# Nothing to Fear but Fear Itself?

# Nuclear Proliferation and Preventive War[*]

Alexandre Debs[†]  and Nuno Monteiro[‡]

November 5, 2010

### Abstract

When does nuclear counterproliferation succeed? When does it lead to preventive war? We argue that the answers to these questions hinge on the effect of nuclearization on the balance of power relative to the cost of preventive war. When it is low, threats of preventive war are not credible; proliferation continues apace and peace prevails. Such was the case during the Cold War. When it is high, threats of preventive war are credible, slowing down the rate of proliferation. At the same time, since the decision to proliferate is not perfectly observable, there is a higher likelihood of mistaken preventive wars. This characterizes the post Cold War. We trace the logic of our argument by looking at the cases of Soviet nuclear acquisition in 1949 and the US-led invasion of Iraq in 2003.

Keywords: deterrence, nuclear weapons, power, preventive war, proliferation.

[†]Dept. of Political Science, Yale University. Email: alexandre.debs@yale.edu
[‡]Dept. of Political Science, Yale University. Email: nuno.monteiro@yale.edu

# 1    Introduction

In October 2002, pressing the case for invading Iraq, President Bush warned of terrible consequences should Saddam Hussein acquire nuclear weapons. "We refuse to live in fear," Bush insisted (Bush, 7 Oct. 2002a). This position is emblematic of the centrality of nuclear proliferation in U.S. foreign policy since the end of the Cold War. According to the official discourse, the nonproliferation regime is fragile and its future prospects are bleak. Is this heightened fear of nuclear proliferation justified? Or could it be that an irrational fear of proliferation is leading the United States to pursue an unnecessarily forceful counterproliferation policy?[1]

During the Cold War, the objective risk of proliferation was high, with more than twenty countries trying to develop nuclear weapons, of which nine acquired them. Yet neither the Soviet Union nor the United States proved willing to wage war in order to prevent proliferation. In contrast, since the end of the Cold War, less than a handful of countries have attempted proliferation and only one – North Korea – has succeeded (see Figure 1). And yet, Washington now regularly considers preventive war to stop the spread of nuclear weapons. Fear of nuclear proliferation led President Clinton to the brink of war with North Korea in 1994; drove President Bush to invade Iraq nine years later; and continues to press grave dilemmas on President Obama concerning Iran. What explains the lower level of proliferation in the post Cold War? And the concomitant centrality of preventive war in U.S. counterproliferation efforts?

— Figure 1 about here —

Unsurprisingly, concerns about nuclear proliferation have percolated through foreign-policy and IR scholarship. In policy circles, no consensus has emerged in the heated debate on the best counterproliferation approach: engagement, containment, or preventive war. In scholarly circles, recent articles have shed light on the dynamics of nuclear proliferation, both from the supply and demand sides, and formal approaches are increasingly used to highlight the determinants of military investment.

Yet, we argue, we are still missing a theory capable of predicting the success of counterproliferation efforts and the likelihood they will result in preventive war. This paper presents a first step in that direction.

---

[1]For the purposes of this paper, "counterproliferation" refers to the implicit or explicit threat of military action to prevent nuclear acquisition.

In our view, attempts to deter nuclear proliferation are unlikely to succeed when the potential shift in the balance of power resulting from nuclearization is sufficiently small relative to the costs of preventive war.[2] Under such conditions, the threat of preventive war is not credible, and proliferation will occur. In the opposite scenario, when the impact of nuclear acquisition on the balance of power is sufficiently high relative to the costs of preventive war, the threat of war is credible and counterproliferation should succeed. Since information about a country's nuclear program is usually imperfect, however, mistaken preventive wars – *i.e.*, wars launched against states suspected of trying to proliferate when they are not – become more likely.

Applying this framework to the nuclear age, we argue that, during the Cold War, the effect of proliferation on the balance of power was outweighed by the costs of preventive war. During that period, both great powers possessed robust retaliatory capabilities (conventional, in the case of the Soviets until 1949). Given their mutually assured retaliation and the relatively small impact of nuclear acquisition on their dyadic balance of power, neither superpower could credibly threaten to stop a member of the opposite bloc from acquiring nuclear weapons.

In the post-Cold War period, however, the balance of power largely favors the United States in any interaction with a non-nuclear state. Nuclear acquisition by another state would therefore have a greater effect on the balance of power relative to the cost of preventive war. This allows the United States credibly to threaten preventive war, making counterproliferation more successful. Other states understand that they can improve their standing by acquiring nuclear weapons only should they go undetected. This results in a lower risk of proliferation but also makes for a higher risk of preventive (if mistaken) war, such as the Iraq invasion.

Our argument unfolds as follows. Section 2 reviews the literature and introduces our theory. Section 3 formalizes the theory. Section 4 presents the empirical evidence, discussing the U.S.S.R. (1949) and Iraq (2003) cases. Section 5 summarizes our findings and presents implications. Proofs of the formal results are in the Appendix.

---

[2]For the purposes of our argument, "preventive war" includes a whole range of military actions, from surgical strikes against a limited set of targets to full-scale war. For a literature review on preventive war, see Levy (2008).

## 2 Theory and Literature

The current U.S. interest in countering proliferation stems in part from a consensus – in our view, wrongheaded – that "nuclear proliferation and its effect on U.S. national security interests constitutes the gravest threat facing the United States, that it is worse than ever before, and that new, more effective policies are needed to confront the problem" (Gavin, 2010, 7). Among the causes of this nuclear alarmism is the end of the Cold War. Building on realist theories of international politics, Mearsheimer (1990) argued that "[t]he most probable scenario in the wake of the Cold War is further nuclear proliferation in Europe." Frankel (1993, 37) wrote, along similar lines, that "nuclear arms proliferation will likely intensify" in the post Cold War. More recently, Potter and Mukhatzhanova (2010, 78) conclude that "[t]oday the proliferation metaphors of choice are 'nuclear cascade' and 'tipping point,' but the implication is the same – we are on the cusp of rapid, large-scale nuclear weapons spread." In short, extant security-based explanations for nuclear proliferation over-predicted its incidence in the post-Cold War world.

Why did predictions of a nuclear cascade fail to materialize? The recent literature has sharpened our understanding of nuclear proliferation decisions (Sagan, 1996-97, 2010), insisting on regional dynamics (Paul, 2000), the preferences of leaders (Hymans, 2006) and of ruling coalitions (Solingen, 2007), and testing existing theories with sophisticated tools (Singh and Way, 2004; Jo and Gartzke, 2007). Yet we still lack a theory that would explain the sharp decrease in nuclear proliferation since the end of the Cold War.

The answer is not trivial. One could argue that the low proliferation rate can be explained by the fact that few states find the benefits of nuclear weapons superior to the costs of investing in a nuclear program. We agree that this could explain why many states do not consider acquiring nuclear weapons, but not why *fewer* states have attempted to acquire nuclear weapons since the end of the Cold War. As shown by the recent wave of supply-side studies of proliferation, the general spread of nuclear know-how and the rise of nuclear networks such as the one ran by A.Q. Khan have lowered the costs of nuclear acquisition (Fuhrmann, 2009*a,b*; Kroenig, 2009; Montgomery, 2005; Montgomery and Sagan, 2009). In fact, the only state to nuclearize in the past twenty years – North Korea – is one of the world's least developed countries. In parallel, the realist literature made a strong argument that, with the end of the Cold War and the loss of a competing superpower, countries would stand more to gain from acquiring their own nuclear capability. The puzzle thus remains.

An alternative explanation would rely on the success of the Nuclear Non-proliferation Treaty (NPT), which provided non-nuclear states with incentives to maintain that status in exchange for support in their civilian nuclear programs. We find this alternative explanation unconvincing for two reasons. First, there was no change in the rate of proliferation since the signing of the NPT and the end of the Cold War, relative to the pre-NPT period, with one state acquiring nuclear weapons every five years, on average, in each period. The pace dropped only after the end of the Cold War, with one single country acquiring nuclear weapons in this twenty year period. Second, there is an obvious endogeneity problem in attributing a causal effect to the NPT. It is possible that countries would sign the NPT when they have already decided, for independent reasons, to drop their nuclear-weapons programs. By contrast, it is clear that the Cold War ended for reasons exogenous to the nonproliferation decision of individual countries.

In spelling out a causal effect for the end of the Cold War, we rely on the original realist intuition that states acquire nuclear weapons in order to improve their security. Yet, we argue that in order to understand why security concerns may lead to nuclear restraint, we must analyze this decision in the context of a strategic interaction between a state that is considering whether to develop nuclear weapons (using deterrence terminology, the target) and another state that is considering whether to resort to military action in order to stop proliferation (the deterrer).

This strategic-interaction approach allows us to capture the calculations of both target and deterrer. Nuclearization shifts the balance of power in favor of the target. Whenever this shift is greater than the cost of a nuclear program, therefore, the target should invest in a nuclear capability. Yet, the target understands there is a risk that its investment will be nipped in the bud. It must then anticipate the deterrer's incentive to strike preventively.

On its end, the deterrer must weigh the cost of action against that of inaction. The cost of action is the value of the resources destroyed in military conflict, *i.e.*, the cost of preventive war. The cost of inaction is the value of the concessions the deterrer will have to make to the target once the latter has nuclearized. Put differently, it is the increased ability of the target to convert policy preferences into outcomes once it possesses nuclear weapons.

Our theory shows how these tensions are resolved. When the impact of nuclearization on the balance of power is small relative to the cost of preventive war, proliferation occurs and peace prevails. Intuitively, if the costs of preventive war are great relative to the additional concessions that the target will be able to extract from the deterrer as a result of its newly-acquired nuclear

capability, preventive war is not a rational option. Under such circumstances, the deterrer's threat to launch a preventive strike should the target pursue nuclear weapons is not credible. Knowing this, the target develops nuclear weapons undeterred.[3]

When, however, the effect of nuclearization on the balance of power is large relative to the cost of preventive war, the deterrer's threat of military action is credible. In this case, the outcome depends on the quality of the information the deterrer receives about the target's investment decision. If it is perfectly observable, neither proliferation nor preventive war occur. The potential proliferator understands that attempting to develop nuclear weapons would result in a preventive strike. Anticipating such an outcome, it decides not to.

In reality, though, perfect observability is unlikely. A state will thus be tempted to develop nuclear weapons if it can avoid detection. Given this strategic incentive, the deterrer cannot commit to reward the target with a favorable peace even in the absence of evidence that the latter is acquiring nuclear weapons. As a result, the target may sometimes develop nuclear weapons and the deterrer may sometimes strike preventively (in game-theoretic terms, the unique equilibrium is in mixed strategies).

When information is imperfect, the likelihood of nuclear investment and that of preventive war depend on the effect of nuclearization on the balance of power. The greater this effect, the less likely the target is to acquire nuclear weapons and the more likely the deterrer is to launch a preventive war. As the effect of nuclearization on the balance of power increases, then the deterrer is more tempted to declare war to prevent the adverse shift. Therefore, in order to keep the deterrer indifferent between war and peace, the probability of the target deciding to develop nuclear weapons must decrease. At the same time, this greater effect means the target would benefit more from developing nuclear weapons, and would therefore be more tempted to proliferate. Consequently, in order to leave the target indifferent about proliferating, the deterrer must be more likely to declare preventive war. Combining these two results – a lower probability of proliferation and a higher probability of war – we conclude that, as the effect of nuclear acquisition on the balance of power increases, so does the likelihood of *mistaken* preventive wars.

Our theory depends heavily on measurements of – and comparisons between – the costs of

---

[3]Our theory relies on a straightforward cost/benefit analysis and is neutral in relation to offense/defense dominance and distinguishability (Montgomery, 2006).

preventive war and the magnitude of the shift in the balance of power resulting from nuclearization. We operationalize and measure such broad concepts the same way policymakers do. We determine the expected outcome of two scenarios: peace, leading to nuclearization by the target; and preventive war, leading to no nuclearization. We then compare the two. As we will see, in the run-up to Soviet acquisition in 1949, U.S. decisionmakers envisioned preventive war would lead to the Soviet conquest of Western Europe (and other areas) with near certainty. Soviet nuclearization, on the other hand, was envisioned as potentially degrading the deterrent effectiveness of the U.S. nuclear umbrella over Europe, but not necessarily leading to the Soviet conquest of Western Europe. Washington therefore decided that Soviet nuclearization was a less problematic outcome than preventive war with the Soviet Union. Similarly, as we show below, preventive war against Iraq in 2003 was perceived in U.S. policymaking circles as leading to a swift, costless, and certain victory. Iraqi nuclear acquisition, on the contrary, was seen by U.S. decisionmakers as potentially leading to nuclear attacks against one or more U.S. cities. Comparing the two outcomes, U.S. decisionmakers decided that preventive war was a better course than allowing Iraqi nuclearization.

