A Steadying Hand or a Strike in the Night: Proliferation, Preemption, and Intervention in the Nuclearization of Second-Tier States

Christopher R. Dittmeier

A thesis submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Master of Arts in the Department of Political Science (International Relations).

Chapel Hill
2010

Approved by:
Mark J.C. Crescenzi
Navin A. Bapat
Stephen Gent

© 2010
Christopher R. Dittmeier
ALL RIGHTS RESERVED

ABSTRACT

Christopher R. Dittmeier:
A Steadying Hand or a Strike in the Night: Proliferation, Preemption, and Intervention in the Nuclearization of Second-Tier States
(Under the direction of Mark J.C. Crescenzi)

Nuclear proliferation has in part led to a vastly-different security environment from that which existed during the Cold War. While Schelling's theory of deterrence through mutually-assured destruction established a precarious stability for forty years among the great powers, its assumptions render it of limited utility for evaluating the effects of nuclear proliferation below this level. Using an elaboration on Powell's bargaining models of conflict, this paper shows that the introduction of nuclear weapons in second-tier states radically alters the future distribution of power. These states therefore face a commitment problem vis-à-vis conventionally-stronger neighbors, inviting preemptive attacks on soon-to-be nuclear powers. This paper analyzes the dynamics behind this problem, as well as offers a theory of great-power intervention that explains the empirical lack of preemption.

Keywords: *bargaining model; commitment problem; conflict initiation; extended deterrence; nuclear weapons*

ACKNOWLEDGEMENTS

I would like to thank Mark Crescenzi, Navin Bapat, and Stephen Gent for their participation as members of my committee during the course of this research project. I would also like to thank Art Gibb, Timothy McKeown, and Andy Pennock for the constructive conversations we have had while developing the theory and model contained in this project. Lastly, this project would not have been possible without the constant support of my wife Cristina and my parents, Ed and Lisa, who have endured many drafts over the course of this year, and who have successfully deterred me from testing this project's implications experimentally.

TABLE OF CONTENTS

List of Tables vi

List of Figures vii

Introduction 1

Literature Review 2

- Deterrence Theory 3
- The Problem of Dynamic Commitment 4
- The Environment of Second-Tier States 5

Bargaining and Nuclear Proliferation 7

- Game Background 7
- Nuclear Weapons and Changes in the Distribution of Power 9
- The Commitment Problem and Preemption 14

A Case for Great-Power Intervention 18

Empirical Illustrations 24

- Pakistan: A Case of Preemption Deterred 26
- Egypt: A Case of Nuclearization Deterred 29

Conclusion 31

Appendix 33

- Proof of the Preemption Condition 33
- Inflection Point for p_0 in the Preemption Condition 35
- Proof by Backward Induction: Effects of Great-Power Intervention on Challenger and Defender Behavior 36

References 39

LIST OF TABLES

1 Comparative Statics of Equilibrium Bargain 11

2 Comparative Statics of Critical Change in p 16

LIST OF FIGURES

1 Offensive Dominance as a Function of Nuclear Sophistication 11

2 Equilibrium Bargain as a Function of Nuclear Arsenal Sophistication 16

3 Powell-Type Conflict Model 20

4 Conflict Model with Great-Power Intervention 20

5 Effect of Great-Power Intervention on Bargaining Failure ($x_g > q$) 22

6 Effect of Great-Power Intervention on Bargaining Failure ($x_g < q$) 25

> "The weak and the defenseless in this world invite aggression from others. The best way we can serve peace is by removing the temptation from the path of those who think we are weak and, for that reason, they can bully or attack us. That temptation can only be removed if we make ourselves so strong that nobody dare entertain any aggressive designs against us."
> —Muhammad Ali Jinnah (February 1948)

The invention of nuclear weapons fundamentally changed the discourse surrounding the nature of warfare; however, since 1945, no nuclear warhead has ever been used in an act of war. Today, it is difficult to consider whether any of the first generation of nuclear states (the United States, Russia, France, the United Kingdom, and China) would ever engage in a nuclear strike of any scale. This is a consequence of the evolution of great-power warfare since 1945, a function of these states' move from the strategy of total war to that of limited or indirect/proxy warfare. This change resulted from the accumulation of large, survivable nuclear arsenals and the development of the doctrine of mutually-assured destruction (cf. Schelling 1966). In this context, the costs of direct warfare grew tremendously.

The behavior of second-tier states (or middle powers) differs in several ways from that of great powers. Firstly, the absolute magnitude of these states' conventional capabilities places limitations on their ambitions; however, nuclear weapons can drastically increase these capabilities by providing additional counterforce capabilities. Secondly, nuclear weapons serve a different military function in newly-nuclearizing states (such as Iran and North Korea) than they do for states that have already achieved viable secure second-strike capabilities—the value of these weapons is in their direct military application, rather than in their implicit coercive abilities. Thirdly, middle powers act in a system shaped by the preferences and behaviors of more powerful states. These variations from great-power behavior have profound implications for understanding the relationship between nuclear weapons and the onset of conflict. While deterrence has been central to the defense policies of all nuclear states, and

is cited as a principal motivating factor for second-tier states to acquire their own nuclear arsenals, the factors stated above cast doubt on whether the order concluded by nuclear deterrence theory will hold given limited nuclear proliferation to second-tier states. This paper evaluates the effect of second-tier nuclearization on the onset of conflict in the context of a power-transition framework. This paper argues that a second-tier state's drive to acquire nuclear weapons leads to a commitment problem and may incentivize a preemptive strike against this capacity; however, such militarized conflicts are rarely seen as a result of great powers' abilities to dissuade war among smaller actors.

To derive this argument, this paper first reviews previous attempts to incorporate nuclear weapons into theories of conflict onset through deterrence theory, as well as their limitations based on the US-Soviet dyadic inspiration. Second, this paper offers an elaboration on Powell's (1999, 2006) bargaining model of conflict. By examining the effect of nuclear weapons on the conditions of conflict bargaining, it will become apparent that second-tier nuclearization presents the necessary conditions for war by way of the commitment problem, which in equilibrium may lead to preemptive war. Third, this paper modifies the bargaining framework to include a third actor—a great power—and shows how the threat of intervention can render moot the commitment problem by altering the preference structures of the initial actors in the bargaining process. This paper concludes with an analysis of the consequences of second-tier nuclearization, with the assistance of empirical illustrations, and the policy questions that arise from this scenario, as well as with opportunities for future research in this field.

