results below. If war exhaustion fades away slowly, it becomes possible for D to credibly buy off R during the final period of its war exhaustion because R impatiently prefers capturing a

[11] The results presented would be similar if war exhaustion wore off non-deterministically.

[12] Note that nothing in the model strictly ties the interpretation to war exhaustion. Indeed, the model generally speaks to any situation in which preventive war becomes more attractive for the declining state over time. The case study about the Soviet Union considers one such alternative interpretation.

larger share today. Under these conditions, the flow of goods can satisfy D since it allows D to steal the surplus from R not building.

In interpreting the substantive meaning, the assumption is analogous to known results about preventive war: large, rapid, exogenous shifts in power create a commitment problem (Powell 1999, 115-148; Powell 2006). The difference here is that this is not a model of preventive war. Rather, the rapid shift in D's cost of preventive war causes inefficient arms construction to occur.

In addition, I restrict the parameter space away from the "too cold" outcome from Proposition 2; even if war exhaustion changes the credibility of preventive war, R will never build if the return on investment is too small relative to the cost of weapons, or $p'_R < \frac{p_R+(1-\delta)(k-c_R)}{\delta}$.

Proposition 4. *In every SPE, D offers* $x_t = \delta(p'_R - c_R) - (1-\delta)k$ *and R accepts in periods* $t = 1, ..., t^* - 2$. *In period* $t = t^* - 1$, *R builds regardless of D's offer.*

In words, the parties negotiate non-armament for the first $t^* - 2$ periods; the continued threat to build in the future compels D to give concessions or lose out on the surplus. However, that continued threat disappears in period $t^* - 1$, as D can effectively threaten preventive war beginning in period t^*. At this point, similar to Proposition 1's outcome, a power shift is "too hot" for D to let go without preventive war. As a result, R knows it will not receive concessions to match its potential power in these future periods. In contrast, if it builds, it receives a larger share of the bargaining good, as per Lemma 1. Consequently, it invests in arms to force the concessions from D.

A time inconsistency commitment problem causes the inefficiency. Since bargaining is zero sum and investment in weapons adds deadweight loss to the system, resolutions exist that leave both parties better off. However, D cannot credibly commit to such settlements. Indeed, in period $t^* - 1$, D would like to commit to continuing its level of concessions to R for the rest of time. Such an offer—if credible—would negate R's need to shift power. Unfortunately, R's credible threat to develop weapons drives D's credible commitment to give concessions into the future. But once D's cost of war sufficiently decreases, R loses the threat to arm due to D's credible preventive war response. Negotiations unravel as a result.

4 Illustrating the Mechanism: The Soviet Union, 1949

The Soviet Union became the second member of the world's nuclear club on August 29, 1949. Why Moscow viewed proliferation as attractive is evident. The United States and Soviet Union had just begun the Cold War, and the race for geopolitical supremacy was on. Nuclear weapons provided the Soviet Union with inherent security and stabilized communist grasp over Eastern Europe. Although nuclear technology was far more expensive back then, the investment was reasonable given the issues at stake.

Existing work on the origins of the Cold War focus primarily on whether the United States or Soviet Union actually had reason to be antagonists. Researchers have not arrived at a consensus (Kydd 2005, 80-83). However, the existence of mutually preferable agreements per the baseline model means that this distrust alone cannot outright explain why the Soviet Union proliferated in 1949. This is in contrast to the conventional wisdom on nuclear weapons, which largely argues that states proliferate when the additional security is worth the cost of construction (Sagan 1997, 54-55). Put bluntly, the notion that "security is the only necessary and sufficient cause of nuclear proliferation" (Thayer 1995, 486) is incorrect.

Because the literature has often assumed that such deals are impossible, existing research on the Soviet decision to proliferate focuses on the United States' choice not to launch preventive war; after all, the U.S. held a nuclear monopoly at the time and could have forcibly ended the Cold War before the Soviet Union obtained a nuclear deterrent. Ultimately, the general consensus is that war would have been too costly and ineffective to be worthwhile (Sagan and Waltz 2003, 56-59; Gaddis 1982, 149). Thus, the U.S. stood pat and allowed the nuclear monopoly to become a nuclear duopoly.

Given that preventive war was not a viable option, this paper's baseline model poses a new question: why didn't the United States bargain its way out of the nuclear escalation during the Cold War? That preventive war was too costly to be worthwhile merely says that the interaction does not fit the "too hot" parameters of Proposition 1; that the weapons were worth the investment merely says that the interaction does not fit the "too cold" parameters of Proposition 2. Surely, the United States would have preferred offering a settlement to forcing the Soviets to proliferate; nuclear weapons were still enormously expensive at the time, leaving plenty of surplus for the United States to capture if negotiated succeeded.[13] Instead, bargaining failed, and Moscow obtained a nuclear weapon.