Our theory therefore offers a simple explanation for the lower rate of proliferation and the higher likelihood of preventive war in the post Cold War. During the Cold War, nuclear proliferation had a relatively small effect on the overall balance of power relative to the costs of preventive war. Thus, neither superpower had the ability credibly to threaten a member of the other's bloc with a preventive counterproliferation strike. Such a strike risked inviting a retaliatory escalation, resulting in general war. Nuclear proliferation thus continued apace while peace prevailed. In the post Cold War, however, the overall balance of power is skewed towards the United States (Posen, 2003), which can therefore launch preventive wars at a relatively lower cost. At the same time, nuclearization would significantly improve a state's position vis-à-vis the United States. Thus, the United States should be concerned with nuclear proliferation, while recognizing that the credibility of its threat to strike preventively ensures the general success of its counterproliferation policy.

Counterproliferation, by involving an (implicit or explicit) threat of military action to prevent the spread of nuclear weapons, is essentially a problem of deterrence. Throughout the Cold War, deterrence was one of the most influential bodies of IR literature and the cornerstone of

peace.[4] Since the fall of the Soviet Union, however, deterrence has lost much of its appeal, both in theory and in practice. As one of the foremost experts on the topic laments, "interest in deterrence collapsed with the Cold War itself" (Freedman, 2005, 789). This waning interest results from the unparalleled power the United States enjoys, which enables it to deter state-led attacks on itself and its main allies with relative ease. The U.S.'s security concerns have therefore been replaced with a more diffuse set of problems, such as nuclear proliferation and terrorism – problems that are *prima facie* beyond the purview of deterrence (Smith, 2003, 155).

In our view, however, the deterrence conceptual apparatus is of great use in analyzing nuclear proliferation. By modeling counterproliferation as a deterrence problem, we can examine the strategic interaction between, on one side, the state that is considering the development of nuclear weapons and, on the other, that which is threatening it with negative consequences should it develop them. This interaction – which takes place *before* nuclearization and, therefore, before the balance of power shifts – conditions both the likelihood of investment and that of preventive war.

As the classical deterrence literature has shown, a necessary condition for successful deterrence is the credibility of threats (Schelling, 1966). During the Cold War, the critically high costs of superpower conflict made it hard for U.S. threats to be credible. Since the fall of the Soviet Union, however, the costs of U.S. military intervention have significantly decreased. As a result, U.S. deterrent threats should now be more credible. And yet, these threats have failed to deter North Korea from nuclearizing. Moreover, fear that such threats were ineffective in the Iraqi case led to the 2003 invasion. Why would there be proliferation, as well as preventive war, when threats of military action are credible?

The answer is that the credibility of threats is not a sufficient condition for successful deterrence. Deterrence depends on credible threats *and credible assurances.* To be successful, a deterrent effort must involve not only a credible threat of punishment in case of defection (nuclearization) by the target – it must also include a credible assurance of reward for compliance (non-nuclearization).

In our view, the credibility of threats and of assurances depends largely on the balance of power. The Cold War balance of power, although undermining the credibility of threats, supported that of assurances. As a result, the problem of credible assurances was relatively

---

[4]For a good summary of the deterrence literature, see Lupovici (2010, 706-710).

neglected. Schelling (1966, 74-75), in his classic *Arms and Influence*, despite acknowledging their conceptual symmetry, devotes sixty pages to the discussion of threats and only one to assurances. In the post Cold War, however, U.S. power preponderance supports the credibility of threats but undermines the credibility of assurances.

In the case of counterproliferation, the credibility of assurances is further undermined by the nature of nuclear-weapons programs. Given the difficulty of obtaining conclusive evidence about a country's decision to acquire nuclear weapons, U.S. assurances to reward a state for forfeiting nuclear acquisition are not credible. Understanding that a nuclear-weapons program might not necessarily be detected, and that therefore compliance might go unrewarded, a state may decide to launch a weapons program, hoping that it will go unnoticed.

While our theory applies to any investment in military power, we restrict it to nuclear proliferation. Nuclearization is perhaps the greatest single discrete shift in relative power that can be achieved through a process of investment in military capability. As Levy (2008, 7) puts it, "[t]he crossing of the nuclear threshold is the most consequential manifestation of a step-level power shift." Therefore, we should be particularly likely to find our theory at work in cases of *nuclear* counterproliferation.

The theory laid out here also allows for an understanding of the effect of the balance of power on the likelihood of successful and peaceful counterproliferation. The literature on systemic effects of the balance of power on international conflict is large (Levy, 2002). Structural realists have long argued that peace depends on the presence of a balance of power (Waltz, 1979; Mearsheimer, 2001). Hegemonic realists have made the opposite point – that peace depends on power preponderance and that power shifts are prone to generate wars (Gilpin, 1981; Organski and Kugler, 1984). The question of whether investments that create – or disrupt – a balance of power can be deterred is therefore of paramount importance.

So is the question of when will counterproliferation be likely to lead to preventive war. The concept of preventive war has been the object of great scrutiny, particularly in the aftermath of the invasion of Iraq in 2003 (Powell, 1996*a*,*b*, 2006; Lemke, 2003; Gaddis, 2004; Reiter, 2006). Yet the conditions under which preventive motivations for war lead to conflict have never been clearly stated. More particularly, there are very few studies of the causes of preventive strikes against WMD-producing facilities. Feaver and Niou (1996) is an exception, but the scope of the theory is limited as it depends on the risk preferences of the proliferator and the commitment of

the deterrer to non-proliferation (as pragmatist or purist), variables that are difficult to observe directly. Instead, we ground our theory on the effect of systemic changes on the cost-benefit analysis that rational, risk-neutral actors would take. We argue that incentives to launch such strikes are greater in the post Cold War – an argument that is supported by Fuhrmann and Kreps (2010)'s empirical findings.[5]

On this point, note that in his study of democracy and preventive war, Schweller (1992, 238) argues that "only nondemocratic regimes wage preventive wars against rising opponents." But, in a caveat that is rarely acknowledged (Levy, 2008, 9), Schweller writes that his argument about democratic pacifism "*concerns only power shifts between states of roughly equal strength; it is not relevant to all power shifts, for example, the case of the relative decline of a large state vis-à-vis a much smaller state*" (Schweller, 1992, 248, emphasis added).[6] Our theory dovetails nicely with Schweller's point, specifying the conditions under which preventive war is rational. At the same time, we specify those under which appeasement makes sense. When the effect of nuclear acquisition on the balance of military power is small relative to the costs of a preventive war, "appeasement" (*i.e.*, peaceful acceptance of another state's investment in nuclear weapons) is the rational policy response (Powell, 1996*b*; Rock, 2000; Treisman, 2004).

Finally, we contribute to the literature on rationalist explanations for war (Fearon, 1995; Powell, 1999). In the last fifteen years, the reasons structural theorists have presented as causes for war – anarchy, shifts in the balance of power, uncertainty about intentions, etc. – have been shown to provide an insufficient account. Since Fearon (1995), informational and commitment problems have been established as the mechanisms through which war occurs. In his seminal paper, Fearon formalizes the argument that a declining state may launch a war to prevent an adverse shift in the balance of power. His argument, however, assumes that shifts in the balance of power happen exogenously. Very few papers have attempted to endogenize such shifts

---

[5]Small numbers make their finding statistically insignificant, though. For example, the U.S. considered 12 strikes (enemy-year) and attacked in 3 out of 9 of these episodes during the Cold War and 2 out of 3 of these episodes after the Cold War. The results could even be stronger with a less stringent definition of the Cold War, which in their coding, starts after the collapse of the Soviet Union (*i.e.* in 1992). Note that one of these 'Cold War' strikes was against Iraq in 1991, when the country had already lost the Soviet Union as a patron (see section 4 below).

[6]Recent experimental evidence shows that popular support in a democracy (the U.K.) for a preventive counterproliferation strike is greater if the target state is 'half as strong,' rather than 'as strong as,' the home country (Tomz and Weeks, 2010).

in the balance of power (Fearon, 1996; Chadefaux, 2009; Powell, 2010; Bas and Coe, 2010) or considered the incentives to acquire military capacity (Baliga and Sjostrom, 2008; Meirowitz and Sartori, 2008; Jackson and Morelli, 2009; Bas and Coe, 2010; Fearon, 2010).

None of these papers has modeled the acquisition of military power as an investment *with delayed returns*. By modeling the strategic interaction this way – *i.e.*, as a deterrence problem – we show that commitment problems are not a sufficient cause of war. Under complete information, large shifts in the balance of power make the threats of war by the deterrer credible and, as a result, enforce peace. Only if the deterrer is imperfectly informed about the target's action can war occur. In short, when shifts in the balance of power are endogenized, they can lead to war only when coupled with imperfect information.

## 3    The Model

### 3.1    Strategies and Payoffs

This is a game between two states, $D$ (the 'deterrer') and $T$ (the 'target'), which divide a pie of size 1 in each of two periods, 1 and 2. Initially, $T$ has no nuclear weapons and decides whether to acquire them through an investment $I \in \{0, 1\}$, where $I = 1$ means that the investment takes place, $I = 0$ otherwise. The cost of investing in a nuclear-weapons program is $k > 0$.

$T$'s investment decision is not observable to $D$ in period 1. Formally, $D$ receives a signal $s_t$ about $I$ in period $t$, which takes one of two values, 0 or 1. If $T$ does not invest in a nuclear-weapons program ($I = 0$), signal $s_1$ takes a value of 0. If $T$ invests ($I = 1$), it takes a value of 1 with probability $p_s$ and 0 with probability $1 - p_s$. Intuitively, a signal of 1 represents the discovery of hard evidence of a nuclear-weapons program. If $D$ receives such a signal, it learns that $T$ decided to invest. It is possible, however, that an investment by $T$ in a nuclear-weapons program does not produce this signal. In other words, the program can go undetected. We consider three cases: a perfectly informative signal ($p_s = 1$), a perfectly uninformative signal ($p_s = 0$), and a partially informative signal ($p_s \in (0, 1)$). We assume that $T$'s investment decision is revealed in period 2, when the investment comes to fruition (*i.e.*, signal $s_2$ is perfectly informative, or $s_2 = I$). In other words, if $T$ invests in a nuclear-weapons program in period 1, then in period 2, when nuclearization occurs, $D$ gets a perfectly informative signal of $T$'s decision to go nuclear, through, *e.g.*, a nuclear test.

In period 1, after $T$ decides whether to forfeit or invest in a nuclear-weapons program and $D$ receives the signal about this decision, the two countries divide a pie. First, $D$ offers a share $z_1$ of the pie to $T$, keeping $1 - z_1$ for itself, or unilaterally declares war. If $T$ accepts $D$'s offer, it is implemented. If $T$ rejects $D$'s offer, war ensues and country $i$ gets a payoff $w_i(N_t) \geq 0$ which depends on the nuclear-weapons status $N_t$ of country $T$ at time $t$ ($N_t \in \{0, 1\}$, where $T$ possesses nuclear weapons if and only if $N_t = 1$). We assume that $T$ starts the game without nuclear weapons and that the nuclear investment has delayed returns. Thus, $T$ always remains non-nuclear in period 1. If $T$ invests in period 1 and peace prevails, it acquires nuclear weapons in period 2. If war occurs in period 1, then $T$ remains non-nuclear throughout the game.[7] In period 2, the game follows the same timing as in period 1, except that $T$ does not have the option of investing in nuclear weapons.[8]

We also assume that war is costly, so that, for any $N_t \in \{0, 1\}$,

$$w_T(N_t) + w_D(N_t) < 1 \tag{1}$$

We call $1 - w_T(0) - w_D(0)$ the *cost of a preventive war*.

As per the usual protocol, countries discount future payoffs by a factor of $\delta$. We call $\delta[w_T(1) - w_T(0)]$ the *effect of nuclearization on the balance of power*. We restrict our attention to *productive* investments – i.e., the effect of nuclearization on the balance of power is large relative to the cost of a nuclear-weapons program:[9]

$$\delta[w_T(1) - w_T(0)] > k + w_T(0) \tag{2}$$

Summing up, the timing of the game is as follows:

---

[7]It is common to assume that war ends a game. Such an assumption would produce the same results, but we prefer our current set-up, as it captures the extreme case where any preventive war succeeds with probability 1 in destroying the target's nuclear program. We plan to consider intermediate cases in future work.

[8]We could let $T$ invest in a nuclear-weapons program period 2, but $T$ would never choose to do so, since this investment is costly, takes one period to come to fruition, and period 2 is the last period of the game.

[9]We could call $\delta w_T(1) - (1 + \delta)w_T(0)$ the effect of nuclearization on the balance of power. This would not affect the results. The description of the regions of the parameter space would be more elegant, but comparative statics would be less elegant.

## 3.2 Timing

First Period

1. $T$ decides whether to invest in a nuclear-weapons program ($I$).

