Arms Negotiations, War Exhaustion, and the Credibility of Preventive War*

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Abstract

Why do some states agree suspend their weapons programs in exchange for compensation while others fail to come to terms? I argue that the changing credibility of preventive war is an important determinant of arms construction. If preventive war is never an option, states can reach mutually preferable settlements. 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, agreements 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 induced 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 proliferation, offering improved diplomatic relations and even food to induce more cooperative relations. On the non-nuclear front, Russia has sought to quash a proposed missile defense shield in Eastern Europe and successfully negotiated a pause in development by giving the U.S. access to Russian supply 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. The incentives to negotiate are clear: not developing weapons creates a surplus that everyone benefits from. 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 suspend their weapons programs in exchange for compensation while others fail to come to terms?

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. During times of weakness, states have an incentive to appease adversaries to keep them from increasing arms production. I show that this negotiation process can be successful, even though increasing arms would result in power shifts favorable to the adversary. However, during times of strength, rivals can leverage the threat of preventive war to deter arms building. Thus, if willingness to intervene changes over time, potential builders can face a "window of opportunity." In the waning days of their opponents' reluctance to fight, building forces the opponent to provide concessions under the threat of costly war; not building means that rivals can cut concessions without fear of significant reprisal. As result, potential builders take the opportunity while they can.

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 negotiate a mutually preferable outcome and save on the cost of proliferation? I argue that fading war exhaustion from

World War II rendered any such deal inherently unstable. The Soviet Union thus proliferated to secure the benefits of nuclear power well into the future.

This paper speaks to three literatures. First, it builds on a rich research tradition on preventive war dating back to Thucydides (1972). Although many researchers add nuance to the motivation for preventive war, the overall idea 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).[1] I maintain this common definition. However, the focus here is *not* on the motivations for preventive war. Rather, the model developed below analyzes how incentives to prevent affect whether states successfully negotiate an agreement.

Second, I build on formal models of preventive war and arms building. 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 power shifts in the context of explaining preventive war (Chadefaux 2011). I maintain this innovation, but again I use the logic of preventive war to investigate its indirect consequences.

In this regard, my model is most similar to Debs and Monteiro (2014), who also investigate how the shadow of preventive war affects costly arming decisions. However, in their interaction, a potential proliferator begins the game by deciding whether to build weapons or not. This prevents them from analyzing how the opponent might proactively attempt to buy compliance. After all, compliance (or lack thereof) is set in stone at the start. Negotiations with Iran—which have lasted over a decade—suggests that the final decision to build should come after the opponent has the opportunity to entice the proliferator with an attractive nonproliferation deal. Therefore, in contrast to Debs and Monteiro, I begin the interaction with negotiations. I also allow the opponent's willingness to engage in preventive war to vary over time to investigate the sustainability of potential agreements.

Thus, my paper breaks from the standard guns-versus-butter model (Powell 1993) in that opponents can interfere with arms construction in two ways: bribes (the carrot) and preventive war (the stick). A critical question here is whether states can buy compliance through concessions. I show that compliance is possible—provided that the target can credibly commit to continuing to provide concessions over time.

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

Lastly, this paper directly engages a substantive debate on the Soviet Union's decision to build nuclear weapons in 1949. Conventional wisdom treats such decisions as trivial. For example, Thayer (1995, 486) claims that "security is the only necessary and sufficient cause of nuclear proliferation," so Soviet proliferation to balance the United States was inevitable. 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 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 opponents are eager to reach agreements, the model shows that potential builders can credibly commit to status quo arms levels by threatening to invest if the opposing state does not cede to its demands. The following section extends the model to cover 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 over Arms?

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 negotiate because 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, B (the potential **B**uilder) and A (the builder's **A**ntagonist)[2], as illustrated in Figure 1. The game begins before B has

[2]One might alternatively conceptualize A as the coalition of states against B.

invested in new arms. A makes an offer $x_t \in [0,1]$ to B, where t denotes the period. B accepts, rejects, or builds in response. Rejecting results in game ending war; B receives $p_B \in [0,1)$ while A receives $1-p_B$. These payoffs persist through all future periods, but the states pay respective costs $c_A, c_B > 0$ in each future period regardless.[3]

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

If B builds, it forgoes the concession A offered and pays a cost $k > 0$ to begin constructing the new weapons. A 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 B had rejected A's offer x_t. If A advances, the period ends, and B receives x_t for the period while A receives $1-x_t$.