This section argues that two complementary factors led to the breakdown of bargaining. Both fit the causal mechanism the model's extension illustrates. First, American and British war exhaustion made immediate preventive war against the Soviet Union an impossibility in the short term but not the long term; American restraint during the Berlin Blockade but acceptance of war during the Cuban Missile Crisis illustrate the United States' evolving willingness to fight. Second, as Western intelligence infiltrated the previously undisturbed the Soviet Union, the material cost of preventive war diminished over time. Combined, these factors kept the United States from credibly committing to concessions over the long term, which in turn forced the Soviet Union to proliferate while the opportunity remained open.

[13]To wit, American proliferation just a few years earlier required 130,000 workers (the size of America's automobile industry at the time) to construct the first nuclear weapon (Hugues 2002, 9). While secrets stolen from the Manhattan Project eased the Soviet effort, the Soviet Union lost the nuclear race in the first place due to an inferior industrial base. This meant that the Soviet Union had to pay a greater cost in diverting industrial resources to the Soviet bomb project.

4.1 Rising Tensions: Conflict in Germany

Some historical background is in order, beginning with the breakdown in cooperation between the United States and the Soviet Union at the end of World War II. During the war, Washington worked to build ties with Moscow. Indeed, the Soviet Union received the second most aid from the Lend-Lease Program after the United Kingdom, and the U.S. offered the Soviets disproportionately large voting shares in the International Monetary Fund and World Bank during the Bretton Woods conference (Mikesell 1994, 22-23; Stone 2011, 54-56).

While tensions between the allies remained below the surface in the immediate aftermath of the war, the conflict became evident in the next couple years. Moscow pressed for war reparations from Germany and began dismantling German factories to ship useful parts back to the Soviet Union (Naimark 1995, 141-204). At the time, Stalin was uncertain whether the Soviet Union could hold onto its territorial gains; reparations ensured at least some long-lasting benefit from the post-war advantage (Stone 1996, 27-28). This presented a problem for Washington, which wanted to return its troops home as soon as possible. Doing that would require rebuilding the German economy to self-sufficiency; reparations had the opposite effect. Lucius Clay, governor of American-occupied Germany, halted payments from the Western allies' sectors in May 1946 (Reynolds 2006, 276). But this had a spiral effect, causing Stalin to further distrust the Americans. From here, it became clear that the period of cooperation was over.

However, the bargaining logic dictates that even the most antagonistic of states have incentive to negotiate with one another. Without bargaining frictions, states ought to resolve the conflict and avoid the deadweight loss cost of nuclear weapons. So even if American/Soviet tensions began as a matter of distrust (Kydd 2005), that does not explain why the Cold War powers could not develop some sort of *ad hoc* resolution.

4.2 War Exhaustion and Domestic Political Resistance

What else explains the lack of agreement? One critical factor was American war exhaustion immediately following World War II. The rush to send troops home created a manpower problem. Some divisions lost all their soldiers with specialized training (Quester 2000, 74); needless to say, tanks without any tank drivers are not useful. This left the United States in a moment of strategic vulnerability. The Soviet Union held a substantial tactical advantage on the ground at the time, outnumbering allied soldiers in Berlin 18,000 to 6,500 with an additional 300,000 in near proximity (Tusa and Tusa 1988, 173). Indeed, NSC-68 advised that a preventive nuclear assault on the Soviet Union would not compel Moscow to surrender, but the Soviets would "dominate most or all of Eurasia" (Sagan and Waltz 2003, 56-57).

To some extent, the discrepancy was a residual from World War II. Whereas the Red Army had fought mostly against Nazi Germany, the United States fought a two-theater war. This meant that Soviet soldiers had a natural numbers advantage in Europe. Worse, the Truman administration tried but failed to

keep the United States armed and proactive after the war ended; the domestic political situation in the United States simply was not conducive to this policy (Friedberg 2000, 98-107). Republicans accordingly took control of the House and Senate on a platform of demobilization and lower taxes, at the expense of military preparedness. Following the electoral defeat, Truman gave in, allowed the military balance in Europe to decay and reduced defense expenditures.[14] The Truman administration did not act naively here; a few years later, despite NSC-68's warning, defense budget cuts persisted due to the lack of domestic political will.

Similar electoral problems meant that the United States could not expect help from the United Kingdom, either. Winston Churchill, British political hero of World War II, expounded the virtues of preventive war against the Soviet Union (Quester 2000, 47-48; Trachtenberg 1985, 9).[15] However, the Labour party defeated the Conservatives in the 1945 Parliamentary election, after victory in Europe but before victory in Japan. Despite his successes during the war, British civilians had lost their appetite for conflict and believed Clement Attlee's Labour party would better implement domestic reforms (Jenkins 2001, 789-794; Berinsky 2009, 201). Churchill had to settle in as leader of the opposition.

The discrepancy between short-term military realities and long-term inevitabilities compelled the Soviet Union to take on a more aggressive policy. Washington engaged Moscow in good faith following the end of World War II. However, worried that the United States would ultimately marginalize the Soviet Union, Moscow pursued an expansionist policy in Eastern Europe. When the U.S. realized Soviet intentions, Washington began a more antagonistic approach. But without domestic resolve for more conflict abroad, the American response was weak—despite calls for preventive war coming moderate voices and not exclusively the "lunatic fringe" (Trachtenberg 1985, 7-11), Washington adopted a passive stance in the aftermath of World War II.