2. Signal $s_1$ about $T$'s decision ($I$) is sent.

3. $D$ proposes a division of the pie, indexed by $z_1$, or declares war.

4. $T$ accepts/rejects $D$'s offer.

Second Period

1. Signal $s_2$ about $T$'s decision ($I$) is sent.

2. $D$ proposes a division of the pie, indexed by $z_2$, or declares war.

3. $T$ accepts/rejects $D$'s offer.

## 3.3 Solution Concept

This is a dynamic game of incomplete information. We solve for Perfect Bayesian Equilibria. This requires that at each information set, play is sequentially rational given beliefs and that beliefs are updated using Bayes' rule whenever possible (Fudenberg and Tirole, 1991, 325-326).[10]

## 3.4 Solving the Game

First, it is straightforward to show the following result:

**Proposition 1** *In period 2, there is always peace, where $D$ offers $z_2^* = w_T(N_2)$ and $T$ accepts if and only if $z_2 \geq w_T(N_2)$.*

**Proof.** *$T$ accepts $z_2$ if and only if $z_2 \geq w_T(N_2)$. $D$ prefers peace if and only if $1 - z_2 \geq w_D(N_2)$. Since war is costly (by (1)), $D$ prefers to offer $z_2^* = w_T(N_2)$ to declaring war.* ∎

---

[10]If there is an equilibrium with no investment, beliefs are not pinned down by Bayes' rule after a signal of $s_1 = 1$. We will assume that, after such a signal, $D$ believes that $T$ invested with probability 1, which is the only decision that can generate such a signal.

This proposition shows that peace prevails in period 2, since there is no commitment problem (it is the end of the game) and no information problem persists. In equilibrium, $T$ receives a more generous offer in period 2 if it possesses nuclear weapons, since it would fare better in a conflict with $D$.

We now move up to period 1. Consider first the benchmark case where signal $s_1$ is perfectly informative ($p_s = 1$). Then we can show:

**Proposition 2** *In equilibrium, peace prevails. Moreover, proliferation occurs if and only if the effect of nuclearization on the balance of power is sufficiently small relative to the cost of a preventive war.*

**Proof.** *See the appendix.* ∎

The intuition for this result is as follows. By failing to respond to $T$'s investment in nuclear weapons with a preventive war, $D$ must make larger concessions to $T$ in period 2 (see proposition 1). If the effect of nuclearization on the balance of power relative to the cost of a preventive war is sufficiently large, then $D$ prefers to respond to $T$'s investment in nuclear weapons with preventive war. Anticipating this reaction, $T$ does not invest. Investment by $T$ would mean paying the cost of a nuclear-weapons program, but fighting before it can shift the balance of power. If the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, however, then $D$ prefers peace as a response to $T$'s investment in nuclear weapons. Since this investment is productive (by (2)), $T$ invests.

A few interesting points stand out from this analysis. First, proliferation occurs only if the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war. The model thus captures a key concern of the classic deterrence literature. During the Cold War, the cost of preventive war was so high relative to any possible shift in the balance of power that neither superpower could credibly threaten it. In the post-Cold War period, however, nuclear proliferation has a large effect on the balance of power relative to the cost of preventive war. Proliferation is thus more likely to be deterred.

Second, when nuclear acquisition is modeled as an investment, we can rationalize why $D$ would punish $T$ for attempting to develop nuclear weapons. Once nuclearization is accomplished – in period 2 – $T$ is able to extract a greater share of the *status quo*. Therefore, a state that is developing nuclear weapons, having more to gain from peace, is willing to accept a lower offer in

period 1. At the same time, a state that is not investing in nuclear weapons must be rewarded with more generous terms in period 1.

Third, by modeling the change in the balance of power as the result of a decision by $T$, we show that the anticipation of large shifts in the balance of power does not produce war. This stands in contrast with the seminal work of Fearon (1995). In that framework, a declining state decides to fight a war to prevent the (exogenous) shift in the balance of power. In our set-up, the shift in the balance of power is the (endogenous) result of $T$'s decision to acquire nuclear weapons. When $T$'s decision to nuclearize is perfectly observable, it leads $D$ to fight a war to prevent the adverse shift in the balance of power. But since the decision to nuclearize does not lead to the immediate acquisition of nuclear weapons, $T$ would end up fighting a war before it is able to shift the balance of power. In other words, when the decision to acquire nuclear weapons (i) is observable and (ii) leads to a large shift in the balance of power, $T$ never gains from investing in a nuclear program. Knowing that $D$ would launch a preventive war against it, $T$ forfeits nuclear acquisition.

In reality, however, the decision to invest in a nuclear-weapons program is not perfectly observable to outside actors. We now consider the benchmark case where the signal about $T$'s investment decision in the first period is completely uninformative ($p_s = 0$). Then we can show

**Proposition 3** *In equilibrium,*

*(i) If the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, peace prevails and proliferation occurs;*

*(ii) If the effect of nuclearization on the balance of power is sufficiently large relative to the cost of preventive war, $T$ invests in a nuclear-weapons program with probability $q^* = \frac{1 - w_T(0) - w_D(0)}{\delta[w_T(1) - w_T(0)]}$ and preventive war happens with probability $1 - r^* = 1 - \frac{k}{\delta[w_T(1) - w_T(0)]}$.*

**Proof.** *See the appendix.* ■

First, this proposition builds on the fact that, if the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, then $D$ always prefers peace. Even if $D$ knew that $T$ was investing in a nuclear-weapons program, it would still prefer not to wage war. Thus, the informativeness of the signal does not change the conclusion: under these circumstances, peace prevails and, since the investment is productive, $T$ invests in a nuclear-weapons program.

Second, the proposition shows that, if the effect of nuclearization on the balance of power is sufficiently large relative to the cost of preventive war, then the equilibrium is in mixed strategies. Indeed, assume that $T$ invests in nuclear weapons with certainty. Then $D$'s best response is to wage war. But $T$ would then prefer not to invest in a nuclear-weapons program, as doing so is costly and war happens before the balance of power is changed. Likewise, assume that $T$ does not invest in a nuclear capability. Then $D$'s best response is to reward $T$ with a generous peaceful offer (of $z_1 = w_T(0)$). But $T$ would then prefer to invest in nuclear weapons. The deviation (from forfeiting nuclearization) would go unnoticed, $T$ would still be rewarded in period 1 and benefit from a favorable change in the balance of power in period 2. Thus the equilibrium has $T$ mixing between forfeiting and investing in a nuclear-weapons program and $D$ mixing between war and a generous offer. In this case, both proliferation and war occur because $D$ cannot condition its response on $T$'s decision, which it does not observe.

We can also add:

**Corollary 1** *Ceteris paribus, the greater the effect of nuclearization on the balance of power,*

*(i) The smaller the probability of proliferation;*

*(ii) The greater the probability of preventive war;*

*(iii) The greater the probability of preventive war against a state that is not investing in nuclear weapons.*

**Proof.** *See the appendix.* ∎

The intuition for these results is as follows. It is clear that the probability of proliferation is one when the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, and it is smaller than one when this effect becomes sufficiently large relative to the cost of preventive war. When the latter obtains, countries play a mixed strategy equilibrium. The greater the effect of nuclearization on the balance of power, the greater the benefit of war for $D$, as it prevents a greater fall in peaceful terms in period 2. To ensure $D$'s indifference between war and peace, $T$ must be less likely to invest in a nuclear-weapons program, in which case a preventive war is unwarranted. This proves point $(i)$.

The same logic proves point $(ii)$. The probability of war is zero when the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, and it is positive when this effect is sufficiently large. In this mixed strategy equilibrium, $D$'s strategy leaves $T$ indifferent between forfeiting and investing in a nuclear-weapons capability. The

greater the effect of nuclearization on the balance of power, the greater the benefit of nuclear acquisition for $T$, as it leads to a larger change in the peaceful terms for $T$ in period 2. To ensure $T$'s indifference between acquiring and forfeiting a nuclear capability, $D$ must declare war with a greater probability, reducing the benefit of investing in a nuclear-weapons program. ($T$ pays a cost but endures war before the shift in the balance of power is realized.) This proves point ($ii$).

This argument also proves point ($iii$). $D$ has no information about $T$'s decision, so that proliferation and preventive wars are independent events. In other words, the share of preventive wars that are mistaken, $i.e.$, against an unarming $T$, should they be fought, is simply the rate of successful counterproliferation. It is increasing with the effect of nuclearization on the balance of power (by ($i$)). Likewise, war is increasingly likely as the effect of nuclearization on the balance of power increases (by ($ii$)). As a result, the probability of preventive war against a state that is not investing in nuclear weapons increases with the effect of nuclearization on the balance of power.

Of course, countries will in reality have some information about their enemy's decision to forfeit or invest in a nuclear-weapons capability. We now consider the more realistic case in which the signal about $T$'s investment decision in the first period is partially informative ($p_s \in (0, 1)$). We get the following:

**Proposition 4** *In equilibrium,*

*($i$) If the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, peace prevails and proliferation occurs;*

*($ii$) If the effect of nuclearization on the balance of power is sufficiently large relative to the cost of preventive war, then there are two cases:*

*($ii$.1) If the signal of $T$'s decision is sufficiently informative, i.e. if*

$$p_s \geq 1 - \frac{k}{\delta \left[ w_T(1) - w_T(0) \right]} \tag{3}$$

*then $T$ does not invest (counterproliferation succeeds). If $D$ receives signal $s_1 = 1$, it declares war. If it receives signal $s_1 = 0$, it offers $z_1 = w_T(0)$, which is accepted by $T$ along the equilibrium path;*

*($ii$.2) If the signal of $T$'s decision is not sufficiently informative (($3$) does not hold), then $T$*

*invests in a nuclear-weapons program with probability*

$$q^* = \frac{1}{p_s + (1 - p_s) \frac{\delta[w_T(1) - w_T(0)]}{1 - w_T(0) - w_D(0)}} \tag{4}$$

*If $D$ receives signal $s_1 = 1$, it declares war. Otherwise, $D$ declares war with probability*

$$1 - r^* = 1 - \frac{k}{(1 - p_s)\, \delta\, [w_T(1) - w_T(0)]} \tag{5}$$

*and offers $z_1 = w_T(0)$ with probability $r^*$, which is accepted by $T$ along the equilibrium path.*

**Proof.** *See the appendix.* ∎

First, this proposition confirms that when the effect of nuclearization on the balance of power is sufficiently small relative to the cost of preventive war, the outcome of the game is independent of the informativeness of the signal.

Second, if the effect of nuclearization is sufficiently large relative to the cost of preventive war, then the outcome does depend on the informativeness of the signal. When it is sufficiently high ((3) holds), $D$'s counterproliferation effort is successful. $T$ understands that it is likely to be detected if it invests in a nuclear-weapons program, with $D$ declaring war before the balance of power is affected. Therefore, $T$ prefers not to invest. When the signal is not sufficiently informative, however, $T$ is reasonably confident that it can invest in a nuclear-weapons capability without being detected. The unique equilibrium is in mixed strategies, for the same logic outlined above. We can also add the following:

**Corollary 2** *If the signal is sufficiently informative ((3) holds), then peace prevails, and proliferation occurs if and only if the effect of nuclearization on the balance of power is sufficiently small relative to the cost of a preventive war. If the signal is not sufficiently informative ((3) does not hold), then, ceteris paribus, the greater the effect of nuclearization on the balance of power,*

    *(i) The smaller the probability of proliferation;*

    *(ii) The greater the probability of preventive war;*

    *(iii) The greater the probability of preventive war against a state that is not investing in nuclear weapons.*

**Proof.** *See the appendix.* ∎

These conclusions follow from the same logic we outlined for corollary 1. They form the main predictions of the model, which we now explore in the empirical record.

# 4   Evidence

In this section, we use two case studies – the Soviet nuclear acquisition in 1949 and the invasion of Iraq in 2003 – to display the mechanisms developed in our theory about how (i) the effect of nuclear acquisition on the balance of power, (ii) the cost of preventive war, and (iii) the quality of the signal about the decision to proliferate interact to condition the probability of successful counterproliferation and that of preventive war.

## 4.1   Soviet Nuclear Acquisition

On August 29, 1949, the Soviet Union ended a four-year U.S. nuclear monopoly by testing its own nuclear device. The Soviet nuclear program, launched in 1942, had been known to the United States throughout the nuclear-monopoly period. Still, the United States did not launch a preventive strike in order to stop the Soviet nuclear program. Why did the only state in history to possess a nuclear monopoly fail to use this advantage to prevent its end?