Literature Review

Nuclear weapons quickly transformed from military tools to instruments of coercive diplomacy (Rosenberg 1983; Gaddis 2005), a consequence of the United States' short-lived nuclear supremacy. Both policy and the scholarly literature therefore continue to treat the political

effect of nuclear weapons within the context of deterrence. This section will conduct an overview of the role of nuclear weapons in deterrence theory as well as in a broader expected utility framework, which underlies the logic of deterrence. Incongruences between the literature's assumptions or conclusions and the environment of second-tier states will be pointed out as the theory of second-tier nuclear behavior is elaborated.

Deterrence Theory

Classical deterrence theory derives from neorealism's power-preponderance theory (Bremer 1992; Bennett and Stam 2004). In this situation, as the costs of war against a particular state increase, potential conflict-initiators are less willing to engage that state (or its clients) militarily (Huth 1988; Huth, Gelpi and Bennett 1993). Snyder and Diesing (1977) argue that this is because states become more prudent (ie. risk-averse) as the absolute costs of war increase, *ceteris paribus*; therefore, they are less likely to exploit momentary increases in power to revise the distribution of benefits. This environment makes stability more dependent on defensive military technologies being advantaged over offensive ones (Zagare and Kilgour 2000). In such a scenario, states are dissuaded from deliberate war, and the greater threat is accidental war resulting from informational asymmetries (Ellsberg 1959). Waltz (2003) argues that nuclear proliferation among states would drive the costs of war sufficiently high so as to result in stable peace (cf. also Bueno de Mesquita and Riker 1982; Zagare and Kilgour 2000).[1]

Mutually-assured destruction is the logical consequence *ad absurdam* of this theory. Both the United States and the Soviet Union had sufficiently-large nuclear arsenals to maintain secure second-strike (S3) capability—the ability to inflict enormous costs on the enemy's state with only those weapons that survived a first strike (Huth, Gelpi and Bennett 1993; Freedman 2003). S3 necessitates weapon survivability, which was achieved through the expansion and diversification of conventional and nuclear arsenals (Schelling 1966; Gaddis 2005). One of

[1] This claim remains controversial (cf. Sagan 2003).

the fundamental consequences of S3 is its defensive orientation: the opportunity costs of using a nuclear weapon for offensive purposes is much higher compared to its utility as a survivable, retaliatory weapon (Wagner 1991). The execution of a nuclear strike therefore becomes an irrational action among states with S3 (Bennett and Stam 2004; Lieber and Press 2006*b*). While war is generally considered a continuing bargaining process in the line of von Clausewitz, a "shooting war" among states with S3 would arrive at an absolute conclusion (total victory) much earlier than a negotiated one could take shape (Schelling 1966; Wagner 2000). Thus, conflict bargaining must be reduced to a competition in risk-taking *ex ante bellum* (Schelling 1966). To date, no state has a critical level of risk-acceptance sufficient to trigger the nuclear option in a bargaining scenario.

The Problem of Dynamic Commitment

The expected-utility framework has difficulty in accommodating dramatic shifts in the distribution of power, such as those associated with nuclearization. The traditional bargaining model of conflict only moves to war when there is no win-set—when informational asymmetries prevent the construction of a bargain preferable to the *ex post* inefficient outcome of war (Powell 1999; Wagner 2000; Kydd 2003; Slantchev 2003). However, other studies have shown that, in instances of drastic shifts in the distribution of power, bargaining breakdown is not a function of the zone of agreement, but of the states' inability to credibly commit not to renege on the bargain (Fearon 1995, 1998; Powell 2004, 2006).

The commitment problem revises earlier rationalist arguments for war by acknowledging that, under certain conditions, the inefficient outcome of war may be the superior option for one state, compared to the "efficient" negotiating away of most of its share of the distribution of benefits during a power transition. While gradual shifts in the distribution of power may result in future payoffs being sufficiently discounted (and therefore not enough to justify inefficient action), Powell notes that "[c]omplete-information bargaining can break down. . . if the shift in the distribution of power is *sufficiently large and rapid*" (2006, 181, emphasis

added). In these scenarios, the shift in power is not discounted, and the stronger state must choose between a preemptive attack and the revision of the *status quo* away from its favor. If the (slightly-discounted) expected revision exceeds the costs of war to that state, staving off the transition through preemption becomes the rational option.

The Environment of Second-Tier States

Second-tier states operate in an environment that is fundamentally different from that of the great powers that occupied earlier scholars of nuclear weapons and warfare. The fundamental differences include their lesser levels of absolute power and the presence of substantially stronger states in the system (ie. great-power states). Middle powers, by definition, have less of a capacity to inflict costs on their adversaries than do great powers. However, they also have less ability to absorb the costs inflicted on them by their adversaries. In this environment of lower absolute levels of power, the offensive or defensive advantage provided by military technology is more important for predicting conflict onset (Powell 1999). The introduction of new technology, such as nuclear weapons, can drastically alter the relative distribution of power within a dyad of second-tier states, contributing to the commitment problem described above.

Second-tier states that enter the nuclear club will necessarily pass through a period of time before they achieve S3 capability necessary for nuclear deterrence. If individual nuclear weapons (or a whole nuclear arsenal) are susceptible to destruction, their utility as a deterrent (second-strike) falls relative to their value as an offensive weapon (first-strike). Nuclear states are incentivized most to initiate conflict at the point between the creation of their first nuclear weapon and the achievement of S3 because these weapons' principal value is in their military, not coercive, uses. The very desire to preserve nuclear weapons for a future deterrent encourages their use while first-strike is advantaged (Wagner 1991; Fearon 1995).