[14]The United States had a similar underprovision of nuclear weapons following Hiroshima and Nagasaki (Hewlett and Anderson 1962, 624-633). However, this was not a matter of capabilities. Instead, the U.S. decided not to engage in further conflict and consequently let the nuclear program go into temporary disarray (Quester 2000, 57-61). Many scientists left the project, having decided that "their mission had been accomplished" (Hewlett and Anderson 1962, 625). The U.S. also lacked sufficient bombers to to deliver an all-out assault, and U.S. planners worried about Soviet anti-aircraft defenses regardless (Quester 2000, 82-85).

[15]At the end of the war in Europe, Churchill commissioned a contingency plan, entitled *Operation Unthinkable*, which called for a surprise attack on the Soviets on July 1, 1945. Advisors ultimately scrapped the idea as infeasible; the best Britain could hope for was fleeting change in Poland, as an invasion of Russia would have been prohibitively difficult for the reasons outlined below. Still, when collecting German arms, Churchill required British troops organize the weapons in a manner such that they could be easily redistributed to the Germans, in case Britain needed German soldiers for the offensive. See Reynolds 2006 (249-251).

4.3 War Exhaustion in Action: The Berlin Airlift

The Berlin Blockade and subsequent Berlin Airlift provide the ideal illustration of this exhaustion around the time of Soviet proliferation. At the end of war, the allies divided Germany into four occupation zones. Although Berlin fell squarely in the Soviet sector, Western allies shared the western half of the city. West Berlin relied on imports for its basic food and energy needs. Yet, in dividing Germany, Washington failed to secure land access to Berlin through the Soviet zone; the U.S. would try to rectify this one month after victory in Europe, but the Soviets limited the West to a single rail line (Miller 2000, 6-7). Moscow soon cut that off, too.

With trust breaking down, the West developed a plan to rebuild Germany's economy on its own. However, the Soviets sought substantial war reparations. Currency manipulation was a major issue; unbacked Soviet printings had so completely devalued the Reichsmark that cigarettes became a *de facto* currency (Turner 1987, 24). As such, the Western economic reconstruction plan began with the introduction of the Deutsche Mark. For Moscow, this amounted to economic warfare (Miller 2000, 31-33). Realizing that East-West cooperation in the German occupation was over, the Soviet Union blockaded West Berlin beginning June 24, 1948. Without shipments of basic necessities from the East or the West, Moscow aimed to starve West Berlin into submission within a matter of weeks.

Decision-makers in Washington lamented the seemingly unwinnable situation. Withdrawal was unacceptable. The chances of negotiation a solution with Moscow appeared slim, given that the Soviet Union began the crisis in the first place. Moreover, Western propaganda partially tied American and British hands because elites had expressed sympathy for Russians and touted Stalin's trustworthiness throughout during World War II (Holloway 1994, 256).[16] While not insurmountable—the United States could mobilize back to World War II levels—this created a stumbling block for accelerated war against the Soviet Union.

Nonetheless, if ever there was an opportunity to challenge the Soviets militarily, this was it. The United States held a nuclear monopoly at the time; the first successful Soviet test was still more than a year away. Moscow would have been hard-pressed to push the issue past Berlin given the shadow of the American nuclear arsenal. Moreover, the blockade represented a direct violation of the occupation agreement. A military confrontation was justifiable.

Ultimately, President Harry Truman ordered a massive airlift, the most conservative option available. Washington did not believe the airlift would have any substantive effect on the political situation; to wit, when a reporter asked Lucius Clay whether an airlift could sustain West Berlin, Clay responded "absolutely not."[17] Rather, the airlift represented a lack of viable alternatives at

[16] See Gaddis 1972 (32-62) for the evolution of America's perception of the Soviets from 1941 to 1944. Churchill, in particular, once commented that by trusting Stalin he was not making the same mistake Chamberlain made in trusting Hitler (Yergin 1977, 65).

[17] Quoted in Harrington 2012 (101). See Harrington (99-118) for an overview of American

the time. Simpler alternatives, such as sending convoys on the highway with a military escort, created more risk of Soviet intervention and full-scale war. In the end, Washington did not want to leave anything to chance.[18] Thus, the airlift policy aimed to minimize the chances of war—accidental or deliberate—at all costs (Tusa and Tusa 1988, 173-174; Harrington 2012, 86). Delivering essential supplies through the air would keep West Berlin running and stall for time while not being as provocative as military convoys.

In hindsight, though, the decision was brilliant. West Berlin survived for more than ten months thanks to the non-stop deliveries. Moscow eventually lifted the blockade on May 12, 1949. The result was a propaganda coup for the United States and a devastating loss for the Soviet Union, as the blockade entrenched West Germans against the communist regime. Nevertheless, at the time, the Airlift was a shot in the dark, a least-bad option given that war exhaustion mandated a peaceful outcome even at the expense of Berlin.