The conventional wisdom on why a U.S.-launched preventive attack against the Soviet nuclear program never materialized is centered around two reasons.[11]

First, the information possessed by the United States about the state of the Soviet program was poor (Richelson, 2006; Goodman, 2007). By 1945, U.S. intelligence pointed to a date for a Soviet nuclear test anywhere between three and twenty years down the road. Eventually, a consensus emerged around a five-year estimate. This five-year figure, however, remained unchanged. Consequently, at no point did U.S. leaders think that the Soviets were close to acquiring the bomb (Gordin, 2009, 66).[12] Therefore, the argument goes, preventive war was

---

[11]Quester (2000), the most thorough investigation of the decision not to use the U.S.'s nuclear monopoly to prevent the Soviets from ending it, lays out more than twenty practical/procedural and moral factors that *may* have played a role in the decision-making, but does not conclude which effectively did.

[12]On July 1, 1949, less than three months before the Soviet test, Admiral R.H. Hillenkoeter, Director of the CIA, predicted that "the earliest date by which it is remotely possible that the U.S.S.R. may have completed its first atomic bomb is mid-1950, but the most probable date is believed to be mid-1953" (quoted in Holloway (1994, 220)). An estimate published *after* the

not considered seriously because the Truman administration never estimated Soviet acquisition to be imminent. As Gordin (2009, 87) writes, "[t]he first immediate effect of a lengthy estimate was to discourage a preemptive strike against the Soviet Union."

But the presumed length of the window of opportunity until Soviet acquisition does not necessarily lead to a dovish stance. For example, General Leslie Groves, the top military commander in charge of nuclear weapons, estimated the duration of the American atomic monopoly at more than twenty years, and yet strongly advocated for preventive war. As early as January 1946, he wrote to Congress that either the Soviets accepted a global nuclear disarmament treaty (which they wouldn't) or the United States "should consider a preventive attack against Soviet atomic research facilities to guarantee American supremacy" (quoted in Buhite and Hamel (1990, 374)). More generally, U.S. top decisionmakers knew the estimates were mere guesses. David Lilienthal, the chairman of the Atomic Energy Commission (henceforth AEC, which controlled the U.S. arsenal in the early post-war years), noted that the intelligence estimates were "five percent information and ninety-five percent construction ... [based on sources] so poor as to be actually merely arbitrary assumptions" (quoted in Goodman (2007, 28)). These doubts prompted the military to prepare preventive war plans as early as October 1945.

The second reason usually invoked to explain the absence of a U.S. preventive strike is morality. In a 1948 meeting with members of the AEC, Truman opposed the military's request for control of the nuclear arsenal, arguing that nuclear weapons' destructive power places them in a category of their own and adding "It is a terrible thing to order the use of something ... that is so terribly destructive, destructive beyond anything we have ever had" (quoted in Rhodes (1995, 327)). After the Soviet test, Truman (1950) justified the absence of a preventive strike by saying: "Such war is the weapon of dictators, not of free democratic countries like the United States". In short, moral reasons seem to have precluded a preventive attack.

Yet many in American society – including political elites – had no moral qualms about endorsing a preventive strike. Indeed, Trachtenberg (2007, 4-5) writes that "when you look at the evidence from this period, you find preventive war arguments all over the place. ... [P]reventive war thinking was surprisingly widespread in the early nuclear age."[13] Moral arguments, there-

Soviet test – but before U.S. detection – reasserted these predictions (CIA, 1994, 319).

[13]Quester (2000, chapter 3) devotes an entire chapter to what he calls "outright advocates" of the preventive war option, listing prominent politicians, scientists, and military leaders who advocated for a strike. See also: Buhite and Hamel (1990, 367) and Williamson Jr. and Rearden

fore, cut both ways, and many invoked the morality of using military force to prevent the Soviets from acquiring the means to incinerate the West.

While each of these two arguments – time window and morality – may have mattered, we argue that neither, in and of itself, offers a convincing explanation of the U.S. decision not to strike the Soviet Union preventively. Our own explanation is that Truman understood – as did Stalin – that, although Soviet nuclear acquisition would have a significant adverse impact on U.S. power vis-à-vis the Soviet Union, the costs of war (even accounting for the U.S. nuclear monopoly) were too high to allow for a preventive U.S. strike against the Soviet program.

The reasons were the following. To begin with, the quality of U.S. intelligence on the location of Soviet nuclear facilities was poor. U.S. intelligence in the late 1940s (in the pre-satellite, pre-surveillance airplane era) relied mostly on data obtained from German prisoners of war and maps from the German invasion of Russia in 1941, before the Soviet program took off.[14] This intelligence gap made it impossible to launch a surgical strike. As a consequence, the target-set for any preventive strike would have to be very large; in practice, indistinguishable from an attempt to destroy the entire Soviet state.

In fact, we believe it was the magnitude of a hypothetical attack that exacerbated the moral concerns about prevention. Initial U.S. war plans admitted that a war with the Soviet Union would be long and costly, first forcing the U.S. out of Europe. Later war plans were more optimistic about the prospects of victory, but only because a massive air-atomic campaign would compensate for the weakness of American conventional forces.

Such an exacting military goal, however, was well beyond the reach of the United States. Indeed, the U.S. nuclear arsenal was remarkably small throughout the monopoly period. As David Rosenberg notes, in the early post-war era

> the most critical determinant in strategic and operational planning was capability. From 1945 through 1948, the vaunted era of American nuclear monopoly, the nation's stockpile and delivery capability were extremely limited. There were only two weapons in the stockpile at the end of 1945, nine in July 1946, thirteen in July 1947, and fifty in July 1948. None of these weapons was assembled (Rosenberg, 1983, 14).

(1993, 140).

[14]On the difficulty of U.S. intelligence gathering on the Soviet nuclear program, see Gordin (2009, 80-85). The Soviets proved extremely apt at hiding their nuclear facilities, in one case under a lake – see Zaloga (1993, 50, 62, 68) and Rhodes (1995, 287).

Although the 1948 Berlin blockade led to an increase in the production of nuclear weapons, by the time the Soviets tested their nuclear device in September 1949, the United States arsenal consisted in less than 200 bombs.[15] By mid-1950, one year *after* the Soviet nuclear breakthrough, the U.S. arsenal totaled less than 300 bombs (Holloway, 1994, 230).

This small number of nuclear devices, when combined with a shortage of modified bombers able to drop them and of crews trained to load the bombs and fly the airplanes (Rosenberg, 1982*b*, 29), left the United States very far from the military requirements for destroying a country as vast as the Soviet Union, which, according to a 1945 military study, were placed at 466 bombs (Rhodes, 1995, 226).[16] This means that, as Buhite and Hamel (1990, 383) write, U.S. "war plans consistently demanded more bombs than existed in the U.S. arsenals well into the 1950s." The U.S. nuclear monopoly was, in essence, a nominal monopoly. Any preventive strike would therefore need to rely overwhelmingly on conventional forces, entailing considerable casualties and a protracted war. In sum, the U.S. administration had no clear line of sight to a quick military victory in a preventive strike against a pre-nuclear Soviet Union.

Without such a quick victory in sight, however, a preventive strike posed a third problem – Soviet retaliation. U.S. war plans were extremely pessimistic in this respect. After the quick post-World War II U.S. demobilization, the balance of conventional forces, especially in Europe, heavily favored the Soviets. A November 1945 JIC/JCS report argued that, in case of a war in Europe, "the Soviets would enjoy a great preponderance in numbers of men against the United States or even against the United States, Great Britain and France" (Holloway, 1994, 231). By mid-1946, the staff in charge of drafting the (failed) Baruch nuclear disarmament plan noted that the "U.S. has gone so far in its demobilization of the Army and Navy that if we were to stop making bombs we would be almost defenseless and would certainly have only a modicum of military power with which to stand up to the U.S.S.R." (Gordin, 2009, 54).[17] In

---

[15]The most accurate estimate available puts the number at 169 – see Norris and Arkin (1983*b*, 48) and Norris and Arkin (1983*a*, 58-59). Their figures supersede the previous (inflated) estimates in Rosenberg (1982*b*, 25-30). On the limiting effect of the small stockpile on U.S. war plans, see Buhite and Hamel (1990, 383) and Williamson Jr. and Rearden (1993, 107-111).

[16]As Rhodes (1995) notes, some in the armed forces thought these requirements to be too high and underestimate the destructive potential of nuclear weapons, but the basic point is that the arsenal of the time was much below what was needed to deal a decisive blow to the Soviet Union was consensual.

[17]Along similar lines, Rhodes (1995, 301) writes: "By 1947, with fewer than 1.5 million men

December 1947, Secretary of Defense James Forrestal considered the "predominance of Russian land power in Europe and Asia" to be one of the "outstanding military factors in the world" at the time (Rhodes, 1995, 313). As Gaddis (1987, 109) notes, "one Pentagon estimate credited [the Soviet Union] with sufficient strength to overrun most of continental Europe, Turkey, Iran, Afghanistan, Manchuria, Korea, and North China."

Explicitly addressing the issue of preventive war with the Soviet Union, the Harmon Committee report, published in May 1949, concluded that even if the United States were able to destroy seventy Soviet cities as planned, this would not "bring about the capitulation, destroy the roots of Communism, or critically weaken the power of the Soviet leadership to dominate the people." In a remarkable understatement, the report mentioned that such an attack would "produce certain psychological and retaliatory reactions detrimental to the achievement of Allied war objectives and its destructive effects will complicate post-hostilities problems." Furthermore, "the capability of Soviet armed forces to advance rapidly into selected areas of Western Europe, the Middle East, and the Far East would not be seriously impaired."[18] In short, certain Soviet retaliation against a U.S. preventive strike was likely to lose to massive manpower, materiel, and territorial losses to the United States.

To conclude, in the absence of intelligence that enabled the construction of a target-set for a surgical strike against Soviet nuclear facilities, a preventive strike required a nuclear arsenal capable of crippling the Soviet Union. Since the U.S. arsenal was far from possessing this capability, a preventive strike would require a massive conventional attack. Alas, such an attack was likely to lead to retaliation in areas – *e.g.*, Western Europe – where the balance of power strongly favored the Soviets. Retaliation was thus likely to result in great territorial gains for the Soviet Union. A combination of poor intelligence, the small size of the U.S. nuclear arsenal, and the balance of conventional forces meant a preventive strike would involve costs beyond the point at which it no longer made sense. While morality may have played a role, as Buhite and Hamel (1990, 382-383) conclude, "[l]imited American capabilities were probably a greater

---

under arms, the United States had made the atomic bomb its first line of defense (however thin the line) as it began to mount a broad, worldwide challenge to what it perceived to be Soviet expansionism." For an estimate of the balance of forces in the European theatre that was less unfavorable to the U.S., see Evangelista (1982-83). The key point is that U.S. decisionmakers and the general public at the time took for granted the Soviet ability to overrun Western Europe (Evangelista, 1982-83, 110).

[18]All quotes of the Harmon Report come from Rosenberg (1982*a*).

element behind the decision not to engage in preventive war."

In sum, preventive war against the Soviet Union in the period of U.S. nuclear monopoly was estimated to lead precisely to the outcome U.S. policy feared might result from Soviet nuclear acquisition – Soviet territorial expansion in areas of crucial interest. A preventive strike would therefore be self-defeating (see Borowski (1982, 125-128), Nitze, Rearden and Smith (1989, 109-110), and Williamson Jr. and Rearden (1993, 140-141)).

## 4.2   The U.S.-led Invasion of Iraq

On March 20, 2003, a U.S.-led coalition invaded Iraq, quickly defeating Iraqi forces and deposing Saddam Hussein's regime. Baghdad fell a mere twenty one days after the invasion was launched and the major-operations phase of the war ended six days later.

In the past, Iraq had possessed impressive military forces, supplied mostly by the Soviet Union. But as the Cold War ended, Saddam's regime found itself in a weaker position. Already in 1991, during the Gulf War, Iraqi forces had been decisively defeated and expelled from Kuwait by a U.S.-led coalition (Gordon and Trainor, 1995). Significantly, Iraq lost much of its military materiel in that conflict.[19] The vulnerability created by the Soviet collapse was duly noted in Baghdad. Tariq Aziz, Saddam's foreign minister, lamented after the 1991 defeat, "[w]e don't have a patron anymore. ... If we still had the Soviets as our patron, none of this would have happened" (Friedman and Tyler, 2006). Severely weakened by defeat in the Gulf War, Saddam's armed forces were further crippled by the stringent sanctions imposed on the country as a result of that conflict. By 2003, Iraq's geostrategic position was at its weakest, with no great-power sponsors and a poorly trained and equipped military. By then, the balance of power clearly favored the United States.

The swift victory obtained by the U.S.-led coalition in the 2003 invasion hence reflects the striking imbalance of power at the outset of the war. Although fighting a defensive war in well-

---

[19]On February 22, 1991, well into the opening air campaign against Iraqi forces but before the ground war started, Saddam accepted a modified Soviet plan to withdraw from Kuwait in 21 days. The U.S. administration, however, rejected this offer, demanding a seven-day withdrawal, with the purpose of forcing Saddam to leave behind his materiel, in particular armored vehicles. The ground war resulted from Saddam's rejection of this demand, which would leave him with little more power than a military defeat. Most Iraqi materiel deployed in Kuwait ended up being destroyed, however (Pape, 1996).

known terrain, against an expeditionary force deployed across the globe from its home countries, they lost all engagements with coalition forces and ended up suffering 9,200 fatalities – or more than fifty times the 172 lives lost by coalition forces.[20] In sum, in the post-Cold War era, the United States' ability to depose Saddam was never in doubt.