This has important consequences to the extent that it can turn the tide of battle. The

counterforce use of nuclear weapons can help an otherwise-weaker state overcome the aggression of a larger neighbor. This effect is two-fold: nuclear-weapons provide a boost in military capabilities, allowing these states to overcome their conventional weaknesses, and—consequently—their opponents self-censor their aggressive behaviors in the face of this altered distribution of capabilities. Beardsley and Asal (2009, 251–252) show in detail how this dynamic plays out in the context of the Israeli nuclear arsenal. However, this change incentivizes newly-nuclear states to act more aggressively, and for their conventionally-stronger neighbors to preempt nuclearization. This is the fundamental commitment problem that is faced by Fearon (1998) and Powell (2006), and which will be discussed below.

What differentiates the commitment problem of second-tier nuclearization from Powell's study is the existence of higher-capacity states, and therefore of the ability of great powers to solve the commitment problem in the middle-power dyadic relationship. Leeds and Savun (2007) show that alliance utility is intimately connected to the allies' ability to influence military outcomes. Second-tier states cannot meaningfully change the distribution of power in a major-major dyad; however, that same major-minor alliance can provide enormous benefit to the junior partner engaged in a minor-minor dispute (Altfeld and Bueno de Mesquita 1979). When an attack is certain, the third party can decide to intervene on behalf of its ally; if its committed resources are sufficiently large and credible, this commitment can dissuade the initial attack (Werner 2000; cf. also Huth and Russett 1984, 1988; Fearon 1994). However, the great power's threat to intervene is only likely when it serves that state's particular interests to do so (Fearon 1994; Gent 2007). Where intervention is not seen as credible, preventive war becomes a rational option in the face of drastic shifts in the distribution of power (Roth 2009). In a similar fashion, the great power may also choose to intervene on behalf of the preempting state if the shock to the distribution of power threatens its own interests. If credible, such a threatened intervention may be sufficient to deter the initial provocation, preventing this shift from occurring in the first place.[2]

[2]This would be possible only if the change results from an active change in the distribution of power, rather than an exogenous shock. Nuclearization, for example, is a change in military technology that results

Bargaining and Nuclear Proliferation

Game Background

This paper begins by building off of the model of conflict developed by Powell (1999, 2006). The game is played between two unitary, rational state actors, who must divide some good[3] along a continuous bound $[0, 1]$. *Ex ante*, the good is divided $(q, 1-q)$ between the challenging state (C) and the defending state (D).[4] The value associated with a negotiated solution redistributes the good such that C receives x and D receives $1-x$. To achieve this solution, C demands some division $(x_t, 1-x_t)$ in each round t, which D can either accept or reject with a counteroffer. In the absence of an agreement, the payoff set $(q, 1-q)$ remains in effect. However, there is also an exit option—war—which is available to both C and D and settles the bargaining process directly. If one player defects from the bargaining framework, the equilibrium division of the good is moved to $x = p > q$, which reflects the underlying distribution of capabilities between the states. However, since war is an *ex post* inefficient activity, each state suffers some cost c to represent the portion of the good that is destroyed during the conflict[5] (Fearon 1995). Therefore, the exit option of war produces a division of the good $(p - c_c, 1 - p - c_d)$.

The underlying distribution of capabilities (p) shows how the good would be divided based on the outcome of a war. This measure is equally useful if the conflict is considered theoretically as an all-or-nothing lottery (where p is understood as the probability of victory)

from a specific action on behalf of the challenger. That action can therefore be deterred. An environmental change, such as the discovery of oil deposits on challenger's territory, is non-deterrable because the change is not dependent on a reversible action, but by an exogenously-defined condition.

[3]While the good in question can be any divisible good, it is traditionally treated as territory. However, it may be more useful to treat the good in a more fungible (though admittedly abstract) conception: the distribution of benefits in the dyadic relationship. This may include territory as well as other attributes and consequences of power.

[4]For the purposes of the game, the *ex ante* distribution leaves C's share (q) at a level less than its actual share of the distribution of capabilities.

[5]Powell represents these costs as d and s for the costs to C (dissatisfied state) and D (satisfied state), respectively, but this paper will use subscripted values of c in order to represent both costs as arising from the same mechanism.

or as a continued bargaining process (where p shows the metagame agreement). The measurement of the balance of capabilities is determined by comparing the two players' military capabilities ratio, weighted by offensive dominance of available military technology. Thus, in a situation where C chooses the exit option of war,

$$p = \frac{\beta m_c}{\beta m_c + m_d} \tag{1}$$

where m_c and m_d are the military capabilities of C and D, respectively, and β is the offensive dominance factor (a positive value). If the current military technology favors offense, $\beta > 1$, expanding the weight of C's capabilities within the dyad. Conversely, if current military technology favors defense, $\beta < 1$, lessening the weight of C's power within the dyad (Powell 1999).

The utility to C of initiating a conflict at time $t = w$ is therefore described by the following equation:

$$\begin{aligned} U_C(\text{War}) &= \sum_{t=0}^{w-1} \delta^t q^{\rho_c} + p\left[\sum_{t=w}^{\infty} \delta^t (1 - c_c)\right] + (1-p)\left[\sum_{t=w}^{\infty} \delta^t (-c_c)\right] \\ &= \underbrace{\sum_{t=0}^{w-1} \delta^t q^{\rho_c}}_{\text{Payoff to Status Quo}} + \underbrace{\sum_{t=w}^{\infty} \delta^t (p - c_c)}_{\text{Payoff to War Lottery}} \end{aligned} \tag{2}$$

where $\delta \in (0, 1)$ represents a discount factor on future gains and $\rho \in (0, 1]$ is the state's level of risk-aversion, which weights the utility of preserving the *status quo*.[6] In a static environment, the utility of war is greater than the utility of the *status quo* if and only if $p - c_c > q^{\rho_c}$. To avoid this, when C threatens war in a situation of complete information, D concedes

$$x^* = (p - c_c)^{1/\rho_c} = \left(\frac{\beta m_c}{\beta m_c + m_d} - c_c\right)^{1/\rho_c} \tag{3}$$

[6]States are considered more risk-averse as ρ approaches 0. A level of $\rho > 1$ would indicate risk-acceptant behavior, which will be excluded from possibility in this paper: as in Powell's work, risk-neutrality or risk-aversion will be assumed.

the minimum value within the domain $(q, 1]$ for which C prefers to accept a negotiated settlement over going to war.[7] Using comparative statics, it can be seen that military technology, capabilities, and the challenger's cost of war and level of risk-aversion all affect the minimum bargain x^* that would avoid C's revising the *status quo* by force.