If B successfully builds, B's outside option of war improves in all future periods. A makes an offer y_{t+1} to B in such a post-shift period. If B accepts, the period ends, B receives y_{t+1} for the period, A receives $1-y_{t+1}$ for the period, and the game repeats the post-shift bargaining period, where A makes another offer y_{t+2}. If B rejects, a game-ending war results. Here, B takes $p'_B \in (p_B, 1]$ in expectation while A receives $1-p'_B$. That is, B expects to receive more from war with the weapons than without. These payoffs again persist through time, but the sides still pay their respective costs c_A, c_B.[4] Thus, a power shift occurs because B's (A's) outside option is comparatively better (worse) in the post-shift periods than the pre-shift periods.

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 B takes 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.

The model makes a couple of noteworthy assumptions. In particular, I assume that the decision to arm is public and that A can retract any offer it makes if B decides to build. Both these assumptions make arming look less attractive—the public observation

[3]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 $c'_i = \frac{c_i}{1-\delta}$.

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

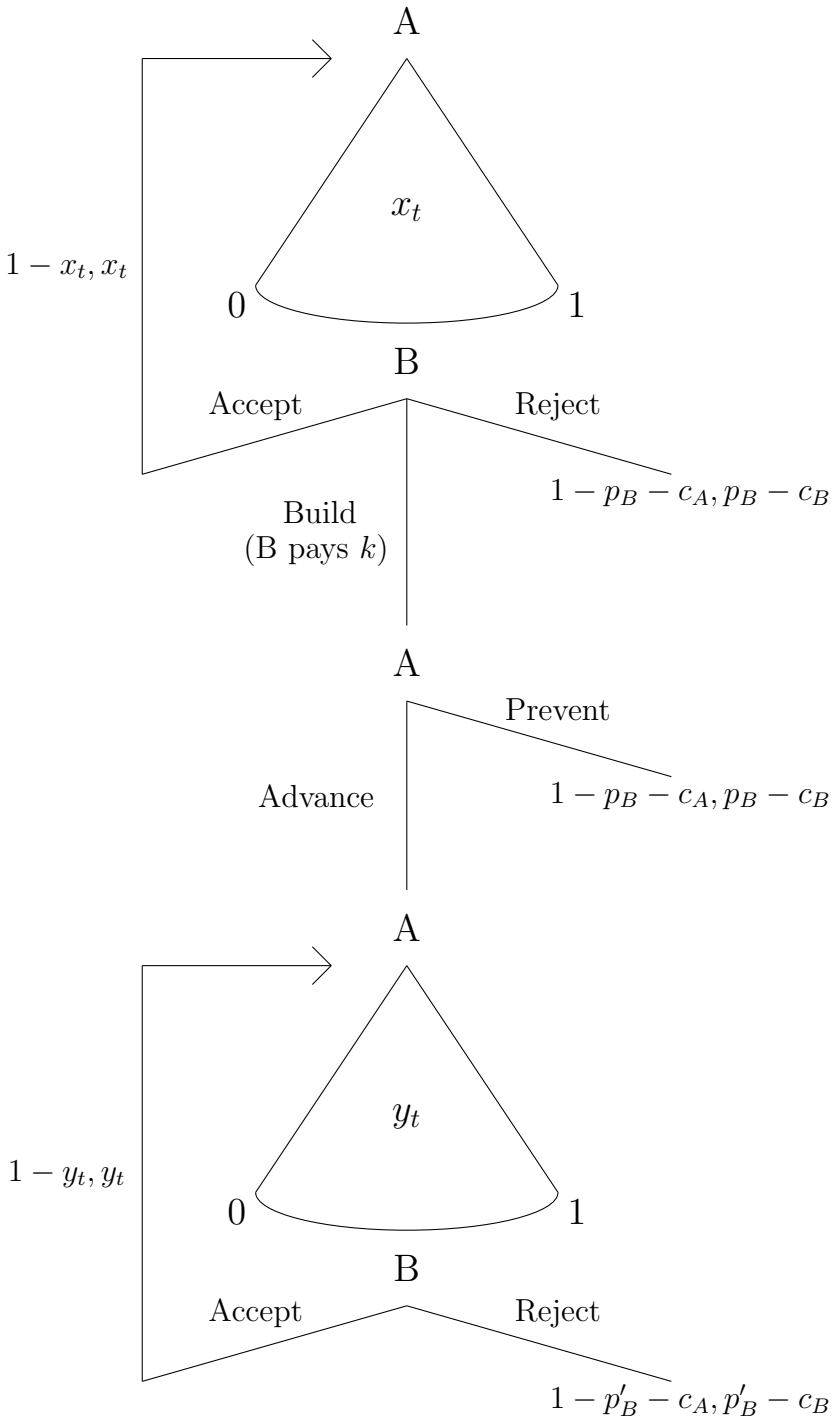

Figure 1: The baseline model. All payoffs listed are for the period, though the war outcomes lock in their respective payoffs every period for the rest of time.

means that B cannot build weapons without facing the direct threat of preventive war, while retractable offers forces B 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 harsher circumstances. The reason is interesting and previews the results that follow for the model described. B'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, A can strategically manipulate B's opportunity cost, making B's stake in the status quo so compelling that developing weapons is never optimal. Under such conditions, B will not build regardless of whether its build decision is hidden or whether A can retract its offer upon B building.