4.4 American Intelligence Failures

As reluctant as the United States was to engage over the Berlin Blockade, the cost to halt the Soviet nuclear weapons program would have been exponentially larger. Poor intelligence was a major factor. Indeed, it is hard to imagine the United States in a worse position than that of 1946. During World War II, the United States focused its intelligence efforts on Nazi Germany and Japan. This in part created to the Soviet proliferation problem—American efforts to stop German espionage on the Manhattan Project opened the door to Soviet spying (Gaddis 1997, 93). More importantly, though, it left an embarrassing gap at the end of the war:

> [T]he Workers' Paradise was "denied territory" in intelligence parlance: there were *zero* American ground agents in the Soviet Union. In 1949 the CIA began a five-year program to recruit and train former Soviet citizens to be air-dropped back on Soviet territory to serve as informants. Almost all of them were arrested immediately and unceremoniously shot. (Gordin 2009, 82)

Washington thus had to rely mostly on open-source information (Goodman 2007, 8), which hardly helped given the issue at hand.

Making matters worse, U.S. intelligence was undergoing a bureaucratic shuffle at the time. Wartime called for an extremely powerful intelligence organization; peacetime no longer required that necessary evil. As such, the Office of Strategic Services disbanded. But this led to a power vacuum. Competing bureaucratic organizations fought to succeed the OSS, leaving the United States without streamlined intelligence (Ziegler and Jacobson 1995, 14-21). The Central Intelligence Agency would not consolidate bureaucratic power for a few years.

pessimism.

[18] See Schelling 1960 (199-201).

Details on the Soviet nuclear program were correspondingly sparse both in terms of time and location. As policymakers in the United States debated whether to initiate preventive war, estimates of Moscow's nuclear timetable were notoriously vague and pushed the best-guess back to 1953 (Holloway 1994, 220).[19] Even after the Soviets tested their first bomb in 1949, the United States still had yet to develop an effective system to monitor test explosions. Low-level flyovers used against Nazi Germany (Ziegler and Jacobson 1995, 1-10) were not practical against the Soviet landmass. Scientists instead conceived of a seismic detector. Unfortunately, the United States had too few bombs available to accurately test the device (Ziegler and Jacobson 1995, 14) and worried about the environmental externalities. Washington would eventually obtain strong intelligence from Germany but not until 1955, six years too late (Gordin 2009, 83).

Consequently, unlike Israel's precision strikes in Iraq in 1981 and Syria in 2007, preventive war against the Soviet Union would have required a full scale invasion and was thus inconceivable. Americans simply had no desire to engage in a potentially small scale conflict in Berlin, never mind a complete invasion of the world's largest country. Given these constraints, the United States' remaining option was to drop nuclear bombs on the entire Soviet Union. But this too was infeasible. In 1948, the United States had a minuscule arsenal of thirty nuclear weapons and only fifty B-29 bombers to deliver them (Gaddis 1987, 109). Even if the United States could have accelerated nuclear weapons production, the bombers were slow. Destroying targets deep in Soviet territory would have been impossible (Harrington 2012, 81). In the meantime, due to the conventional imbalance that war exhaustion caused, Soviet forces would have overrun American troops in Europe. Put simply, preventive war was not worth the substantial cost at the time.[20]

4.5 Fading War Exhaustion, Improving Intelligence, and the Closing Commitment Problem

So preventive war was not an option for the United States in 1949. By itself, this is insufficient to explain the Soviet's decision to proliferate given that agreements should resolve the proliferation problem. However, both sources of American reluctance to prevent were diminishing over time. This placed the United States in the commitment problem described in the extension of the model, which in turn forced Moscow to proliferate.

First, American exhaustion from World War II declined as the calendar

[19] This led to a second-order problem: the United States never believed that preventive war was urgent, since Washington consistently held the belief that the Soviet Union would need more time to build a bomb. But even in a counterfactual world in which Washington knew about the short time line, preventive war was still not an option for the reasons outlined here.

[20] American leaders also expressed moral concerns about how such a poorly-targeted preventive war would undoubtedly result in a high number of civilian casualties, though others thought *not* engaging was immoral (Bhite and Hamel 2005, 375). See Silverstone 2007 (51-75) for an overview of the normative concerns in Washington.

pushed well beyond 1945.[21] The Korean War began in 1950. America's intervention sent a mixed message. On one hand, the U.S. fought a proxy regime that was much weaker than the Soviet Union. On the other hand, Korea was not an existential threat to the United States and of arguably less value than Berlin. But dollars and votes tell a compelling story. The Korean War revitalized America's deflated defense budget, allowing Truman to begin implementing NSC-68's recommended policies (Jervis 1980). Meanwhile, on the domestic political front, former Supreme Allied Commander Dwight D. Eisenhower won the 1952 U.S. presidential election. Cold War tensions also propelled Churchill back into his seat as Prime Minister, largely due to his foreign policy credentials.[22] In the counterfactual world in which the Soviet Union did not proliferate, perhaps the United States and United Kingdom were not ready for preventive war in the early 1950s, but they were certainly *more* ready than just five years earlier. To wit, the calls for preventive war continued in Washington even after the Soviet Union started producing nuclear bombs (Buhite and Hamel 1990, 376-381).