Nuclear Weapons and Changes in the Distribution of Power

The introduction of nuclear weapons affects three components of this equilibrium level: the offensive dominance factor β, the challenger's military capabilities m_c, and the challenger's cost of war c_c. While the effect of introducing nuclear weapons on m_c is readily apparent, this section examines the effects of such a shock on β and c_c, and the subsequent effect on the equilibrium state of the bargaining process.

Offensive Dominance

Nuclear weapons, like all military technologies, change the level of offensive-defensive balance when they are introduced into a dyadic relationship. Where there are low numbers of nuclear weapons or where the delivery systems are unreliable or immobile, these weapons are less survivable, and a state is incentivized to use them for first strike (offense) against the opponent's military capabilities. Such direct action would solidify the change to the distribution of power. However, as the size of an arsenal increases, or as delivery systems become more reliable, mobile, and protected, increased survivability adds to the relative utility of these weapons as a deterrent (defense), and increases the opportunity cost of first-strike. Figure 1 shows the effect of nuclear survivability on the offensive dominance parameter β. Holding constant the effects of conventional military technology, low levels of nuclear weapon survivability show high offensive dominance consistent with the first-strike incentive (cf. Lieber and Press 2006*a*). This decreases as the level of survivability increases,

[7] In order to allow for discrete equilibrium states, it is assumed that C does not choose war if it is indifferent between the expected utilities of war and of a proposed bargain (or the status quo).

reaching a level of 1—offensive-defensive neutrality—when a nuclear capacity reaches the minimum threshold of S3.[8]

As the state's nuclear arsenal becomes more survivable beyond what is necessary for S3, β asymptotically approaches 0, indicating ever-greater defensive dominance. Thus, a state with a highly-survivable nuclear capacity constrains itself against nuclear aggression: the weapons are more useful as deterrents than as offensive weapons. While conventional interpretations of MAD focus on the increased costs of warfare associated with warfare in the nuclear era, it can also be argued that mutual deterrence occurred as both the United States and the Soviet Union developed large, self-constraining nuclear arsenals.

Figure 1 represents the marginal opportunity cost to nuclear weapons' capacity for first strike with respect to the survivability of the state's nuclear arsenal. However, these weapons do not exist in a vacuum: their effect interacts with that of the previously-available military technology (Wagner 1991). A state whose nuclear arsenal causes it to be indifferent between first- and second-strike still must respond to the offensive or defensive pressures of its conventional military technology. Nonetheless, an offensive- or defensive-leaning nuclear posture will likewise affect a state's overall military strategy, even if its conventional posture is not biased in either direction.

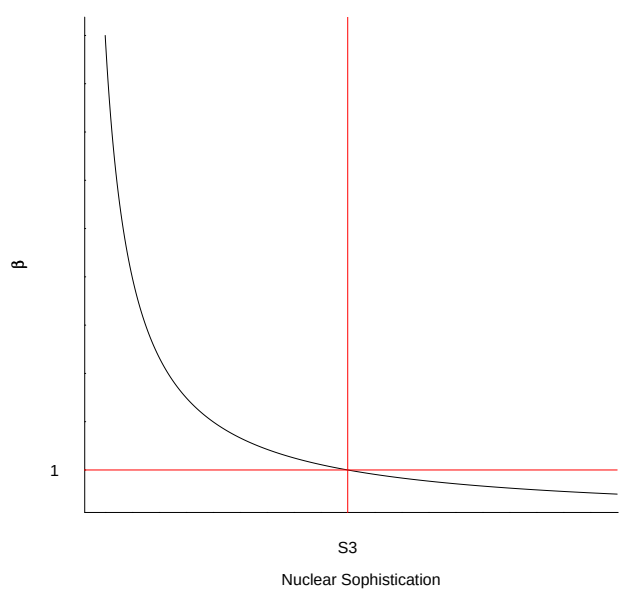
This effect is common to both the newly-nuclear challenger and the defender (regardless of its own possession or nonpossession of nuclear weapons). Non-survivable nuclear arsenals present a strong incentive for the defender to attack preemptively; its own first strike—if successful—can eliminate the challenger's offensive nuclear capacity, thus returning the distribution of power to its *ex ante* level. Conversely, highly-survivable nuclear arsenals incentivize highly defensive-oriented strategies; this is the central tenet of MAD. While the dynamics of preemption will be discussed in greater detail in the subsection below, it is

[8]The minimum threshold of S3 is highly context-driven, a function of conditions such as the size of the nuclear arsenal, the reliability, accuracy, and diversification of delivery systems, and the presence (or absence) of an adversary's first-strike and counter-first-strike capacities. While this article will not attempt to derive a general operationalization of the minimum S3 threshold, Lieber and Press (2006*a*) examine this question in detail in the context of American nuclear primacy.

Table 1: Comparative Statics of Equilibrium Bargain

Variable	Symbol	Δx^*
Offensive Dominance	β	$+$
Challenger's Military Capabilities	m_c	$+$
Defender's Military Capabilities	m_d	$-$
Challenger's Cost of War	c_c	$-$
Challenger's Risk Tolerance	ρ_c	$+$

Figure 1: Offensive Dominance as a Function of Nuclear Sophistication



important to note that nuclearization restructures the offensive-defensive balance of both the nuclear challenger and the defender, who must consider the dynamics of this transition in their own expected utility calculations.

The Cost of War

The fundamental military principle behind nuclear weapons is to increase the costs of warfare (Huth, Gelpi and Bennett 1993). It is for this reason that Brodie (1946) refers to nuclear weapons as "the absolute weapon." Schwartz et al. (1990) argue that nuclear weapons exist outside of the "weapons paradigm" around which the military value of weapons is commonly discussed. While low-level nuclear weapons (similar to the Hiroshima bomb) carry enormous firepower, a one-megaton bomb "equals half of the total destructive power of all bombs used by the Western Allies in Europe during all of World War II" (Schwartz et al. 1990, 3).