During the crisis that led to the invasion, the U.S. government's *casus belli* rested on suspicion that Saddam Hussein was developing WMD – including nuclear weapons – and thus presented an imminent threat (Freedman, 2004). Granted, a multiplicity of arguments was introduced to justify the invasion, including links to terrorism, human-rights abuses, and democratization in the Middle East (Tenet, 2007, 301). But WMD played the central role in the U.S. administration's arguments for forcible regime change. Ever since the President's 2002 State of the Union Address, the U.S. administration had publicly declared that it would "not permit the world's most dangerous regimes to threaten us with the world's most destructive weapons" (Bush, 2002*b*). Two days later, President Bush reiterated the argument: "Saddam Hussein must understand that if he does not disarm, for the sake of peace, we, along with others, will go disarm Saddam Hussein" (CNN, 2003). On February 5, 2003, in what was the most publicized attempt to legitimize the invasion, Secretary of State Colin Powell made a presentation to U.N. Security Council titled 'Iraq: Failing to Disarm.' Powell argued that "possession of the world's most deadly weapons was the ultimate trump card [and] the United States would not – could not – run the risk to the American people that Saddam Hussein would one day use his weapons of mass destruction" (UN, 2003). The day after Baghdad fell, in the absence of any WMD findings on the ground, White House press secretary Ari Fleischer repeated it: "[W]e have high confidence that they have weapons of mass destruction. *That* is what this war was about" (emphasis added).[21]

---

[20]A U.S. Army study attributes the outcome of the war to "a synergistic interaction between advanced coalition technology and a major skill differential" (Biddle et al., 2004, v). The performance of Iraqi forces was plagued by constant strategic and tactical errors. Worse, were Iraqi forces to have operated at the maximum effectiveness permitted by the technology at their disposal, the outcomes would have changed little (Press, 2001).

[21]Later, in the absence of WMD findings, Paul Wolfowitz, one of the architects of the war, claimed that there were four motivations behind the invasion: Iraq's WMD, its support for terrorism, the nexus between these two, and the regime's treatment of the Iraqi population. According to Wolfowitz, "for reasons that have a lot to do with the U.S. government bureaucracy we settled on the one issue [WMD] that everyone could agree on" (Wolfowitz, 2003).

This heightened perception of the threats posed by WMD proliferation for the United States is perhaps best captured by 'the one percent doctrine,' attributed to Vice President Dick Cheney. In the new security environment, the United States must deal with 'low-probability, high-impact' events as if they were certain (Suskind, 2006). If there is a one percent chance a great threat will materialize, U.S. policy must deal with it as if it were certain.

The impact of Iraq acquiring a nuclear capability was one such 'low-probability, high-impact' development. The United States feared not only that Saddam would give nuclear weapons to a terrorist group for use against U.S. targets. It also worried that preventing him from doing so (or retaliating against having so done) would be exceedingly costly. Were Iraq to acquire nuclear weapons, its relative power vis-à-vis the United States would shift very significantly, curtailing the U.S.'s scope of action. Specifically, a U.S. attempt to depose Saddam by force would place him in a "use them or lose them" situation regarding his nuclear capability, and was therefore out of the question (Posen, 1997, 22-26). In short, a nuclear-armed Iraq would pose a grave risk to U.S. security, decrease the probability of a U.S. military victory, and multiply the costs of any U.S. military action against it. Therefore, though unlikely, Iraqi nuclear acquisition posed grave consequences, leading to U.S. preventive action. Put differently, according to this mindset, in the absence of certainty about Iraq not arming, the United States must act.

In sum, the crisis leading to the invasion of Iraq was grounded on a dispute about Iraqi efforts to acquire WMD – a development the United States was determined to avoid. In the absence of information that proved Iraq was not investing in a WMD capability, the United States, possessing the ability to disarm it, could not and did not hesitate to do so. As Packer (2005, 60) puts it, the argument for the war was syllogistic:

> Saddam has had and still seeks weapons of mass destruction; he has used them on his own citizens in the past; he might now give them to al-Qaeda or another terrorist group; terrorists want to destroy the United States. Therefore, the United States must disarm or overthrow Saddam.

According to the terms of the 1991 ceasefire, Iraq was forbidden from developing WMD and long-range missiles. To verify Iraqi compliance, UNSCOM was created and its inspectors worked in the country. Iraq, however, was repeatedly found in violation of its disarmament obligations (Ritter, 1999). By December 1998, after growing tension and U.S. airstrikes, UN-SCOM was evicted of Iraq, still unable to verify Saddam's disarmament. At the time, Scott

Ritter, the Commission's chief inspector, noted that "without effective monitoring, Iraq can in a very short period of time measured in months, reconstitute chemical biological weapons, long-range ballistic missiles to deliver these weapons, and even certain aspects of their nuclear weaponization program" (Ritter, 1998). In sum, the inspections regime imposed on Iraq failed, with no U.N. certification of complete disarmament (Thompson, 2009).

It was only on September 26, 2002 – almost four years after inspections had ceased – that Saddam, under mounting pressure, agreed to let U.N. inspectors back in. Earlier that month, the British International Institute for Strategic Studies concluded that Iraq possessed the scientific apparatus to "assemble nuclear weapons within months if fissile material from foreign sources were obtained" (Chapman, 2002, 4). In fact, Hans Blix, the chief inspector for UNMOVIC (which had replaced UNSCOM), was unable to ascertain whether Iraq possessed any WMD. UNMOVIC's work was plagued by discrepancies between Iraqi reports of WMD quantities produced and destroyed. According to Blix, UNMOVIC's reports "do not contend that weapons of mass destruction remain in Iraq, but nor do they exclude that possibility. They point to lack of evidence and inconsistencies, which raise question marks, which must be straightened out, if weapons dossiers are to be closed and confidence is to arise" (Blix, 2003b). In his final pre-war presentation to the U.N. Security Council, Blix (2003a) was remarkably ambiguous:

> It is obvious that, while the numerous initiatives, which are now taken by the Iraqi side with a view to resolving some long-standing open disarmament issues, can be seen as 'active,' or even 'proactive,' these initiatives 3-4 months into the new resolution cannot be said to constitute 'immediate' cooperation. Nor do they necessarily cover all areas of relevance.

Indeed, there was a broad political consensus in Washington that Saddam possessed, or intended to acquire, WMD. Senator John Kerry from Massachusetts, soon to become the Democratic presidential nominee, stated: 'According to the CIA's report, all U.S. intelligence experts agree that Iraq is seeking nuclear weapons. There is little question that Saddam Hussein wants to develop nuclear weapons' (Kerry, 2002, S10172-10173).

As it turned out, Iraq possessed no WMD and had no consistent WMD programs. All the Iraq Survey Group could find after the invasion was evidence that Saddam intended to revive such programs if and when sanctions were lifted. The Group's Final Report states:

27

Saddam wanted to recreate Iraq's WMD capability – which was essentially destroyed in 1991 – after sanctions were removed. ... Saddam aspired to develop a nuclear capability – in an incremental fashion, irrespective of international pressure and the resulting economic risks – but he intended to focus on ballistic missile and tactical chemical warfare (CW) capabilities (CIA, 2004, 1).[22]

Much has been made of this intelligence failure (Bamford, 2004; Cirincione et al., 2004; Danchev, 2004; Prados, 2004; Isikoff and Corn, 2006; Phythian, 2006). But Robert Jervis convincingly dismisses the thesis that politicization was responsible for the intelligence failure on Iraq's WMD. According to him, "the belief that Iraq had active WMD programs was held by *all* intelligence services, even those of countries that opposed the war" (Jervis, 2010, 134, Jervis's emphasis).[23] Furthermore, for Jervis, "while alternatives [to the picture intelligence reports painted of Saddam's putative WMD programs] should have been considered, doing so probably would not have changed the estimates" (Jervis, 2010, 128). The problem was that in order to change U.S. policy, intelligence reports would have to prove that Iraq *did not have and would not develop* WMD. But it is well nigh impossible for intelligence to prove a negative. As Jervis concludes:

> At best, intelligence could have said that there was no firm evidence that Saddam had stockpiles of chemical and biological weapons or was actively pursuing nuclear bombs. It could not have said that he had ceased his efforts. ... Furthermore, intelligence could not have said that Saddam would not pursuit of WMD at some point in the future (Jervis, 2010, 126).

> The fundamental reason for the WMD intelligence failure in Iraq was that the inferences were very plausible, much more so than the alternatives. Saddam had vigorously pursued WMD in the past, had used chemical weapons to good effect, had powerful incentives to rebuild his programs, had funds, skilled technicians, and a good procurement network at his disposal, and had no other apparent reason to deceive and hinder the inspectors (Jervis, 2010, 146).

Indeed, given the absence of WMD capabilities, Saddam's often obstructionist behavior

---

[22]For a previous report on WMD findings in Iraq after the invasion, see Kay (2004).

[23]For a dissenting opinion, see Rovner (2010, chapter 7).

during the 18 months that preceded the war, "was figuratively and indeed literally suicidal" (Jervis, 2010, 129).[24]

From the point of view of our theory, however, the crucial point is not whether the intelligence supported the policy of forcible overthrow of the Iraqi regime or not. Rather, it is that the information received by the United States about Iraq's WMD capabilities and development programs was imperfect. Simply put, based on such imperfect information "[a] responsible judgment could not have been that the programs had ceased" (Jervis, 2010, 155). It is the imperfect nature of intelligence information that explains why war occurred despite successful counterproliferation.

To summarize, by 2002-2003, the United States possessed an overwhelming power advantage over Iraq. Such power differential made possible a sanctions regime that had long ago forced Saddam to cease his nuclear program. But when a heightened perception of the threat posed by Saddam's putative WMD capability led the United States to focus on the need to ensure Iraq's disarmament, U.S. decisionmakers were never able to obtain definitive information about Iraq's decision to forfeit nuclear acquisition. Consequently, the United States proceeded to invade Iraq despite its success in deterring Saddam from acquiring a nuclear capability. Possessing preponderant power and unable to obtain perfect information, the United States were undeterred in launching a preventive war against an unarming Iraq.

In this section, we provided two case studies to illustrate the logic of our argument, highlighting the differences between the Cold War and the post-Cold War periods. Beyond these cases, we think the argument is generalizable by considering a country's pre-nuclear relative power and its alliance status. We expect the effect of nuclearization on the balance of power (i) to decrease with the target's relative conventional military power; (ii) to be lower if the target is allied with a (nuclear) great-power sponsor than if it is neutral. The logic is straightforward: possession of, or alliance with, significant relative power reduces the effect of nuclearization. At the same time, it increases the costs of preventive war.

Given our model, then, neutral countries with small conventional forces are not very likely

---

[24]Saddam's rationale appears to have been based on his estimate that, first, Russia or France would intercede on Iraq's behalf, preventing war and, second, if that failed, Iraqi forces would be capable of increasing the military costs for the United States to the point at which American public opinion would force Washington to back down (Woods et al., 2006, 28-32)

to acquire nuclear weapons. The empirical pattern confirms this prediction. Among neutral states, only a few with relatively powerful conventional forces – *e.g.*, China – managed to acquire nuclear weapons. Both the United States and the Soviet Union considered a preventive attack against China, but decided against it given its high costs relative to the effect of China's nuclearization (Burr and Richelson, 2000-01; Gavin, 2004-2005). Less powerful neutral countries like Sweden and Switzerland, however, never acquired nuclear weapons despite their status as likely proliferators at the start of the Cold War. It is well documented that one of the reasons for their decision not to nuclearize was the fear of a preventive strike by the Soviet Union (Paul, 2000, chapter 5). At the same time, it is hardly conceivable that the Soviet Union would strike France or Great Britain to prevent their acquisition of nuclear weapons. Both these countries had relatively large conventional forces and the support of a great-power sponsor.

## 5    Conclusion

The last two decades have witnessed a resurgence in nuclear alarmism, leading to a consensus that "the world again is approaching a tipping point that could lead to a nuclear proliferation epidemic" (Potter and Mukhatzhanova, 2010, 1-2). But the predictions of successive waves of pessimism about the future of non-proliferation have failed to materialize. In fact, one of the greatest puzzles of international politics since 1945 is "the failure of nuclear proliferation to assume a pandemic-like dynamic" (Muller and Schmidt, 2010, 124). Even strong pessimists acknowledge that – with the possible exception of North Korea – "[t]here are no more nuclear weapons states now than there were at the end of the Cold War" (Allison, 2010).