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 agreements fail when the credibility of preventive war changes over time. Consequently, if agreements 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, A offers* $y_t = p'_B - c_B$*, and B accepts.*

The intuition is a straightforward application of Fearon's seminal bargaining game.[5] Since war creates deadweight loss to the system, A can always offer enough to satisfy B, and the optimal acceptable offer is preferable to war for A as well. Thus, A offers just enough to induce B to accept. A keeps all of the surplus. In particular, B earns $p'_B - c_B$ and A earns $1 - p'_B + c_B$ for the rest of time. Peace prevails.

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

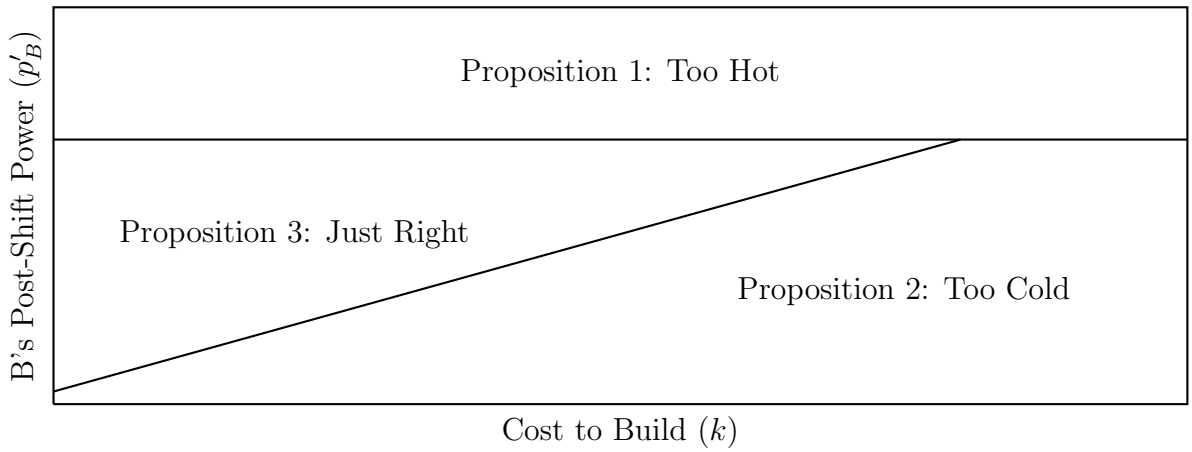

Figure 2: Equilibrium outcomes as a function of p'_B and k. Figure drawn with values $p_B = .3$, $c_A = .3$, $c_B = .1$, and $\delta = .9$.

Overall, Lemma 1 shows that B has great incentive to build—additional weapons mean greater coercive power, forcing A to offer more concessions to maintain the peace. Consequently, it is not remarkable that opponents want potential builders to terminate their programs. What is surprising is that potential builders can credibly abide by such deals.

Before stating the propositions, Figure 2 previews the results. When the power shift is great (relative to the other parameters), A finds a power shift "too hot" to permit. Internalizing this, B 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, B 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* $p'_B > \frac{p_B + c_A}{\delta} + c_B$*, A offers* $x_t = p_B - c_B$ *in the unique SPE. B accepts these offers and never builds.*

Note that the right side contains the inefficiency of war while the left side of the inequality (in part) measures the extent of the power shift, defined as the improvement in B's outside option. When the shift is sufficiently greater than war's inefficiency, the power shift is "too hot." If B were to build, A would respond with preventive war. As a result, the credible threat to fight makes B's threat to build incredible. In turn, A

can treat the bargaining problem as though B cannot build. Consequently, A offers $x_t = p_B - c_B$ (the amount B would receive in a static bargaining game), B accepts, and the states avoid war.[6] The stick is sufficient.