The exponential growth in the costs of warfare after nuclearization indicate that their inclusion among available military technology quickly becomes untenable. Any number of nuclear weapons above a very few, or any degree of advanced nuclear weapons, and the destruction wrought by their use outweighs any practical military benefit. However, counterforce or tactical nuclear bombing lends itself to the analysis of newly-nuclear states. Under these conditions, both the quantity and quality of the weapons are likely to be relatively primitive. While this is nonetheless certain to change the underlying dynamic of conflict-bargaining scenarios in the immediate term, a sustained effort to build a nuclear arsenal would eventually move a newly-nuclear state closer to a rational-deterrence framework.

Equilibrium After Systemic Shock

Table 1 shows that increased offensive dominance and military capabilities increase C's ability to extract a greater share of the distribution of benefits, while increased costs and risk-aversion restrict that same ability. However, this does not render nuclearization inde-

terminate with respect to the likelihood of war. At early stages of a state's nuclearization, the systemic shock incentivizes a revision of the *status quo* in favor of the newly-nuclear state. This occurs when the equilibrium bargain $x^{*\prime}$ (that which follows the systemic shock) exceeds the *status quo* bargain q.[9] All of the principal factors under consideration change as a function of the size and sophistication of the state's nuclear arsenal; therefore, Figure 2 can show how the level of the equilibrium bargain $x^{*\prime}$ moves in a similar fashion.

Figure 2 shows the combined effects of nuclearization on offensive dominance, costs of war, and risk aversion. β is modeled as inversely-proportional to the sophistication of C's nuclear arsenal. As in Figure 1, the effect of nuclearization on the offensive dominance of C's military technology is null when C achieves S3, but deviates exponentially away from $\beta = 1$ toward ∞ for less-sophisticated arsenals, and toward 0 for more-sophisticated ones.

Figure 2 shows that the dichotomous move from non-nuclear to newly-nuclear status presents a radical departure from the equilibrium bargain *ex ante*. Newly-nuclear states enjoy greatly outsized leverage resulting from the strong offensive bias of their highly-vulnerable nuclear arsenal. In these early, transitional phases, C is incentivized to take advantage of this leverage to revise the distribution of benefits in its favor. However, this incentive quickly evaporates. As C's nuclear arsenal becomes more sophisticated, its higher costs of war and more-intense risk-aversion begin to outweigh the decreasing offensive incentive. Much earlier than the achievement of S3, C's benefit to revising the distribution of benefits falls below its utility for the *status quo* distribution.

The most important conclusion that can be drawn from this systemic shock is the change in the likelihood that C revise the distribution of benefits in the immediate aftermath of achieving a nuclear capacity. While deterrence is a logical strategy, given highly-sophisticated nuclear capacity, the dynamics of early post-nuclearization present a very different story.

[9] For ease of use, the "prime" values (ie. x', p') will be used to indicate values after the systemic shock, while unmarked values (or values subscripted as 0) are used to denote the initial values of those terms at $t = 0$.

The Commitment Problem and Preemption

The equilibrium condition described in the subsection above is a marked difference from the state that exists prior to the systemic shock. Traditional rationalists would treat this scenario, in isolation, as consistent with a bargaining solution; however, this conclusion does not hold if the bargaining process is continuous over multiple periods. While small or gradual changes in the distribution of power do not often result in war because of the discounting of future gains, Powell notes that changes that are "sufficiently large and rapid" may upset the bargaining process (2006, 181). The principal motivation for this commitment problem is the value attached to future streams of benefits relative to the present level of benefits. Gradual changes to the distribution of benefits through negotiated concessions are often discounted sufficiently to justify not upsetting the distribution of benefits in the short-term. In contrast, sudden upsets to the balance are valued more closely to an actor's present state, and have a greater effect on short-term decision-making, including on the possibility of bargaining failure (Fearon 1998).

The above model shows that C experiences a substantial change in its share of the distribution of power in the immediate aftermath of acquiring a nuclear weapons capacity. The traditional bargaining equilibrium in the subsection above shows that the efficient outcome at time $t = w$ is for C to demand $x^{*\prime} = (p' - c'_c)^{1/\rho_c}$ and for D to concede that (rather large) share of the distribution of benefits. However, if this change in the distribution of power can be foreseen, D can value this change within its infinite stream of payoffs.

$$U_D(\text{Revision}) = \underbrace{\sum_{t=0}^{w-1} \delta^t (1-q)^{\rho_d}}_{\text{Payoff to Status Quo}} + \underbrace{\sum_{t=w}^{\infty} \delta^t (1-x^{*\prime})}_{\text{Payoff to Revision by C}} \tag{4}$$

Once C has acquired nuclear capacity, it can no longer credibly commit not to demand this revision of the *status quo* from q to $x^{*\prime}$. If D takes no action prior to $t = w$, it will be forced to accept this revision. However, in an environment of complete information, D is

aware of C's nuclear program and can identify both the time ($t = w$) and the effect ($p_w = p'$) of this change to the distribution of power. D has the ability to prevent a negative revision of the *status quo* by preempting C's nuclearization. While this action is inefficient for the system as a whole, D's action prior to $t = w$ eliminates the change in the distribution of power and settles the division on p_0 (which it prefers to p'). Assuming that D prefers the status quo q to p_0, its preemption will occur at the last clear chance prior to C's nuclearization—that is, at $t = w - 1$—and receive the following stream of payoffs:

$$U_D(\text{Preemption}) = \sum_{t=0}^{w-2} \delta^t (1-q)^{\rho_d} + \underbrace{\sum_{t=w-1}^{\infty} \delta^t (1 - p_0 - c_d)}_{\text{Payoff to Preemption by D}} \tag{5}$$

Preemption occurs when D's relative utility (as measured by the sum of the infinite stream of period utilities) for preempting C's nuclearization outweighs the infinite stream of lost utility resulting from $x^{*\prime} - q$. There is a critical change in p that satisfies this condition.[10] D prefers to preempt C in period $t = w - 1$ if the change in p exceeds this condition:

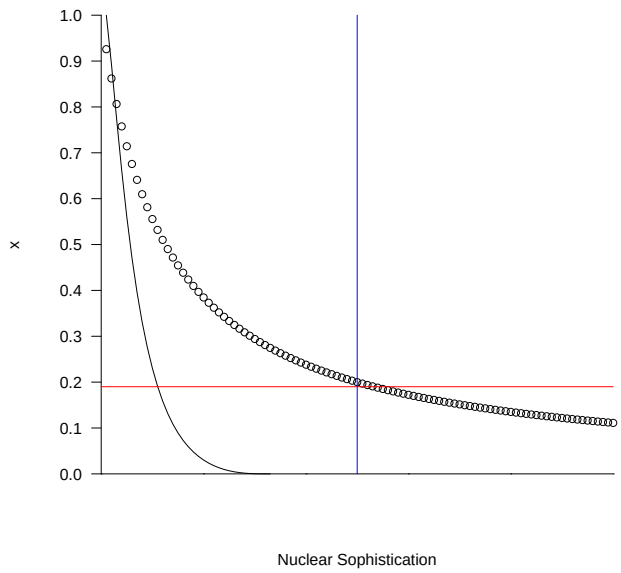
$$\Delta p \geq \left[\frac{p_0 + c_d - (1-\delta)\left[1 - (1-q)^{\rho_d}\right]}{\delta} \right]^{\rho_c} + c_c' - p_0 \tag{6}$$

where Δp_c is the minimum value for which this inequality holds true. Comparative statics of Δp_c show the effects of C's and D's characteristics on the likelihood of preemption. The relationship between Δp_c and the likelihood of preemption is inverse—that is, a factor that increases Δp_c increases the absolute magnitude of the shock to p that is necessary in time $t = w$ in order to make preemption the preferred option for D. A smaller Δp_c indicates that a smaller systemic shock will make D's preemptive strike the rational option.

Table 2 shows the correlations between several fundamental factors and the critical value of Δp at which it becomes rational for D to preempt C's nuclear power-transition. The two actor-unique factors—cost of war c and risk level ρ—both tend to dissuade preemption.

[10] See the appendix for the proof of this condition.

Figure 2: Equilibrium Bargain as a Function of Nuclear Arsenal Sophistication



Red line indicates the level of the *ex ante* equilibrium bargain. Blue line indicates level of S3. Sequence of dots indicates the direct correlation $x = p$, while the solid black line indicates $x^{*\prime}$.

Table 2: Comparative Statics of Critical Change in p

Variable	Symbol	$\Delta(\Delta p_c)$
Discount Factor	δ	$-$
Status quo Distribution	q	$-$
Defender Risk Tolerance	ρ_d	$-$
Challenger Risk Tolerance	ρ_c	$-$
Ex ante Probability of Challenger Victory	p_0	Curv.
Ex ante Defender Cost of War	c_d	$+$
Ex post Challenger Cost of War	c_c'	$+$

As the challenger's costs of war after nuclearization increase, or as the challenger is more risk-averse, C is less willing to revise the distribution of benefits. Knowing this, the rational defender therefore requires the possible change in the distribution of benefits to increase in scale in order to justify the costly preemption. Along a similar dynamic, as the defender's costs of war and level of risk-aversion increase at the moment of the "last clear chance," the more difficult it becomes to justify the costly lottery of war. These dynamics are similar to those that drive the level of the equilibrium bargain (as seen in Table 1).

There are also three joint (or environmental) factors that influence D's decision to preempt C's nuclearization: the common discount factor (δ) on future gains, the value of the distribution of benefits in the *status quo ex ante*, and the *ex ante* probability of C's victory in war. The discount factor is negatively-correlated to the critical change in probability. Thus, as the two states come to value future payoffs more highly, a lower threshold is necessary to justify preemption; conversely, as future gains are valued substantially-less than present payoffs, a higher critical change in C's probability of victory is necessary to make preemption a rational option. The size of D's initial share of the distribution of benefits $(1 - q)$ has a restraining effect on preemption. As D's share of the *ex ante* distribution of benefits decreases (that is, as q approaches 1), D is in a more precarious position within the dyad and therefore requires a lower critical value of Δp in order to preempt C's nuclearization. If D's *ex ante* position is otherwise more secure (as q approaches 0), a higher critical value is necessary to incentivize preemption.

The *ex ante* probability of C's victory in a war has a curvilinear effect on the critical value Δp_c. The inflection point of this curve, which is a maximum value, exists at

$$p_0 = \delta \left(\frac{\rho_c}{\delta}\right)^{1/(1-\rho_c)} - c_d + (1 - \delta)\left[1 - (1 - q)^{\rho_d}\right] \tag{7}$$

For values of p_0 less than the inflection value, increases in p_0 will also increase the critical value of Δp necessary to justify preemption. However, for *ex ante* probabilities of C's victory that

exceed this inflection value, further increases in p_0 begin to lower the preemption threshold.[11]

The conditions described above that contribute to a lower critical preemption threshold overlap strongly with the consequences of C's nuclearization. It is therefore logical to think of nuclearization as an event that causes a "sufficiently large and rapid" change in the distribution of power, the condition which Powell predicts will lead to bargaining breakdown due to the commitment problem. However, this type of bargaining failure is rarely seen empirically, most notably in the 1981 Israeli airstrike against the Osirak reactor outside of Baghdad (Feldman 1982; Freedman 2004). Why, then, do attempts at nuclearization among second-tier states not lead to preemptive wars?

A Case for Great-Power Intervention

The above section shows that the dyadic relationship between C and D degenerates into bargaining failure as a result of C's acquiring a nuclear capacity. When the change in the distribution of power is "sufficiently large and rapid," as is true during nuclearization, there is no endogenous correction to the equilibrium of preemptive war. However, this does not hold true when the dyad is taken out of isolation. The existence of a tier of great powers above the second-tier dyad introduces a new dynamic that can account for the empirical lack of preemption. When a great power has the capacity and interest to intervene in a second-tier dyadic relationship, it can alter the expected utilities of C and D, restructuring the path of play and opening new possible settlements that are not available absent the threat of great-power intervention.