We believe the more pessimistic predictions about nuclear proliferation are unwarranted. The absence of a systemic balance of power, contrary to what is commonly believed, places an important brake on proliferation dynamics. In the post Cold War, power preponderance increases the effect of nuclearization. At the same time, it decreases the costs of (U.S.-launched) preventive war. Taken together, these two factors make proliferation less likely – and preventive war more likely, even against non-proliferating states.

Our argument has important implications for the deterrence literature. The model described above highlights theoretically how deterrence – in this case, counterproliferation – may fail despite credible threats. The would-be proliferator's uncertainty about whether compliance will be rewarded generates the possibility of proliferation in the face of credible threats of preventive

military action. This failure of deterrence caused by non-credible assurances is particularly important in situations of lower war costs, as when a powerful state is attempting to deter a relatively weak state.

Our theory also highlights several points of interest for our understanding of nuclear proliferation. Aside from the unequalled destructive power of nuclear weapons, the proliferation process presents particularly thorny problems for reasons patent in our model. Nuclear programs can be hidden with relative ease. They can also, given their dual-use nature, be portrayed as having non-military purposes. These factors decrease the quality of the information about a state's decision to acquire nuclear weapons, making it harder for other countries to ascertain its nuclear intentions. This dynamic generates incentives for preventive war, particularly when the costs of such war are relatively low. Furthermore, states that want to proliferate have an incentive to make the signals it emits "insufficiently informative" in order to avoid a preventive attack. This explains why potential proliferators deploy strategic ambiguity about their nuclear programs – a clear signal of an investment in nuclear capability, when the effect of nuclearization on the balance of power is high, would invite a preventive attack.

Furthermore, our theory hints at problems with each of the three traditional counterproliferation approaches – containment, engagement, and preventive war. Containment, by making the *status quo* less favorable to would-be proliferators, actually encourage the development of nuclear capabilities as a means to guarantee a better future situation. Engagement, by making the *status quo* more favorable to would-be proliferators, is likely to be perceived as a short-term ploy, since the current balance of power would not – should the target abdicate from its nuclear aspirations – justify maintaining this situation in the future. And, since nuclear proliferation has a large effect on the balance of power, the probability that a preventive war will be launched against an innocent state is at its greatest. Each policy option presents its own problems.

The theory laid out here also accounts for the structural origins of preventive counterproliferation wars. In a nutshell, we explain why mistaken preventive wars are more likely under unipolarity. This qualifies generally accepted claims about the stability of a unipolar world (Wohlforth, 1999). The Iraq war, in this view, was not the result of any idiosyncratic policy preferences by the Bush administration (Jervis, 2003, 317). Much to the contrary, Iraq was made possible by the conditions laid out in our theory. In fact, preventive war has been con-

sistently considered by all post-Cold War U.S. administrations. In 1994, President Clinton was reportedly within minutes of deciding whether to use force against North Korea when news of a negotiating breakthrough came in. As Trachtenberg (2007, 19) writes, "the policy the Clinton administration pursued toward North Korea in 1994 was cut from the same cloth as the Bush strategy." In short, preventive war has consistently been at the center of the U.S.'s counterproliferation policy since the end of the Cold War.

For the past decade, the Iranian nuclear program has been one of the foremost concerns of U.S. administrations. As it progresses, it is likely that debate on how to prevent Iran from acquiring nuclear weapons will intensify. As we have seen, containment can have counterproductive effects. The lesser the ability of the Iranian state to achieve its policy goals without nuclear weapons, the greater the drive towards proliferation. Engagement, for its part, presents serious commitment problems. There is no good reason for Iranian leaders to believe the credibility of U.S. promises of greater future cooperation, were they to stop their nuclear program. If their current relative power is such as to only warrant their current status in the international system, there is no good reason the United States would keep any promises of better relations in the future, once the object of dispute – Iran's nuclear program – is no longer an issue. Finally, preventive war, besides presenting pointed moral dilemmas, may fail to settle the problem conclusively, merely delaying its denouement. And yet, a preventive strike against Iran by the United States or one of its client states (*e.g.*, Israel) is in no way out of the question.

One final implication of our theory is that, if indeed U.S. power wanes as predicted by many (see *e.g.* Pape (2009)), we should expect the pace of nuclear proliferation to pick up. At the same time, the probability of preventive wars – mistaken or not – will also decrease. If our theory is correct, the rise of a peer U.S. competitor would lead to a return to the Cold-War conditions that made for steady nuclear proliferation – but also for a stable peace.

# 6 Appendix

**Proof.** (Proof of Proposition 2). The equilibrium in period 1 is: $I^* = 1$ *if and only if*

$$\delta \left[ w_T \left( 1 \right) - w_T \left( 0 \right) \right] - \left( 1 - w_T \left( 0 \right) - w_D \left( 0 \right) \right) \leq w_T \left( 0 \right) \tag{6}$$

*If $I = 0$, $D$ offers $z_1^* = w_T(0)$ and if $I = 1$, $D$ offers $z_1^* = 0$ if (6) holds and declares war*
*otherwise; $T$ accepts any $z_1 \in [0, 1]$ if $I = 1$ and accepts $z_1 \geq w_T(0)$ if $I = 0$.*

We establish this result by backward induction. $T$ accepts $z_1$ if and only if

$$z_1 + \delta w_T(I) \geq (1 + \delta) w_T(0)$$

$$\Leftrightarrow z_1 \geq w_T(0) - \delta(w_T(I) - w_T(0)) \tag{7}$$

The right-hand side of (7) is $w_T(0)$ for $I = 0$ and it is negative for $I = 1$, by (2) and $k > 0$.

Moving up, $D$ chooses between war and offering $z_1 = w_T(0)$ if $I = 0$ and $z_1 = 0$ if $I = 1$. If $I = 0$, $D$ prefers to offer $z_1 = w_T(0)$ since war is costly. If $I = 1$, $D$ prefers to offer $z_1 = 0$ if and only if $1 + \delta(1 - w_T(1)) \geq w_D(0) + \delta(1 - w_T(0))$, which reduces to (6).

Moving up, if (6) holds, $T$ prefers $I = 1$ if $-k + \delta w_T(1) \geq (1 + \delta) w_T(0)$, which holds by (2). If (6) does not hold, $T$ prefers $I = 0$ since $-k + (1 + \delta) w_T(0) < (1 + \delta) w_T(0)$. ∎

**Proof.** (Proof of Proposition 3). The equilibrium in period 1 is: *$T$ invests with probability*

$$q^* = \begin{cases} 1 & \text{if (6) holds} \\ \frac{1 - w_T(0) - w_D(0)}{\delta[w_T(1) - w_T(0)]} & \text{otherwise} \end{cases}$$

*If (6) holds, $D$ offers $z_1^* = 0$. If (6) does not hold, $D$ offers $z_1^* = w_T(0)$ with probability*
*$r^* = \frac{k}{\delta[w_T(1) - w_T(0)]}$ and declares war with probability $1 - r^*$; $T$ accepts any $z_1 \in [0, 1]$ if $I = 1$*
*and accepts $z_1 \geq w_T(0)$ if $I = 0$.*

We solve this game by backward induction. $T$'s response to $z_1$ is as given in proposition 2.

Moving up, $D$'s optimal strategy is to choose between the best response to either pure strategy by $T$ ($I = 0$ and $I = 1$), as given in proposition 2. Write $r^*$ for the equilibrium probability that $D$ offers $z_1^* = w_T(0)$.

If (6) holds, then $T$ invests with probability $q^* = 1$ and $D$ offers $z_1^* = 0$. Indeed, $T$ prefers $I = 1$ if $-k + r^* w_T(0) + \delta w_T(1) > (1 + \delta) w_T(0)$, which holds by (2). Therefore, $T$ chooses $q^* = 1$ and, as a result, $D$ strictly prefers to offer $z_1^* = 0$.

If (6) does not hold, then $T$ must be using a mixed strategy, as argued in the text. This is a best response for $T$ only if $T$ is indifferent between investing and not investing, *i.e.*, if

$$-k + (1 - r^*)(1 + \delta) w_T(0) + r^*[w_T(0) + \delta w_T(1)] = (1 + \delta) w_T(0) \tag{8}$$

33

or if $r^* = \frac{k}{\delta[w_T(1) - w_T(0)]}$. $r^* \in (0,1)$ means that $D$ also plays a mixed strategy, which is optimal only if declaring war brings the same payoff as offering $z_1 = w_T(0)$, *i.e.*, if

$$w_D(0) + \delta(1 - w_T(0)) = 1 - w_T(0) + \delta(1 - [(1 - q^*)w_T(0) + q^* w_T(1)])$$

or $q^* = \frac{1 - w_T(0) - w_D(0)}{\delta[w_T(1) - w_T(0)]} \in (0,1)$. ∎

**Proof.** (Proof of corollary 1).

($i$) The probability of proliferation is one if (6) holds. Otherwise, it is $\frac{1 - w_T(0) - w_D(0)}{\delta[w_T(1) - w_T(0)]}$, which is less than one and decreasing in $\delta[w_T(1) - w_T(0)]$, everything else equal.

($ii$) The probability of preventive war is zero if (6) holds. Otherwise, it is $1 - \frac{k}{\delta[w_T(1) - w_T(0)]}$, which is positive and increasing in $\delta[w_T(1) - w_T(0)]$, everything else equal.

($iii$) The probability of preventive war is zero if (6) holds and positive otherwise. In the latter case, the probability of a mistaken preventive war is $prob(I = 0 \cap \text{war}) = prob(I = 0 \mid \text{war}) prob(\text{war})$. $prob(\text{war})$ is increasing in $\delta[w_T(1) - w_T(0)]$ by ($ii$). Also, the share of preventive wars that are mistaken ($prob(I = 0 \mid \text{war})$) is increasing in $\delta[w_T(1) - w_T(0)]$, since successful counterproliferation and preventive wars are independent events, and thus $prob(I = 0 \mid \text{war}) = prob(I = 0)$, which is increasing in $\delta[w_T(1) - w_T(0)]$ by ($i$). ∎

**Proof.** (Proof of proposition 4). The equilibrium in period 1 is: *If (6) holds, $T$ invests with probability $q^* = 1$; $D$ offers $z_1^* = 0$ for any $s_1$; $T$ accepts any $z_1 \in [0,1]$ if $I = 1$ and accepts $z_1 \geq w_T(0)$ if $I = 0$.*

*If (6) does not hold, then $T$ invests with probability*

$$q^* = \begin{cases} 0 & \text{if (3) holds} \\ \dfrac{1}{p_s + (1 - p_s)\frac{\delta[w_T(1) - w_T(0)]}{1 - w_T(0) - w_D(0)}} & \text{otherwise} \end{cases}$$

*If $D$ receives signal $s_1 = 1$, it declares war. If $D$ receives signal $s_1 = 0$, it offers $z_1 = w_T(0)$ if (3) holds and otherwise offers $z_1 = w_T(0)$ with probability $r^* = \frac{k}{(1 - p_s)\delta[w_T(1) - w_T(0)]}$ and declares war with probability $1 - r^*$; $T$ accepts any $z_1 \in [0,1]$ if $I = 1$ and accepts $z_1 \geq w_T(0)$ if $I = 0$.*

We solve the game by backward induction. $T$'s response to $z_1$ is as given in proposition 2.

Moving up, $D$'s optimal strategy is to choose between the best response to either pure strategy by $T$ ($I = 0$ and $I = 1$), as given in proposition 2. Write $r^*$ for the probability that $D$ offers $z_1 = w_T(0)$ after receiving signal $s_1 = 0$.

If (6) holds, $T$ invests with probability $q^* = 1$ and $D$ offers $z_1^* = 0$ for any signal. Indeed, $T$ prefers $I = 1$ if $-k + (1 - p_s) r^* w_T (0) + \delta w_T (1) > (1 + \delta) w_T (0)$, which holds given (2). Therefore, $T$ chooses $q^* = 1$ and, as a result, $D$ prefers to offer $z_1^* = 0$ for any signal.

Now assume that (6) does not hold. First, we show that $T$ invests with probability $q^* < 1$. Indeed, assume otherwise, then $D$'s best response is to declare war, but then $T$'s best response is to invest with probability $q^* = 0$.

Second, $T$ invests with probability 0 only if (3) holds. Indeed, if $q^* = 0$, $D$'s best response is to offer $w_T (0)$. $T$ has no incentive to deviate and invest if and only if

$$(1 + \delta) w_T (0) \geq -k + p_s (1 + \delta) w_T (0) + (1 - p_s) [w_T (0) + \delta w_T (1)]$$

which reduces to (3).