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 B is to coerce concessions out of A, preventive war must first not deter B from attempting to build weapons. The next proposition therefore looks at when the potential power shift is relatively small:

Proposition 2. *If $p'_B < \frac{p_B+(1-\delta)(k-c_B)}{\delta}$, A offers $x_t = p_B - c_B$ in the unique SPE. B 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 small relative to that cost, the power shift is "too cold" for B to find investment worthwhile. A observes that B does not have a credible threat to build and therefore offers the same concessions it would offer if power were static. Neither the carrot nor the stick comes into play. 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 B would ever develop weapons it must be in the "just right" region in which A would not want to prevent yet B finds investment worthwhile. Nevertheless, as the next proposition shows, bargaining supersedes the need to engage in inefficient investment:

Proposition 3. *If $\frac{p_B+(1-\delta)(k-c_B)}{\delta} < p'_B < \frac{p_B+c_A}{\delta} + c_B$, A offers $x_t = \delta(p'_B - c_B) - (1-\delta)k$ in all pre-shift periods in the unique SPE; B accepts and never builds.*

Why does bargaining succeed here? B views arms building as an investment in future coercive power. If it were to ever make such an investment, it would reap the rewards $(p'_B - c_B)$ in accordance with Lemma 1. However, A anticipates this and recognizes that B will shift power if its offers are insufficient. Rather than inducing

[6]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).

B to go down that inefficient route, A benefits by immediately offering most of the concessions B would receive in the future. B has no need to invest at that point, while A benefits by extracting the potential investment cost k. The carrot prevails because (when used) it is cheaper than the stick and preferable to non-action.

Note that B's decision to not build is *not* the result of the observability of weapons construction or the quid-pro-quo bargaining structure. Rather, B accepts simply because its advantageous stake in the bargain today outweighs whatever potential value additional power might purchase. This is because building generates $\delta(p'_B - c_B) - (1-\delta)k$ forever, while accepting gives that amount today and *at least* that amount in the future because B can always build later. As a result, similar agreements work even if the model assumes non-retractible offers or hidden arming decisions.

Negotiations between the United States and Belarus, Kazakhstan, and Ukraine at the end of the Cold War nicely illustrate why this mechanism works. Although these three Soviet successor states did not have command control of the nuclear weapons on their soil, international observers were concerned that they would develop their own nuclear deterrents given their sophisticated scientific backgrounds. However, each was in desperate need of foreign aid to lift their economies out of the communist hole. As such, the United States passed the 1992 Cooperative Threat Reduction bill, which led to $2.6 billion in aid between 1992 and 1997 to (Ellis 2001, 9). Moscow added an additional $1 billion concession specifically targeted to Ukraine and began cutting crucial energy subsidies in the absence of an agreement (Drezner 1999, 199-202; Reiss 1995, 122). Although these countries faced intense security challenges at the time, native nuclear programs would have required forgoing enormous economic concessions. Correspondingly, they all eventually accepted their deals, and all parties were better off as a result.

While the Soviet successor states' issue is but one moment in history, it highlights an important insight from the baseline model: arms construction is not an inherently irreconcilable issue. States find weapons programs attractive because additional strength favorably shifts the balance of power. However, any security gain for the builder implies an equal security loss for its rivals. As long as weapons programs are costly, those security losers have incentive to buy off their opponents.

The question then becomes why states fail to reach such an agreement. The extension below details one mechanism.

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 agreements 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 sufficiently over time, B eventually faces a "window of opportunity" that amounts to a now-or-never chance to develop the weaponry. If B chooses to do so, it receives great concessions in the future as Lemma 1 indicates. If B 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 B to pay for the inefficient arms since any promise from A to continue concessions into the future is inherently incredible.

3.1 The Modified Game

The overall structure remains the same—A bargains with B over an infinite horizon, B can choose to invest in an arms program in pre-shift periods, and B receives a greater payoff from war in post-shift periods. The only difference is that A's cost of war now varies over time. Explicitly, A's cost of war is $c_A(t)$, where $c_A(t) > 0$ for all t.[7]

To focus on instances where A finds preventive war more attractive as time passes, suppose $c_A(t) > c_A(t+1)$ for all $t = 1, ..., \bar{t}$ and equals some strictly positive constant for all $t > \bar{t}$.[8] Intuitively, this means that A's reluctance to fight diminishes through the first $\bar{t}$ periods and disappears entirely at period $\bar{t}+1$ and forward. Put differently, war becomes increasingly attractive for the opponent over the short term before reaching some steady state in the long-run. The function is common knowledge, meaning that B can anticipate how belligerent A will be in the future. One might imagine that this is because B can use publicly observable information to extrapolate future willingness to

[7]This extension nests the original model, with $c_A(t) = c_A$.