This can be modeled by overlaying a third player, the great power (G) onto Powell's dyadic bargaining model. The latter model can be simplified to the game tree expressed in Figure 3, where $x^{*\prime}$ is defined endogenously as in the section above on the commitment problem. By allowing the great power to intervene in the event of a preemptive war (the

[11] See the appendix for the proof of this condition.

strategy profile {Nuclearize, Attack}), it is possible to model the effect of an extended-deterrence framework on the initial bargaining model. To do this, G is assumed to be risk-neutral and to have a Hotelling (1929) location-style utility function that references from an exogenously-fixed ideal point x_g. G prefers that benefits are distributed x_g and $1 - x_g$ between C and D, respectively, and G's utility decreases linearly as the actual distribution of benefits moves away from this preferred "location." As Gent (2007) argues, intervention is undertaken not necessarily to support a particular party to the dispute, but the intervener's own strategic interest. As G's military capacity is assumed to outpace those of either C or D, an intervention by G can unilaterally set the distribution of benefits at x_g. However, by intervening, G incurs some cost c_i; therefore, G will only intervene when its utility from the "natural" equilibrium state is lower than the utility derived from intervention. As a result, the single-round payoffs of the Powell-type game can be rewritten as in Figure 4 to include the possibility of intervention by G.

Using the expanded model's subgame-perfect equilibria, it is established that G will prefer to intervene whenever $|p_0 - x_g| > c_i$; that is, whenever the cost of intervention is less than its lost utility from a suboptimal division of benefits resulting from nonintervention. The cost of intervention is the scaling factor in this respect. As the costs of intervention decrease, the set of divisions $p_0 \in x_g \pm c_i$ for which G is unwilling to intervene becomes smaller. However, as the costs of intervention increase, the set of divisions for which G allows the dyadic bargaining model to play through without intervention increases in size.

The possibility of great power intervention not only alters the payoffs *in se* of the second-tier dyadic relationship, but also alters the behavior of the challenger and defender. For the domain in which G is incentivized to intervene ($p_0 \notin x_g \pm c_i$), either D or C may prefer to move off of the path of play and end the game by playing $\sim A$ or $\sim N$, respectively. In this context, G can take three possible actions. For $p_0 \in x_g \pm c_i$, G does not receive sufficient utility from intervention, and allows the second-tier dyadic relationship to play out as it would in Powell's initial game (see Figure 3). The other two options are both interventions

Figure 3: Powell-Type Conflict Model

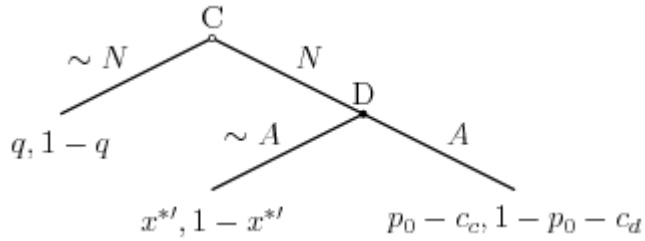
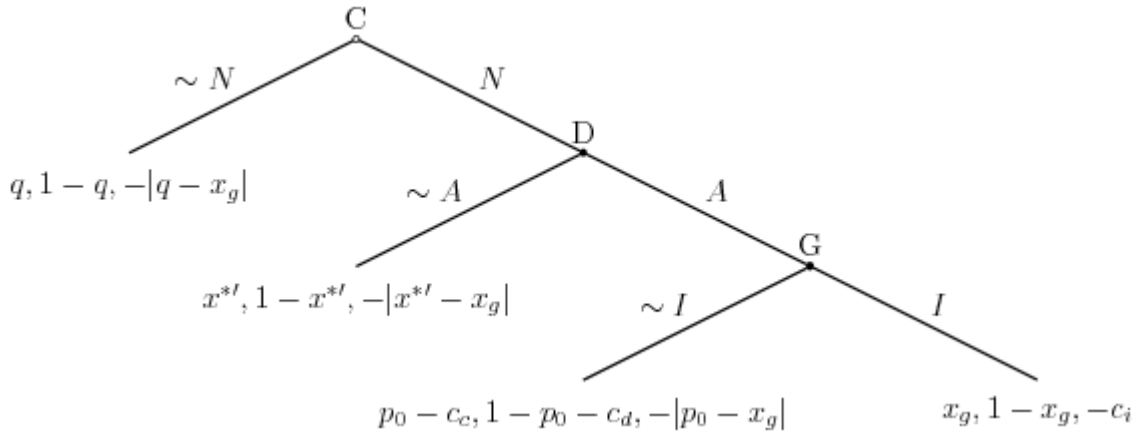


Figure 4: Conflict Model with Great-Power Intervention



to set the equilibrium bargain at x_g. If $p_0 < x_g - c_i$, this intervention is "on behalf of" C, in that it would result in a net gain of benefits for C. Conversely, if $p_0 > x_g + c_i$, the intervention is "on behalf of" D, in that it results in a net gain of benefits for D.

Figure 5 shows the effect of including G on the equilibrium behavior of the interaction when G is dissatisfied with C's inferior position within the dyad; that is, when G's preferred division x_g is greater than q. The zone that is colored red, bounded by $p' > x_g + c'_c$ and $p' > p_0 + \Delta p_c$, does not differentiate between the outcomes of the dyadic and triadic games. In both manifestations, C chooses to nuclearize, while D chooses to attack C preemptively. For the domain $p_0 \notin x_g \pm c_i$, this behavior occurs *despite* G's commitment to intervene in the dispute in favor of C vis-à-vis the *status quo ex ante*.