By 1962, however, the United States was certainly prepared to engage the Soviet Union in preventive war. On October 14, 1962, the CIA discovered medium-range ballistic missile installations in Cuba, beginning the Cuban Missile Crisis. At the time, President John F. Kennedy believed that the missiles were not yet operational and thus a prime target for a preventive strike.[23] Although Kennedy aimed to reduce the probability of war as much as possible and prudently opted to blockade Cuba to buy time to find a diplomatic solution, he believed the probability of war with the Soviet Union ranged from one-in-three to one-in-two (Bundy 1988, 453).[24] Nevertheless, he pressed on. The United States was now ready to take the risks it refused to take thirteen years earlier during the Berlin Blockade.[25] In a counterfactual 1962 where the Soviet Union

[21] It is worth noting that the Soviet Union was suffering from war exhaustion at the time as well; the Soviets had suffered roughly twenty times more military casualties than the United States. Indeed, Moscow had no desire to turn the Berlin Blockade into the Berlin War (Harrington 2012, 77-78). However, for the purposes of the commitment problem, Soviet war exhaustion had little impact on the strategic interaction. Proliferating acts as a *fait accompli* to the declining state. It is up to the declining state to launch preventive war to stop it, which Washington was unwilling to do at the time. The rising state maintains an inherent advantage in this regard.

[22] A counterargument here might be that the West's aggressive rebuttal only occurred because the Soviet Union proliferated. However, the real concern was that the Soviet Union had such expansive aims that American policymakers believed that the United States already needed to operate as though it were at war (Trachtenberg 1985, 13). For nonproliferation agreements to succeed, per the baseline model, Washington would have needed to offer Moscow a division roughly equivalent to the actual status quo during the Cold War. Given Moscow's expansive aims, this would have eventually led to the strong Western response regardless of the Soviet Union's proliferation status.

[23] In reality, Soviet commanders had tactical nuclear weapons—capable of striking Florida—available without needing launch codes from Moscow (Allison 2012, 11). However, as a matter of establishing willingness to fight, Kennedy's beliefs trump strategic realities.

[24] The estimated risk of nuclear war was substantially smaller, though (Gaddis 1997, 269).

[25] Of course, a surgical preventive strike was possible in Cuba because of U-2 aerial photography. The U.S. did not have this luxury in the late 1940s to stop the Soviet Union from first acquiring nuclear weapons. Still, Kennedy knew that a strike on Cuban soil would inevitably kill Soviet troops and consequently spark a greater conflict with the Soviet Union. He was

did not proliferate, Moscow would have had a difficult time expanding Soviet influence and would have been unable to use the threat to proliferate for the coercive advantages that nonproliferation agreements mandate.

Second, the intelligence gap was quickly closing. The CIA firmly established itself within Washington's bureaucracy by the start of Eisenhower's term in office. Although the first round of Soviet espionage ended in absurd failure, future programs would successfully infiltrate the Soviet miliary and intelligence service. Meanwhile, the Lockheed U-2 spy plane took first flight on August 1, 1955. By June 1956, the aircraft was providing reliable aerial surveillance of Cold War foes.

With that in mind, consider the counterfactual world of 1960 in which the Soviet Union had not proliferated. The United States would have had crisp intelligence sources informing Washington of Soviet nuclear installations and a clearer timeline to first Soviet atomic bomb. Political will for intervention would have been higher than in the immediate aftermath of World War II. Thus, the Soviet Union would have had to reconsider its proliferation plans in the shadow of possible preventive war. At that point, any concessions the United States might have offered earlier would have vanished from the table, and Moscow would have regretted not proliferating in the 1940s. In this light, Soviet proliferation is sensible. Stalin, acutely aware from Hitler's betrayal, knew that agreements only work when they remain mutually acceptable over time. Needing an insurance policy, Moscow proliferated to guarantee concessions.

4.6 Stalin's Decision Making

The Soviet Union faced a growing threat to its ability to proliferate as time progressed following World War II. But did this affect the Kremlin's foreign policy planning at the time? Records of Joseph Stalin's private conversations indicate that the answer is yes.

To start, Stalin recognized America's short-term conventional vulnerability at the end of the war (Zubok and Pleshakov 1996, 46). Further, he was aware of Washington's struggles to mass produce nuclear weapons at the time. Combined, these factors gave Stalin the confidence to work on a nuclear weapon unimpeded, at least for a brief period.

Short-term truces aside, Stalin believed that tensions between the Soviet Union and the United States would eventually flare up again (Holloway 1983, 27). He was likely aware of the calls in Washington for preventive war even during the time of American war exhaustion (Buhite and Hamel 1990, 369). Undoubtedly, these voices would only grow louder as the United States established better military reach over the Soviet Union. In turn, American plans to create an international institution with exclusive control over all nuclear projects fell on deaf ears. Stalin believed that the United States would inevitably maintain some nuclear capability. Thus, the Soviet Union would be in a losing position once the post-war lull ended. Stalin correspondingly wanted nothing short of

nonetheless willing to run this risk.

nuclear equality (Zubok and Pleshakov 1996, 46) to maintain the credibility of any post-war deal.