[8]The results presented would be similar if the reluctance to engage wore off non-deterministically.

fight. This seems especially accurate in the case of war exhaustion, which comes as the result of a public war and will predictably wane as time passes, the cost burden of the past war fades away, and a new generation of soldiers prepare to take the battlefield.[9]

In writing the model in this manner, many factors can create the mechanism: the aforementioned war exhaustion, improving military intelligence, and increasing ideological fervor to name a few. To preview the results below, each of these factors can individually make preventive war incredible in the present but a legitimate threat in the future. Due to this, the challenger knows from the baseline model that concessions will terminate later on if it does not build the weapon. In turn, if a large power shift occurs quickly, the target cannot offer large enough bribes in the present to convince the challenger not to proliferate while it can still do so unimpeded.

3.2 Inefficient Equilibria

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

Condition 1. *(Changing Credibility of Preventive War) A's cost of preventive war sufficiently changes over time. In particular, a period* $t^* \geq 2$ *exists such that* $p'_B > \frac{p_B + c_A(t)}{\delta} + c_B$ *for all* $t \geq t^*$ *and* $p'_B < \frac{p_B + c_A(t)}{\delta} + c_B$ *for all* $t < t^*$.

Loosely, Condition 1 says that at the beginning of the interaction, A's cost of war is large enough that the parameters are above the horizontal line separating Proposition 1 from Proposition 3 in Figure 2. However, at some point later in time, A's cost of war is small enough that the parameters drop below that line. The rationale is that all other cases are uninteresting, follow straight from propositions found in the previous section, and render A's changing war tolerance inconsequential. If no such critical period t^* existed, then either A's threat to prevent would be credible throughout the interaction (because the costs of war remain high throughout) or A's threat to prevent would be incredible throughout the interaction (because the costs of war were low to begin with). In the first case, Proposition 1 states the equilibrium strategies; A's threat to intervene

[9]Indeed, as the case study discusses below, Stalin was fully cognizant that the United States would apply greater coercive pressure to the Soviet Union the years passed.

compels B not to build. Intuitively, if A 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; B receives concessions if and only if the cost to build is sufficiently cheap. Intuitively, if A 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 reluctance has no substantive impact on the game's outcomes. Thus, this section restricts the discussion to the middle cases the condition describes.

Also, note that t^* simply represents the first period in which A can credibly threaten preventive war.[10]

Condition 2. *(Large, Rapid Shifts) Let* $\delta(p'_B - c_B) - (1-\delta)k > 1 - \delta + \delta(p_B - c_B)$.

To interpret the cutpoint, note that the left side of the inequality contains $\delta(p'_B - c_B)$, which represents concessions the commensurate with its higher level of power in all subsequent periods, and $(1-\delta)k$, which represents its time-adjusted cost to acquire the weapons immediately. Subject to the constraints its opponent places on it, this is the potential builder's best possible outcome if it constructs weapons. The right side of the inequality is the most concessions the opponent could credibly offer the potential builder on the eve of the change in the credibility of preventive war; $1-\delta$ is the temporally-adjusted amount the potential proliferator would receive in if the opponent concedes the entire prize for the initial period, while $\delta(p_B - c_B)$ is the amount concessions the potential builder receives for the rest of time if it fails to arm while the opponent would still permit construction. This is important because if war reluctance fades away slowly, it becomes possible for the opponent to credibly buy off the potential builder during the final period of its reluctance.

In interpreting the substantive meaning, the condition 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 A'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 fading reluctance changes the credibility of preventive war, B will

[10]Thus, it must be that $t^* \geq 2$; if $t^* = 1$, then A can always credibly threaten preventive war.

never build if the return on investment is too small relative to the cost of weapons, or $p'_B < \frac{p_B+(1-\delta)(k-c_B)}{\delta}$.

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

In words, the parties negotiate non-armament for the first $t^* - 2$ periods; the continued threat to build in the future compels A to give concessions or lose out on the surplus. However, that continued threat disappears in period $t^* - 1$, as A 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 A to let go without preventive war. As a result, B 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 A.

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, A cannot credibly commit to such settlements. Indeed, in period $t^* - 1$, A would like to commit to continuing its level of concessions to B for the rest of time. Such an offer—if credible—would negate B's need to shift power. Unfortunately, B's credible threat to develop weapons drives A's credible commitment to give concessions in the future. Once A's cost of war sufficiently decreases, B loses the threat to arm due to A's credible preventive war response. Negotiations unravel as a result.

Although the model does not inherently focus on nuclear cases, Condition 2 indicates that bargaining over proliferation is especially vulnerable to Proposition 4's commitment problem. Conventional buildups, as the phrase implies, occur over a long period of time. While the magnitude of such a power shift might be great, they are rarely rapid. In contrast, a nuclearizing state can go from rather weak to formidable over a short period of time. Without this speed, there is no commitment problem. This suggests that nuclear proliferation is inherently more difficult to negotiate over than conventional arms buildups. I therefore focus the case study below on an instance of nuclear proliferation.