Third, if (3) does not hold, then $T$ uses a mixed strategy. This is optimal only if the payoff of not investing is equal to the payoff of investing, *i.e.*, if

$$(1 + \delta) w_T (0) = -k + (p_s + (1 - p_s) (1 - r^*)) (1 + \delta) w_T (0) + (1 - p_s) r^* [w_T (0) + \delta w_T (1)]$$

or $r^* = \frac{k}{(1-p_s)\delta[w_T(1)-w_T(0)]}$. $r^* \in (0, 1)$ means that $D$ plays a mixed strategy after signal $s_1 = 0$, which is optimal only if declaring war brings the same payoff as offering $z_1 = w_T (0)$, *i.e.*, if

$$w_D (0) + \delta (1 - w_T (0)) = 1 - w_T (0) + \delta \left[ 1 - \left[ \frac{(1 - q^*) w_T (0) + q^* (1 - p_s) w_T (1)}{(1 - q^*) + q^* (1 - p_s)} \right] \right]$$

or $q^* = \frac{1}{p_s + (1 - p_s) \frac{\delta[w_T(1) - w_T(0)]}{1 - w_T(0) - w_D(0)}}$. ∎

**Proof.** (Proof of corollary 2). Results are trivial if (3) holds. Assume that (3) does not hold.

($i$) The probability of proliferation is one if (6) holds. Otherwise, it is $q^* = \frac{1}{p_s + (1 - p_s) \frac{\delta[w_T(1) - w_T(0)]}{1 - w_T(0) - w_D(0)}}$, which is smaller than one and decreasing in $\delta [w_T (1) - w_T (0)]$, everything else equal.

($ii$) The probability of preventive war is zero if (6) holds. Otherwise, it is

$$1 - (1 - q^* p_s) r^* = 1 - \frac{k}{p_s [1 - w_T (0) - w_D (0)] + (1 - p_s) \delta [w_T (1) - w_T (0)]}$$

which is positive and increasing in $\delta [w_T (1) - w_T (0)]$, everything else equal.

($iii$) The probability of preventive war is zero if (6) holds and positive otherwise. In the latter case, the probability of a mistaken preventive war is $prob (I = 0 \cap \text{war}) = prob (I = 0 | \text{war}) prob (\text{war})$.

$prob$ (war) is increasing in $\delta\left[w_T\left(1\right) - w_T\left(0\right)\right]$ by $(ii)$. Also, the share of preventive wars that are mistaken $(prob\left(I = 0|\text{war}\right))$ is increasing in $\delta\left[w_T\left(1\right) - w_T\left(0\right)\right]$. Indeed,

$$prob(I = 0|\text{war}) = \frac{\left(1 - q^*\right)\left(1 - r^*\right)}{\left(1 - q^*\right)\left(1 - r^*\right) + q^*\left[1 - r^* + p_s r^*\right]} = \frac{1}{1 + \frac{q^*}{1 - q^*}\left(1 + p_s\frac{r^*}{1 - r^*}\right)}$$

$\frac{\partial q^*}{\partial\delta\left[w_T\left(1\right) - w_T\left(0\right)\right]} < 0$ and $\frac{\partial r^*}{\partial\delta\left[w_T\left(1\right) - w_T\left(0\right)\right]} < 0$ imply $\frac{\partial prob(I=0|\text{war})}{\partial\delta\left[w_T\left(1\right) - w_T\left(0\right)\right]} > 0$. ∎

# References

Allison, Graham. 2010. "Nuclear Disorder." *Foreign Affairs* 89(1).

Baliga, Sandeep and Tomas Sjostrom. 2008. "Strategic Ambiguity and Arms Proliferation." *Journal of Political Economy* 116(6):1023–1057.

Bamford, James. 2004. *A Pretext for War: 9/11, Iraq, and the Abuse of America's Intelligence Agencies.* New York: Doubleday.

Bas, Muhamet A. and Andrew J. Coe. 2010. "A Model of Arms Proliferation and Prevention." Paper presented at the Annual Meeting of the American Political Science Association. Washington, D.C.

Biddle, Stephen, James Embrey, Edward Filiberti, Stephen Kidder, Steven Metz, Ivan C. Oerlich and Richard Shelton. 2004. *Toppling Saddam: Iraq and American Military Transformation.* Carlisle Barracks, PA: US Army War College, Strategic Studies Institute.

Blix, Hans. 2003*a*. "Briefing of the Security Council: Oral introduction of the 12th Quarterly Report of UNMOVIC. March 7, 2003." *presentation to the UNSC on Feb. 14, 2003* .

Blix, Hans. 2003*b*. "An Update on Inspection." *presentation to the UNSC on Jan. 27, 2003* .

Borowski, Harry R. 1982. *A Hollow Threat: Strategic Air Power and Containment before Korea.* Westport, CT: Greenwood Press.

Buhite, Russell and Wm. Christpher Hamel. 1990. "War for Peace: The Question of an American Preventive War Against the Soviet Union, 1945-1955." *Diplomatic History* 14(3):367–384.

Burr, William and Jeffrey T. Richelson. 2000-01. "Whether to "Strangle the Baby in the Cradle": The United States and the Chinese Nuclear Program, 1960-64." *International Security* 25(3):54–99.

Bush, George W. 2002*b*. "State of the Union Address. Jan. 29, 2002." *http://georgewbush-whitehouse.archives.gov/news/releases/2002/01/20020129-11.html (Accessed Apr. 9, 2010)* .

Bush, George W. 7 Oct. 2002*a*. "President Bush Outlines Iraqi Threat.". Washington, D.C.: Office of the Press Secretary.

Chadefaux, Thomas. 2009. "Bargaining Over Power: When Do Rapid Shifts in Power Lead to War." University of Rochester Working Paper.

Chapman, John. 2002. "Iraq's Weapons of Mass Destruction: A Net Assessment." *IISS Strategic Dossier* .

CIA. 1994. CIA Intelligence Memorandum 225. In *CIA Cold War Records: the CIA under Harry Truman*, ed. Michael Warner. Langley, VA: Central Intelligence Agency p. 319.

CIA. 2004. "Comprehensive Report of the Special Advisor to the DCI on Iraq's Weapons of Mass Destruction.".

Cirincione, Joseph, Jessica T. Matthews, George Perkovich and Alexis Orton. 2004. *WMD in Iraq: Evidence and Implications*. Washington, D.C.: Carnegie Endowment for International Peace.

CNN. 2003. "Bush, Blair: Time running out for Saddam." *http://www.cnn.com/2003/US/01/31/sprj.irq.bush.blair.topics/. Jan. 31, 2003 (Accessed Apr. 9, 2010)* .

Danchev, Alex. 2004. "The Reckoning: Official Inquiries and the Iraq War." *Intelligence and National Security* 19(3):436–466.

Evangelista, Matthew A. 1982-83. "Stalin's Postwar Army Reappraised." *International Security* 7(3):110–138.

Fearon, James D. 1995. "Rationalist Explanations for War." *International Organization* 49(3):379–414.

Fearon, James D. 1996. "Bargaining over Objects that Influence Future Bargaining Power." University of Chicago Mimeo.

Fearon, James D. 2010. "Arming and Arms Races." Paper prepared for presentation at the Annual Meetings of the American Political Science Association, Washington, D.C.

Feaver, Peter D. and Emerson M. S. Niou. 1996. "Managing Nuclear Proliferation: Condemn, Strike, or Assist?" *International Studies Quarterly* 40(2):209–233.

Frankel, Benjamin. 1993. The Brooding Shadow: Systemic Incentives and Nuclear Weapons Proliferation. In *The Proliferation Puzzle: Why Nuclear Weapons Spread*, ed. Zachary S. Davis and Benjamin Frankel. London: Frank Cass pp. 37–78.

Freedman, Lawrence. 2004. "War in Iraq: Selling the Threat." *Survival* 46(2):7–49.

Freedman, Lawrence. 2005. "Deterrence: A Reply." *Journal of Strategic Studies* 28(5):789–801.

Friedman, Thomas L. and Patrick E. Tyler. 2006. From the First, U.S. Resolve to Fight. The New York Times. March 2, 1991. In *Uberpower: The Imperial Temptation of America*, ed. Josef Joffe. New York, N.Y.: W. W. Norton.

Fudenberg, Drew and Jean Tirole. 1991. *Game Theory.* Cambridge, MA: MIT Press.

Fuhrmann, Matthew. 2009*a*. "Spreading Temptation: Proliferation and Peaceful Nuclear Co-operation Agreements." *International Security* 34(1):7–41.

Fuhrmann, Matthew. 2009*b*. "Taking a Walk on the Supply Side: the Determinants of Civilian Nuclear Cooperation." *Journal of Conflict Resolution* 53(2):181–208.

Fuhrmann, Matthew and Sarah E. Kreps. 2010. "Targeting Nuclear Programs in War and Peace: A Quantitative Empirical Analysis, 1941-2000." *Journal of Conflict Resolution* .

Gaddis, John Lewis. 1987. *The Long Peace: Inquiries into the History of the Cold War.* New York: Oxford University Press.

Gaddis, John Lewis. 2004. *Surprise, Security, and the American Experience.* Cambridge, MA: Harvard University Press.

Gavin, Francis J. 2004-2005. "Blasts from the Past: Proliferation Lessons from the 1960s." *International Security* 29(3):100–135.

Gavin, Francis J. 2010. "Same As It Ever Was: Nuclear Alarmism, Proliferation, and the Cold War." *International Security* 34(3):7–37.

Gilpin, Robert. 1981. *War & Change in World Politics.* Cambridge, U.K.: Cambridge University Press.

Goodman, Michael S. 2007. *Spying on the Nuclear Bear: Anglo-American Intelligence and the Soviet Bomb.* Stanford, CA: Stanford University Press.

Gordin, Michael. 2009. *Red Cloud at Dawn: Truman, Stalin, and the End of the Atomic Monopoly.* New York: Farrar, Straus, and Giroux.

Gordon, Michael R. and Bernard E. Trainor. 1995. *The Generals' War: The Inside Story of the Conflict in the Gulf.* Boston: Little, Brown.

Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939-1956.* New Haven: Yale University Press.

Hymans, Jacques E. C. 2006. *The Psychology of Nuclear Proliferation: Identity, Emotions, and Foreign Policy.* Cambridge: Cambridge University Press.

Isikoff, Michael and David Corn. 2006. *Hubris: The Inside Story of Spin, Scandal, and the Selling of the Iraq War.* New York: Crown.

Jackson, Matthew O. and Massimo Morelli. 2009. "Strategic Militarization, Deterrence, and Wars." *Quarterly Journal of Political Science* 4(4):279–313.

Jervis, Robert. 2010. *Why Intelligence Fails: Lessons from the Iranian Revolution and the Iraq War.* Ithaca, NY: Cornell University Press.

Jervis, Robert L. 2003. "The Confrontation between Iraq and the US: Implications for the Theory and Practice of Deterrence." *European Journal of International Relations* 9(2):315–337.

Jo, Dong-Joon and Erik Gartzke. 2007. "Determinants of Nuclear Weapons Proliferation." *Journal of Conflict Resolution* 51(1):167–194.

Kay, David. 2004. "Iraq's Weapons of Mass Destruction." *Miller center Report* 20.

Kerry, John. 2002. "Congressional Record. 10/9/02.".

Kroenig, Matthew. 2009. "Importing the Bomb: Sensitive Nuclear Assistance and Proliferation." *Journal of Conflict Resolution* 53(2):161–180.

Lemke, Douglas. 2003. "Investigating the Preventive Motive for War." *International Interactions* 29(4):273–292.

Levy, Jack S. 2002. War and Peace. In *Handbook of International Relations*, ed. Walter Carlsnaes, Thomas Risse and Beth A. Simmons. London: Sage pp. 352–55.

Levy, Jack S. 2008. "Preventive War and Democratic Politics." *International Studies Quarterly* 52(1):1–24.

Lupovici, Amir. 2010. "The Emerging Fourth Wave of Deterrence Theory: Toward a New Research Agenda." *International Studies Quarterly* 54(3):705–732.

Mearsheimer, John J. 1990. "Why We Will Soon Miss The Cold War." *The Atlantic Monthly* 266(2):35–50.

Mearsheimer, John J. 2001. *The Tragedy of Great Power Politics.* New York: W. W. Norton & Company.

Meirowitz, Adam and Anne E. Sartori. 2008. "Strategic Uncertainty as a Cause of War." *Quarterly Journal of Political Science* 3(4):327–352.

Montgomery, Alexander H. 2005. "Ringing in Proliferation: How to Dismantle an Atomic Bomb Network." *International Security* 30(2):153–187.

Montgomery, Alexander H. and Scott D. Sagan. 2009. "The Perils of Predicting Proliferation." *Journal of Conflict Resolution* 53(2):302–328.

Montgomery, Evan B. 2006. "Breaking out of the Security Dilemma: Realism, Reassurance, and the Problem of Uncertainty." *International Security* 31(2):151–185.