Faced with a pressing need for nuclear weapons and a ticking clock, speed was Stalin's top priority (Holloway 1983, 27; Bundy 1988, 177-178). When he asked Igor Kurchatov, father of the Soviet bomb, why a bomb was not forthcoming, Kurchatov pleaded that the program was under-equipped. Further, he believed that asking for more resources at a time when the "country was on starvation rations" was not wise (Gaddis 1997, 95). Stalin, not known for his generosity, responded by raising key researchers' salaries and giving them their own *dachas* and cars. They were to enjoy a comparatively luxurious lifestyle so that they could remained focused on accelerating the project. The nuclear project became the state's top priority. At its peak, the CIA "estimated that between 330,000 and 460,000 people" were working on the program (Holloway 1994, 172).[26] Stalin essentially traded efficiency for speed, needing the weapon before the window closed.

All told, Stalin knew that a window existed and actively chose to jump through it. Although there may have been other contributing factors to his decision—all case studies are overidentified—the commitment problem presented here is at least one major consideration.

5 Conclusion

The purpose of this article was two-fold. First, I established that incompatible demands is insufficient to explain arms development. Rather, parties should be able to locate and reach mutually preferable settlements, though the value of such deals vary depending on the cost of those weapons and the credibility of preventive war. Thus, if negotiation fails, it must be the result of some deeper bargaining problem.

Second, I showed that war exhaustion creates such an issue. In particular, the future credible threat of preventive war means that a potential rising state eventually faces a now-or-never decision to shift power. Because the rival cannot credibly commit to offering concessions into the future, the potential rising state must jump through its window of opportunity and realize its full strength. Only then can it force its rival to continue giving a larger flow of the benefits under the threat of war.

While I illustrated the model using the Soviet Union's nuclear proliferation in 1949, the mechanism appears to closely match similar stories with Iran and North Korea recently. After Washington initiated the Iraq War and began dragging itself through a counterinsurgency campaign, the United States faced a rare moment of vulnerability. This coincides with the escalation of the Iranian and North Korean nuclear programs, perhaps due to the fear that Washington would remove all its concessions once the Iraqi conflict improved. If this is the case, Washington would be wise to work at building its international reputation

[26] With a population of around 140 million at the time, this means that roughly 1 in every 400 Soviets were involved in the project.

for maintaining settlements. Put differently, the U.S. ought to consider the commitment problem it faces and work to convince Iran that it will not be capricious with its negotiation position.

On a technical level, this paper details an original but easily malleable baseline model. War exhaustion is one mechanism that leads to inefficient arms building, but it certainly is not the only one. Further extensions of the model to environments with incomplete information or additional causes of a commitment problem could prove fruitful.

Finally, on the broadest level, this paper shows how an outside option need never be realized to still have an impact on bargaining (Voeten 2001). It is well-known that improved outside options lead to larger shares of bargained settlements. However, this paper shows that states do not have to bear the costs to open up the outside option. Instead, anticipating that its rival would build the outside option, the proposer simply makes the concessions it would have made in the future. By doing so, it gains the benefits of the outside option but avoids the costs and risks of fighting.

6 Appendix

This appendix gives full proofs for all lemmas and propositions in the main paper. Throughout, for convenience, I standardize payoffs by multiplying by $1-\delta$. I proceed in order.

6.1 Proof of Lemma 1

First, in every equilibrium for every history of the game, R's continuation value is at least $p_R - c_R$. This is because R can reject in any period and secure that amount.

Second, R must accept $y_t > p'_R - c_R$ in every equilibrium for every history of the game. Recall R earns $p'_R - c_R$ if it rejects in any period. In contrast, if R receives an offer of $y_t > p'_R - c_R$, accepting generates a payoff of $(1-\delta)y_t + \delta V_R$, where V_R is R's continuation value. The previous paragraph ensures that $V_R \geq p'_R - c_R$. Using $V_R = p'_R - c_R$ as a lower bound, accepting is strictly better than rejecting if:

$$(1-\delta)y_t + \delta(p'_R - c_R) > p'_R - c_R$$
$$y_t > p'_R - c_R$$

This holds. So R must accept $y_t > p'_R - c_R$.

Third, in every equilibrium for every history of the game, D's continuation value for an accepted offer must be at least $1 - p'_R + c_R$. To see why, suppose not. Let $1 - z < 1 - p'_R + c_R$ be D's average payoff. Then D can deviate to offering the midpoint between z and $p'_R - c_R$. By the second claim, R must accept. This is a profitable deviation, as the smaller offers to R leave more of

the good for D. Thus, D's continuation value in every period must be at least $1 - p'_R + c_R$.