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 stabilized the communists' 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) and that "security is the only necessary and sufficient cause of nuclear proliferation" (Thayer 1995, 486).

Consequently, research on the Soviet decision to proliferate focuses on the United States' choice not to launch preventive war; the U.S. held a nuclear monopoly at the time and perhaps 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.

Meanwhile, existing formal models on the subject only explain the variance in preventive war outcomes based on the cost of fighting (Powell 2006; Debs and Monteiro 2014). When the costs of war are too high, allowing the power shift to transpire beats militarily preventing it. However, these models do not factor in the possibility of buying off a potential proliferator in the absence of credible preventive war. In turn, these arguments would overlook the critical four year period after World War II but before the Soviet Union's test when the United States knew that Stalin sought a bomb. Put differently, if preventive war was not an option, why didn't Washington bargain its way

out of nuclear escalation at the start of the Cold War?

The cutpoints of the model provide some guidance here. That preventive war was too costly to be worthwhile 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 negotiations succeeded.[11] Instead, bargaining failed, and Moscow obtained a nuclear weapon.

Using the model for guidance, this section argues that American and British war exhaustion made immediate preventive war against the Soviet Union an impossibility in the short term but not the long term.[12] I begin by outlining the general conflict the United States and Soviet Union faced immediately following World War II. After, I turn my attention to matching the historical record to Condition 1. Condition 1 states that preventive war must be incredible during earlier periods but credible during later periods to trigger the commitment problem. I thus discuss how domestic political resistance made preventive war impossible for the West prior to 1949 but would become possible over time. Finally, I trace Stalin's decision making process to ensure that the commitment problem influenced the proliferation decision.

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 a disproportionately large voting share in the International

[11]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 lagged behind U.S. efforts 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.

[12]This concept of war exhaustion 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.

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, which rendered preventive war incredible over the short term as Condition 1 requires. 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). Thus, even if the West could successfully open a front in the Soviet Union, it would have faced an uphill battle in Europe.

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. 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). Wartime price controls and shortages persisted into peace time (Hartmann 1971, 4-5). 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.

Similar electoral problems meant that the United States could not expect help from the United Kingdom. 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).[13] 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.

[13]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 Berlin and the Realities of War against the Soviet Union

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, and the chances of negotiation a solution with Moscow appeared slim. Nonetheless, if ever there was a tactical opportunity to challenge the Soviets militarily over Germany, 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."[14] Rather, the airlift represented a lack of viable alternatives at the time. Simpler options, 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.[15] Thus, the airlift policy aimed to minimize the possibility 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.[16]

Given American reluctance to initiate a fight against the Soviet Union in Berlin, a preventive strike was a political non-starter. The United States suffered from a severe intelligence gap at the time (Holloway 1994, 220; Goodman 2007, 8; Gordin 2009, 82-83). Analysts did not know the location of Soviet nuclear facilities. Consequently, the United States could not launch precision strikes like Israel's incursions into Iraq in 1981 and Syria in 2007. Instead, preventive war against the Soviet Union would have required a full scale invasion. But Americans had no desire to engage in a small scale conflict over Berlin, never mind a land war in Asia.

Facing these constraints, the United States' remaining option was to drop nuclear bombs on the entire Soviet Union. But this too was infeasible. Following the end of World War II, the American nuclear program fell in disarray. Many scientists left the project, having decided that "their mission had been accomplished" (Hewlett and

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

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

[16]Throughout the process, it is worth noting that the Soviet Union was exhausted too: it had suffered roughly twenty times more casualties than the United States. Moscow correspondingly had no desire to turn the Berlin Blockade into the Berlin War (Harrington 2012, 77-78). However, for the purposes of the commitment problem described below, Soviet war exhaustion had little impact on the strategic interaction. Proliferating acts as a *fait accompli* to the opposing state. It is up to the opposing state to launch preventive war to stop it, which Washington was unwilling to do at the time.

Anderson 1962, 625). Those who remained were in the middle of a bureaucratic shuffle between the Manhattan Project and the Atomic Energy Commission. By 1948, the United States only had a minuscule arsenal of thirty nuclear weapons and 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. As such, preventive war was not worth the substantial cost at the time, and those insisting on the hard line quickly found themselves marginalized.[17] All told, this indicates that Condition 1 held: the opposing state was unwilling to initiate preventive conflict in the early years. The next subsection asks whether the parties would have eventually reached a stage when preventive war would have been credible had the Soviet Union not proliferated.

4.4 Fading War Exhaustion 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, America's reluctance was diminishing over time. Condition 1 indicates that appreciating the Soviet decision requires thinking about the counterfactual world of the 1950s and 1960s where the Moscow accepted a deal. Growing American acceptance of conflict put the United States in the commitment problem described in the extension of the model, which in turn forced Moscow to proliferate.