Muller, Harald and Andreas Schmidt. 2010. The Little-Known Story of Deproliferation. Why States Give up Nuclear Weapons Activities. In *Forecasting Nuclear Proliferation in the 21st Century. The Role of Theory. Vol. 1*, ed. William C. Potter and Gaukhar Mukhatzhanova. Stanford, California: Stanford University Press pp. 124–158.

Nitze, Paul H., Steven L. Rearden and Ann M. Smith. 1989. *From Hiroshima to Glasnost: At the Center of Decision.* New York: Grove Press.

Norris, Robert S. and William M. Arkin. 1983*a*. "Nuclear Notebook: Estimated U.S. and Soviet/Russian Nuclear Stockpiles, 1945-94." *The Bulletin of the Atomic Scientist* 50(6):58–59.

Norris, Robert S. and William M. Arkin. 1983*b*. "Nuclear Notebook: U.S. Weapons Secrets Revealed." *The Bulletin of the Atomic Scientist* 49(2):48.

Organski, A.F.K. and Jacek Kugler. 1984. *The War Ledger.* Chicago, IL: University of Chicago Press.

Packer, George. 2005. *The Assassin's Gate: America in Iraq.* New York, N.Y.: Farrar, Straus and Giroux.

Pape, Robert A. 1996. *Bombing to Win: Air Power and Coercion in War.* Ithaca, N.Y.: Cornell University Press.

Pape, Robert A. 2009. "Empire Falls." *National Interest* 99:21–34.

Paul, T.V.. 2000. *Power versus Prudence: Why Nations Forgo Nuclear Weapons.* Montreal: McGill-Queens University Press.

Phythian, Mark. 2006. "The Perfect Intelligence Failure? U.S. Pre-War Intelligence on Iraqi Weapons of Mass Destruction." *Politics & Policy* 34(2):400–424.

Posen, Barry R. 1997. "U.S. Security Policy in a Nuclear-Armed World or: What if Iraq had had nuclear weapons?" *Security Studies* 6(3):1–31.

Posen, Barry R. 2003. "Command of the Commons: The Military Foundation of U.S. Hegemony." *International Security* 28(1):5–46.

Potter, William C. and Gaukhar Mukhatzhanova. 2010. Divining Nuclear Intentions: A Review Essay. In *Going Nuclear: Nuclear Proliferation and International Security in the 21st Century*, ed. Michael E. Brown, Owen R. Cote Jr., Sean M. Lynn-Jones and Steven E. Miller. Cambridge, MA: MIT Press pp. 78–108.

Powell, Robert. 1996*a*. "Stability and the Distribution of Power." *World Politics* 48(2):239–267.

Powell, Robert. 1996*b*. "Uncertainty, Shifting Power, and Appeasement." *American Political Science Review* 90(4):749–764.

Powell, Robert. 1999. *In the Shadow of Power: States and Strategies in International Politics.* Princeton, New Jersey: Princeton University Press.

Powell, Robert. 2006. "War as a Commitment Problem." *International Organization* 60(1):169–203.

Powell, Robert. 2010. "Persistent Fighting and Shifting Power." UC Berkeley Mimeo.

Prados, John. 2004. *Hoodwinked: The Documents that Reveal How Bush Sold Us a War.* New York, N.Y.: New Press.

Press, Daryl G. 2001. "The Myth of Air Power in the Persian Gulf War and the Future of Warfare." *International Security* 26(2):5–44.

Quester, George H. 2000. *Nuclear Monopoly.* New Brunswick: Transaction Publishers.

Reiter, Dan. 2006. Preventive Attacks against Nuclear, Biological, and Chemical Weapons Programs: The Track Record. In *Hitting First: Preventive Force in U.S. Security Strategy*, ed. William Keller and Gordon Mitchell. Pittsburgh: University of Pittsburgh Press pp. 27–44.

Rhodes, Richard. 1995. *Dark Sun: The Making of the Hydrogen Bomb.* New York: Simon & Schuster.

Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea.* New York: W.W. Norton.

Ritter, Scott. 1998. "Interview with Elizabeth Farnsword." *PBS NewsHour. August 31, 1998* .

Ritter, Scott. 1999. *Endgame: Solving the Iraq Problem - Once and for All.* New York: Simon and Schuster.

Rock, Stephen R. 2000. *Appeasement in International Politics.* Lexington: University Press of Kentucky.

Rosenberg, David Alan. 1982*a*. "American Atomic Strategy and the Hydrogen Bomb Decision." *The Journal of American History* 66(1):62–87.

Rosenberg, David Alan. 1982*b*. "U.S. Nuclear Stockpile, 1945 to 1950." *The Bulletin of the Atomic Scientist* 38(5):25–30.

Rosenberg, David Alan. 1983. "The Origins of Overkill: Nuclear Weapons and American Strategy." *International Security* 7(4):3–71.

Rovner, Joshua. 2010. *Fixing the Facts: National Security and the Politics of Intelligence.* Ithaca, NY: Cornell University Press, forthcoming.

Sagan, Scott D. 1996-97. "Why Do States Build Nuclear Weapons?: Three Models in Search of a Bomb." *International Security* 21(3):54–86.

Sagan, Scott D. 2010. "Nuclear Power, Nuclear Proliferation and the NPT." *Paper Presented at the 2010 American Political Science Association Meeting, Washington, D.C.* .

Schelling, Thomas. 1966. *Arms and Influence.* New Haven, CT: Yale University Press.

Schweller, Randall L. 1992. "Domestic Structure and Preventive War: Are Democracies More Pacific?" *World Politics* 44(2):235–269.

Singh, Sonali and Christopher R. Way. 2004. "The Correlates of Nuclear Proliferation: A Quantitative Test." *Journal of Conflict Resolution* 48(6):859–885.

Smith, Derek D. 2003. "Deterrence and Counterproliferation in an Age of Weapons of Mass Destruction." *Security Studies* 12(4):152–197.

Solingen, Etel. 2007. *Nuclear Logics: Contrasting Paths in East Asia and the Middle East.* Princteon: Princeton University Press.

Suskind, Ron. 2006. *The One Percent Doctrine: Deep Inside America's Pursuit of its Enemies since 9/11.* New York, N.Y.: Simon and Schuster.

Tenet, George. 2007. *At the Center of the Storm: My Years at the CIA.* New York: Harper-Collins. with Bill Harlow.

Thompson, Alexander. 2009. *Channels of Power: The U.N. Security Council and U.S. Statecraft in Iraq.* Ithaca, N.Y.: Cornell University Press.

Tomz, Michael and Jessica L. Weeks. 2010. "An Experimental Investigation of the Democratic Peace." Paper presented at the Annual Meeting of the American Political Science Association. Washington, D.C.

Trachtenberg, Marc. 2007. "Preventive War and U.S. Foreign Policy." *Security Studies* 16(1):1–31.

Treisman, Daniel. 2004. "Rational Appeasement." *International Organization* 58(2):345–373.

Truman, Harry S. 1950. "Radio and Television Report to the American People on the Situation in Korea. Sept. 1, 1950." *Public Papers of the Presidents. Harry S. Truman. 1945-1953* .

UN. 2003. "Press Release SC/7658." *http://www.un.org/News/Press/docs/2003/sc7658.doc.htm. Feb. 2, 2003 (Accessed Apr. 9, 2010)* .

Waltz, Kenneth N. 1979. *Theory of International Politics.* New York: Random House.

Williamson Jr., Samuel R. and Steven L. Rearden. 1993. *The Origins of U.S. Nuclear Strategy, 1945-1953.* New York: St. Martin's Press.

Wohlforth, William C. 1999. "The Stability of a Unipolar World." *International Security* 24(1):5–41.

Wolfowitz, Paul. 2003. "Interview with Sam Tannenhaus." *Vanity Fair. http://www.defense.gov/transcripts/transcript.aspx?transcriptid=2594. May 9, 2003 (Accessed Apr. 9, 2010)* .

Woods, Kevin M., Michael R. Pease, Mark E. Stout, Williamson Murray and James G. Lacey. 2006. *Iraqi Perspectives Report: A View of Operation Iraqi Freedom from Saddam's Senior Leadership.* Washington, D.C.: Joint Center for Operational Analysis, United States Joint Forces Command.

Zaloga, Steven J. 1993. *Target America: The Soviet Union and the Strategic Arms Race, 1945-1964.* New York: Presidio Press.
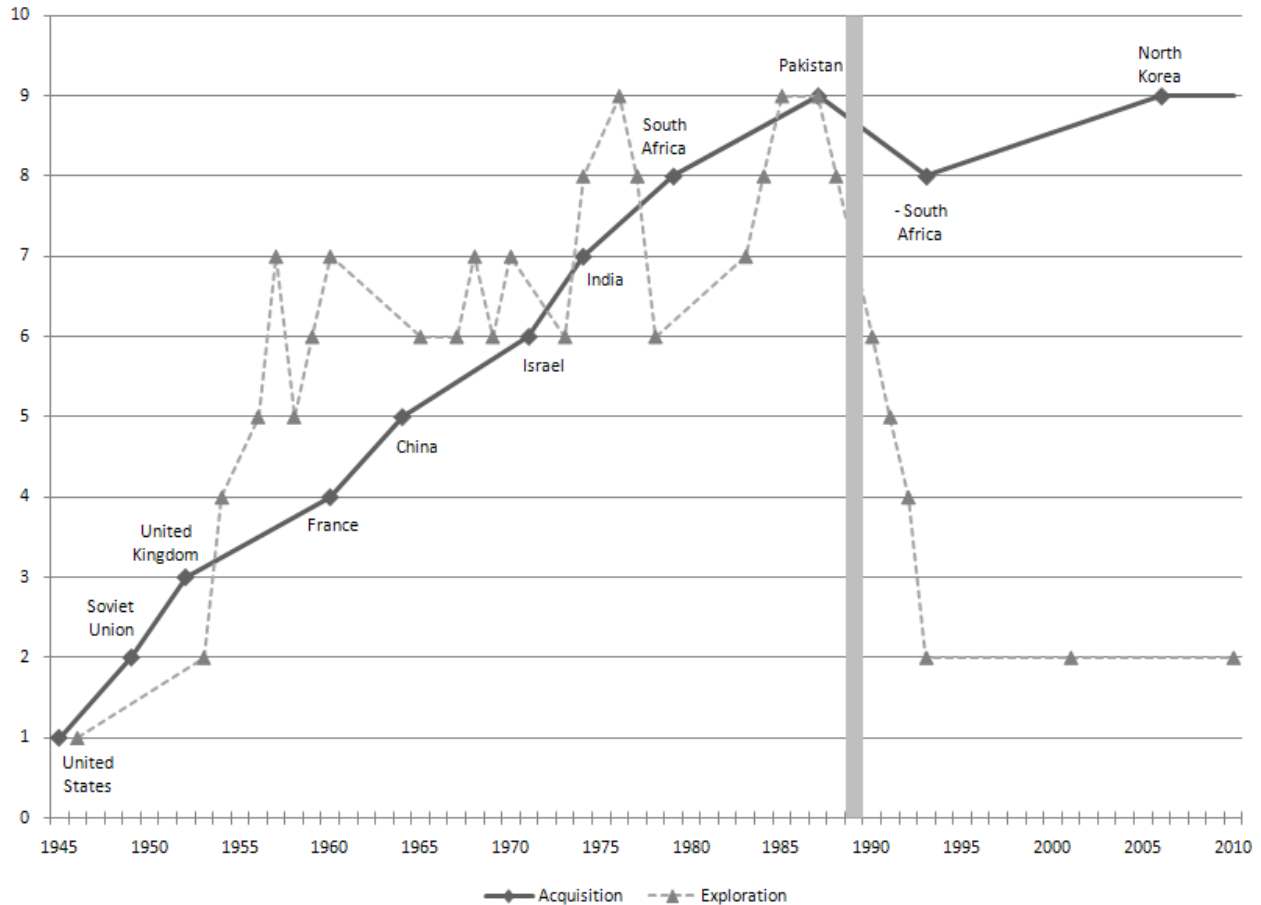
**Figure 1: Timeline of nuclear proliferation**

Data for acquisition from Fuhrmann (2009a). The dataset has two dates for India's nuclear acquisition -- 1974 and 1988. We display only the date of initial acquisition. There is some debate about the timing of Pakistan's acquisition. Singh and Way (2004) place it in 1990, but we think this is overly cautious, since Pakistan had at least one bomb assembled by 1987 (Fuhrmann, 2009a, 20-23). We follow Singh and Way (2004), though, on placing South African nuclear disarmament at 1993, the date President de Klerk announced his country had dismantled all nuclear weapons. Neither dataset goes beyond 2000. We add North Korean acquisition in 2006, following its October 9 test. Responding to doubts about the effectiveness of this test, North Korea tested a second nuclear weapon on May 25, 2009.

Data for exploration initially from Singh and Way (2004), as updated in Sagan (2010).