Fourth, the first and third claims imply that R's continuation value equals $p'_R - c_R$ and D's continuation value equals $1 - p'_R + c_R$ in every period. The only way this can happen is if each actor receives that amount in every period. The only way that can happen is if D offers $y_t = p'_R - c_R$ and R accepts if and only if $y_t \geq p'_R - c_R$. □

6.2 Proof of Proposition 1

First, in every equilibrium for every history of the game, R's continuation value for any pre-shift period must be at least $p_R - c_R$. The proof is identical to the analogous claim in the proof for Lemma 1, swapping y_t for x_t and p'_R for p_R.

Second R must accept $x_t > p_R - c_R$ in every equilibrium for every history of the game. R cannot reject in such circumstances due to the analogous proof in Lemma 1. R's only other alternative is to build. However, D prevents if:

$$1 - p_R - c_D > \delta(1 - p'_R + c_R)$$
$$p'_R > \frac{p_R + c_D}{\delta} + c_R$$

The inequality holds for this parameter space. R earns $p_R - c_R - (1 - \delta)k$ if it builds in this case. But R could make a one-shot deviation to accepting in the current period and rejecting in the next. So R must accept $x_t > p_R - c_R$.

Third, in every equilibrium for every history of the game, D earns at least $1 - p_R + c_R$. The proof is identical to the analogous claim in the proof for Lemma 1.

Fourth, the first and third claims imply that R's continuation value equals $p_R - c_R$ and D's continuation value equals $1 - p_R + c_R$ in every period. The only way this can happen is if each actor receives that amount in every period. The only way that can happen is if D offers $x_t = p_R - c_R$ and R accepts if and only if $x_t \geq p'_R - c_R$. □

6.3 Proof of Proposition 2

First, in every equilibrium for every history of the game, R's continuation value must be at least $p_R - c_R$ for all pre-shift periods. The proof is the same as the first claim of the proof for Proposition 1.

Second, R must accept $x_t > p_R - c_R$ in every equilibrium for every history of the game. R has two alternatives: war and building. War generates a payoff of $p_R - c_R$ forever, while $V_R \geq p_R - c_R$ ensures that accepting $x_t > p_R - c_R$ will give a greater amount than rejecting in period t and at least as much in all future periods. Alternatively, R could build. R would only be willing to do this if D does not prevent. Using Lemma 1, R earns $p'_R - c_R$ in all future periods. Even so, R strictly prefers accepting if:

$$(1 - \delta)x_t + \delta V_R > \delta(p'_R - c_R) - (1 - \delta)k$$

Using $x_t = p_R - c_R$ and $V_R = p_R - c_R$ as a lower bounds, this holds if:

$$(1-\delta)(p_R - c_R) + \delta(p_R - c_R) > \delta(p'_R - c_R) - (1-\delta)k$$
$$p'_R < \frac{p_R + (1-\delta)(k - c_R)}{\delta}$$

This is the cutpoint given in Proposition 2. So R must accept $x_t > p_R - c_R$.

Third, in every equilibrium for every history of the game, D earns at least $1 - p_R + c_R$. The proof is identical to the analogous claim in the proof for Lemma 1.

Fourth, the first and third claims imply that R's continuation value equals $p_R - c_R$ and D's continuation value equals $1 - p_R + c_R$ in every period. The only way this can happen is if each actor receives that amount in every period. The only way that can happen is if D offers $x_t = p_R - c_R$ and R accepts if and only if $x_t \geq p'_R - c_R$. □

6.4 Proof of Proposition 3

First, in every equilibrium for every history of the game, R's continuation value must be at least $\delta(p'_R - c_R) - (1-\delta)k$ for all pre-shift periods. The proof is the same as the first part of the proof for Proposition 1, except now R's optimal outside option is to build rather than reject.

Second, in every equilibrium for every history of the game, R accepts $x_t > \delta(p'_R - c_R) - (1-\delta)k$. R's alternatives are to reject or build. Building nets $\delta(p'_R - c_R) - (1-\delta)k$. However, consider a one-shot deviation to accepting. By the first claim, R receives at least $\delta(p'_R - c_R) - (1-\delta)k$ as its continuation value. Using that as a lower bound, this is a profitable deviation if:

$$(1-\delta)x_t + \delta[\delta(p'_R - c_R) - (1-\delta)k] > \delta(p'_R - c_R) - (1-\delta)k$$
$$x_t > \delta(p'_R - c_R) - (1-\delta)k$$

This holds. So building is not optimal. Meanwhile, rejecting nets $p_R - c_R$. But this is worse than earning $\delta(p'_R - c_R) - (1-\delta)k$ for this parameter space. Thus, R must accept $x_t > \delta(p'_R - c_R) - (1-\delta)k$.

Third, in every equilibrium for every history of the game, D must earn at least $1 - \delta(p'_R - c_R) + (1-\delta)k$. The proof is identical to the analogous claim in the proof for Lemma 1.