To begin, note American exhaustion from World War II declined as the calendar pushed well beyond 1945. 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

[17] 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.

a compelling story. The Korean crisis 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.

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. As such, 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.[18]

By 1962, however, the United States was certainly prepared to engage the Soviet Union in 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.[19] 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).[20] Nevertheless, he pressed on. Despite the additional physical costs of war at the time, American disdain for fighting in general had diminished.[21] The United States was now ready to take the risks it refused to

[18]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), though the overall consensus was the West was only ready to endure the number of causalities a proxy war could create.

[19]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.

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

[21]One might notice an apparent disconnect between the model and this case study here. The model

take thirteen years earlier during the Berlin Blockade.[22] Thus, if the United States was willing to pay such heavy costs in a world with Soviet nuclear weapons, it stands to reason that the United States would have been willing to engage in a large-scale conflict with a non-nuclear Soviet Union. In turn, in a counterfactual 1962 where the Soviet Union had not yet proliferated, 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 require.[23]

With that in mind, consider the counterfactual world of 1960 in which the Soviet Union had not proliferated. Although it is difficult to compare the historical record to what would have happened in a world without Soviet proliferation, the evidence suggests that American political will for intervention would have been higher than in the immediate aftermath of World War II. Thus, the Soviet Union would have likely 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 could have vanished from the table, and Moscow would have regretted not proliferating in the 1940s. This verifies the possibility of a critical period at which the United States' threat to prevent would have become credible. In turn, Condition 1 plausibly holds, indicating that bargaining should break down per Proposition 4.

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says that if the costs of war are decreasing over time, a commitment problem can result. However, "costs" in this context refer to a combination of the physical toll and state resolve. Thus, even though war would have been more expensive, American "costs" in the crisis bargaining sense would have decreased due to resolve's interaction.

[22]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 nonetheless willing to run this risk.

[23]One might then wonder why the United States did not intervene before the People's Republic of China's first test in 1964. Policymakers in Washington briefly considered it a possibility, especially as the Republic of China sought assistance. Compared to the Soviet Union, however, the United States' differences with China were small. Regardless of war exhaustion, this raised the functional cost of intervention to unacceptably high levels; indeed, "Chinese nuclear capabilities would not [have posed] a major threat to U.S. interests, much less change the balance of power in East Asia" (Burr and Richelson 2000, 56). As a result, the Washington passed on the conflict and made peace with Beijing almost two decades before making peace with Moscow.

4.5 Stalin's Decision.

Theoretical reasoning aside, did the above commitment problem logic 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 knew 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. Put differently, he believed Condition 1 held. As the model predicts, this made negotiations with Moscow difficult. Indeed, the United States often made overtures to share nuclear technology with cooperating states through a United Nations regime, beginning with the "Agreed Declaration" and continuing with the Acheson-Lilienthal Report and subsequent Baruch Plan (Meyrowitz 1990). Many policymakers wanted any agreement to allow the United States to maintain its nuclear arsenal, but opponents understood that this was a non-starter for Stalin.

Prospects for an agreement were worse in Moscow. Even if the United States would agree on paper to eliminate its capacity, Stalin believed that America would inevitably maintain some nuclear capability. Meanwhile, he did not trust the United Nations—an institution that the West disproportionately controlled—to create a fair international nuclear trust. Thus, in Stalin's eyes, reaching any agreement in the aftermath of World War II would have put the Soviet Union in a losing position once the post-war lull ended. Stalin correspondingly wanted nothing short of 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 device 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 program became the state's top priority, as though a war was already ongoing. At its peak, the CIA "estimated that between 330,000 and 460,000 people" were working on the program (Holloway 1994, 172).[24] Stalin essentially traded efficiency for speed, needing the weapon before the window closed.

All told, Stalin knew that a window existed. Acutely aware of the need for credible commitments in the shadow of Hitler's betrayal, he took the opportunity to proliferate while he had a chance. Although there may have been other contributing factors to Stalin's decision—all case studies are overidentified—the commitment problem presented here is a major consideration.

5 Conclusion

The purpose of this article was two-fold. First, I established that incompatible demands are insufficient to explain arms development. Rather, parties should 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 and improving military intelligence create such an issue. In particular, the future credibility of preventive war means that a potential builder eventually faces a now-or-never decision to shift power. Because the rival cannot credibly commit to offering concessions into the future, the potential builder must act during 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 decision to proliferate 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 moment of vulnerability. This coincides with the escalation of the Iranian and North Korean nuclear programs, per-

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

haps 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 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. The changing credibility of preventive war is one mechanism that leads to inefficient arms building, but it certainly is not the only one. Modeling environments with incomplete information or other types of commitment problems 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, the receiver 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, B's continuation value is at least $p_B - c_B$. This is because B can reject in any period and secure that amount.