Fourth, the first and third claims imply that R's continuation value equals $\delta(p'_R - c_R) - (1-\delta)k$ and D's continuation value equals $1 - \delta(p'_R - c_R) + (1-\delta)k$ in every period. The only way this can happen is if each actor receives that amount in every period. The only way that can happen is if D offers $x_t = \delta(p'_R - c_R) - (1-\delta)k$ and R accepts if and only if $x_t \geq \delta(p'_R - c_R) - (1-\delta)k$. □

6.5 Proof of Proposition 4

First, note that the proof strategy for Lemma 1 only requires that D pay positive costs of war. Consequently, despite D's variable cost of war over time, the SPE of the game following a power shift is identical. In equilibrium, D offers $y_t = p'_R - c_R$ and R accepts those offers. Thus, if R builds before period $t^* - 1$ and D does not prevent, R receives $p'_R - c_R$ and D receives $1 - p'_R + c_R$ for all periods after $t^* - 1$.

Second, note that if R does not build before period $t^* - 1$, R receives $p_R - c_R$ and D receives $1 - p_R + c_R$ for all future periods. To see this, suppose the states enter period $\bar{t} + 1$ prior to a power shift. Then Proposition 1 holds, as this is subgame is identical to the game from the baseline model. D's value for the remainder of the game equals $1 - p_R + c_R$ while R's is $p_R - c_R$.

If $t^* = \bar{t} + 1$, the proof is done. If not, consider proof by induction. Take the base step of period $\bar{t} + 1$. Following Proposition 1, consider R's optimal response to some offer $x_{\bar{t}+1}$. R earns $p_R - c_R$ if it rejects. If it accepts, it earns $(1 - \delta)x_{\bar{t}+1} + \delta(p_R - c_R)$. If R builds, because $\bar{t} + 1 > t^*$, D prevents, and R earns $p_R - c_R - (1 - \delta)k$. This is strictly worse than rejecting. Thus, R accepts if:

$$(1 - \delta)x_{\bar{t}+1} + \delta(p_R - c_R) \geq p_R - c_R$$

$$x_{\bar{t}+1} \geq p_R - c_R$$

So, in equilibrium, R accepts if $x_{\bar{t}+1} \geq p_R - c_R$ and rejects if $x_{\bar{t}+1} < p_R - c_R$.

Now consider D's offer decision. Since D's payoff is strictly increasing in $x_{\bar{t}+1}$ if R accepts, D's optimal acceptable offer equals $p_R - c_R$. D earns $1 - p_R + c_R$ for this choice. In contrast, it earns less than $1 - p_R$ for making an unacceptable offer, which is strictly less. So D offers $x_{\bar{t}+1} = p_R - c_R$, and R accepts.

For the induction step, suppose R's continuation value equals $p_R - c_R$ and D's continuation value equals $1 - p_R + c_R$. Then the task is to show that in period $t \geq t^*$ D offers $x_t = p_R - c_R$ and R accepts. But showing this is identical to showing the base step, so this holds.

Third, note that if R has not built before period $t^* - 1$, it does so and D does not prevent. To see why, consider R's response to x_{t^*-1}. Note that by Restriction 1, D will not prevent in period $t^* - 1$. If R builds, it therefore earns $\delta(p'_R - c_R) - (1 - \delta)k$. If R accepts, by the second claim, it earns *at most* $(1 - \delta)(1) + \delta(p_R - c_R)$. By Restriction 2, the long-term gain outweighs the short-term benefit, so R prefers building. The remaining option is to reject, which yields $p_R - c_R$. But, again, the parameter space ensures that R prefers building to receiving its war payoff, as this only applies when the power shift is "too cold" under the circumstances of Proposition 2.

Now consider D's options. No matter the offer, R builds and D does not prevent. Since x_t is irrelevant in such a scenario, D is free to offer any amount in equilibrium. The outcome, however, is identical in all cases.

Fourth, the remaining step is to show that the parties successfully negotiate in periods $1, ..., t^* - 2$. The proof is by induction. Consider period $t^* - 2$ as

the base step. As before, R will never reject an offer, as building pays a strictly great amount. (D never prevents in this case, as it is more costly in this period than in period $t^* - 1$.) Thus, R is willing to accept any offer such that

$$(1-\delta)x_t + \delta^2[(p'_R - c_R) - \delta(1-\delta)k] \geq \delta(p'_R - c_R) - (1-\delta)k$$
$$x_t \geq \delta(p'_R - c_R) - (1-\delta)k$$

For the same reasons as with Proposition 3, D prefers making the minimally acceptable offer to inducing R to invest.

For the induction step, the goal is to show that if D offers $x_t = p_R - c_R$ and R accepts in the n periods before t^*-1, then D offers $x_t = p_R - c_R$ and R accepts in the period before. As always, R's payoff for building equals $\delta(p'_R - c_R) - (1-\delta)k$. If R accepts, it receives $\delta(p'_R - c_R) - (1-\delta)k$ in all periods up to $t^* - 2$ and builds in period $t^* - 1$ for a time-adjusted payoff of $\delta(p'_R - c_R) - (1-\delta)k$. Combined together, this simply equals $\delta(p'_R - c_R) - (1-\delta)k$ if R builds the current period. As such, for the same reason as in the base step, D offers $\delta(p'_R - c_R) - (1-\delta)k$ and R accepts any amount at least as large. □

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