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

$$(1-\delta)y_t + \delta(p'_B - c_B) > p'_B - c_B$$

$$y_t > p'_B - c_B$$

This holds. So B must accept $y_t > p'_B - c_B$.

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

Fourth, the first and third claims imply that B's continuation value equals $p'_B - c_B$ and A's continuation value equals $1 - p'_B + c_B$ 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 A offers $y_t = p'_B - c_B$ and B accepts if and only if $y_t \geq p'_B - c_B$. □

6.2 Proof of Proposition 1

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

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

$$1 - p_B - c_A > \delta(1 - p'_B + c_B)$$

$$p'_B > \frac{p_B + c_A}{\delta} + c_B$$

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

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

Fourth, the first and third claims imply that B's continuation value equals $p_B - c_B$

and A's continuation value equals $1 - p_B + c_B$ 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 A offers $x_t = p_B - c_B$ and B accepts if and only if $x_t \geq p'_B - c_B$. □

6.3 Proof of Proposition 2

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

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

$$(1-\delta)x_t + \delta V_B > \delta(p'_B - c_B) - (1-\delta)k$$

Using $x_t = p_B - c_B$ and $V_B = p_B - c_B$ as a lower bounds, this holds if:

$$(1-\delta)(p_B - c_B) + \delta(p_B - c_B) > \delta(p'_B - c_B) - (1-\delta)k$$
$$p'_B < \frac{p_B + (1-\delta)(k - c_B)}{\delta}$$

This is the cutpoint given in Proposition 2. So B must accept $x_t > p_B - c_B$.

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

Fourth, the first and third claims imply that B's continuation value equals $p_B - c_B$ and A's continuation value equals $1 - p_B + c_B$ 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 A offers $x_t = p_B - c_B$ and B accepts if and only if $x_t \geq p'_B - c_B$. □

6.4 Proof of Proposition 3

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

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

$$(1-\delta)x_t + \delta[\delta(p'_B - c_B) - (1-\delta)k] > \delta(p'_B - c_B) - (1-\delta)k$$

$$x_t > \delta(p'_B - c_B) - (1-\delta)k$$

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

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

Fourth, the first and third claims imply that B's continuation value equals $\delta(p'_B - c_B) - (1-\delta)k$ and A's continuation value equals $1 - \delta(p'_B - c_B) + (1-\delta)k$ 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 A offers $x_t = \delta(p'_B - c_B) - (1-\delta)k$ and B accepts if and only if $x_t \geq \delta(p'_B - c_B) - (1-\delta)k$. □

6.5 Proof of Proposition 4

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

Second, note that if B does not build before period $t^* - 1$, B receives $p_B - c_B$ and A receives $1 - p_B + c_B$ 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. A's value for the remainder of the game equals $1 - p_B + c_B$ while B's is $p_B - c_B$.

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 B's optimal response to some offer $x_{\bar{t}+1}$. B earns $p_B - c_B$ if it rejects. If it accepts, it earns $(1 - \delta)x_{\bar{t}+1} + \delta(p_B - c_B)$. If B builds, because $\bar{t} + 1 > t^*$, A prevents, and B earns $p_B - c_B - (1 - \delta)k$. This is strictly worse than rejecting. Thus, B accepts if:

$$(1 - \delta)x_{\bar{t}+1} + \delta(p_B - c_B) \geq p_B - c_B$$

$$x_{\bar{t}+1} \geq p_B - c_B$$

So, in equilibrium, B accepts if $x_{\bar{t}+1} \geq p_B - c_B$ and rejects if $x_{\bar{t}+1} < p_B - c_B$.

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

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

Third, note that if B has not built before period $t^* - 1$, it does so and A does not prevent. To see why, consider B's response to x_{t^*-1}. Note that by Condition 1, A will not prevent in period $t^* - 1$. If B builds, it therefore earns $\delta(p'_B - c_B) - (1 - \delta)k$. If B accepts, by the second claim, it earns *at most* $(1 - \delta)(1) + \delta(p_B - c_B)$. By Condition 2, the long-term gain outweighs the short-term benefit, so B prefers building. The remaining option is to reject, which yields $p_B - c_B$. But, again, the parameter space ensures that B 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 A's options. No matter the offer, B builds and A does not prevent. Since x_t is irrelevant in such a scenario, A 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, B 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, B is willing to accept any offer such that

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

$$x_t \geq \delta(p'_B - c_B) - (1-\delta)k$$

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

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

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