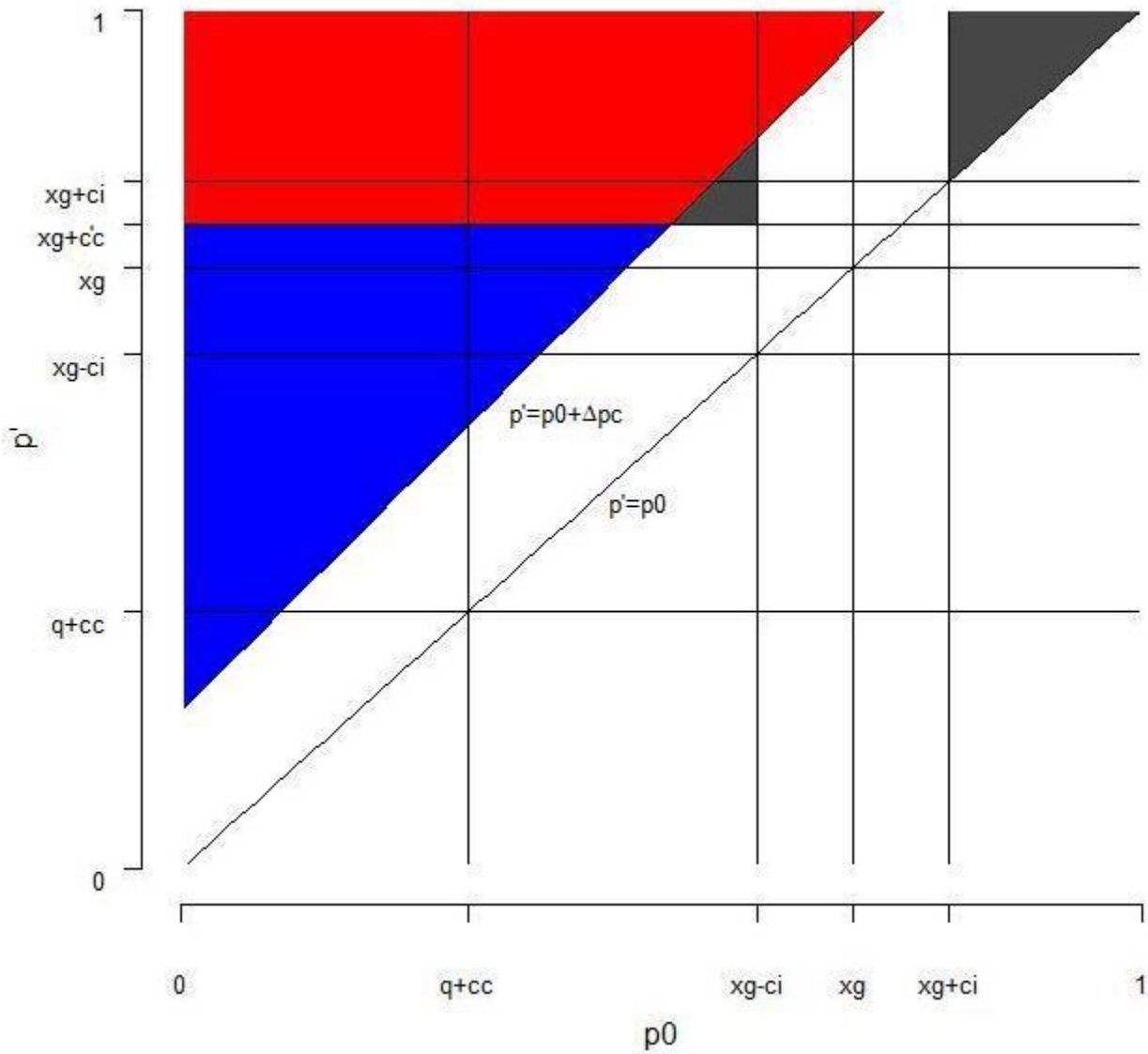
However, the blue and gray regions of Figure 5 show how the inclusion of G alters the regions of bargaining success and failure. Remembering that, for the dyadic scenario, the commitment problem results in preemption for all $p' > p_0 + \Delta p_c$, these regions denote alterations resulting from either successful deterrence or moral hazard. The blue region, demarcated by $p' < x_g + c'_c$, is the region where G is successfully able to deter D's preemptive strike. This is because, at time $t = w - 1$, D has the choice between the following two payoff streams:

$$U_D(A|N, I) = \sum_{t=0}^{\infty} \delta^t (1 - x_g) = \frac{1 - x_g}{1 - \delta} \tag{8}$$

$$U_D(\sim A|N, I) = \sum_{t=0}^{\infty} \delta^t (1 - x'^*) = \frac{1 - (p' - c'_c)^{1/\rho_c}}{1 - \delta} \tag{9}$$

Assuming $\rho_c = 1$ (which would result in the lowest bound of the payoff to $U_D(\sim A|I)$), D prefers to move off of its dyadic equilibrium path and not preempt C's nuclearization when $p' < x_g + c'_c$ (as represented by the strategy profile $\{N, \sim A, I\}$). However, the opposite outcome is also possible. Within the gray region, defined by $p' < p_0 + \Delta p_c$, $p' > x_g + c'_c$, and $p_0 \notin x_g \pm c_i$, the presence of G presents a moral hazard. D is sufficiently disadvantaged under these conditions that it will preemptively attack C's nuclear program when it otherwise

Figure 5: Effect of Great-Power Intervention on Bargaining Failure ($x_g > q$)



Red indicates $\{N, A\}$ in both dyadic and triadic games.
Blue indicates $\{N, A\}$ in dyadic game; $\{N, \sim A, I\}$ in triadic game (preemption deterred).
Gray indicates $\{N, \sim A\}$ in dyadic game; $\{N, A, I\}$ in triadic game (moral hazard).

would not, not because of its own ability to change the distribution of power, but because doing so would entrap G's involvement and provide D with the preferred division at x_g.

Analyzing Figure 5, one can see an important trend between the positioning of the great power within the dyad and its effect on the dyadic bargaining relationship. As x_g tends toward 1—that is, as G is more biased toward C in the dyad—the range of possible bargaining failures decreases: deterrence becomes more reliable as moral hazard and natural preemption scenarios decrease. Conversely, as x_g tends toward q, the range of persistent commitment problems increases relative to that of successful deterrence.

Implication: Preemptive conflict over second-tier nuclearization is less likely as the great power increasingly favors the challenger.

Implication: Preemptive conflict over second-tier nuclearization is more likely as the great power increasingly favors the *status quo ex ante*.

The red region in Figure 5 is consistent with the "sufficiently large and rapid" conditions cited by Fearon (1998) and Powell (2006) for bargaining failure vis-à-vis the commitment problem. This conclusion is robust to the possibility of great-power intervention. However, the great power's ability to alter the rewards to conflict circumscribes the region for which the commitment problem will lead to preemptive conflict. Through threatening to intervene in the dyadic bargaining process, a great power is able to deter a range of challenges to a client's nuclear program. However, this commitment is a double-edged sword; it also presents a moral hazard that can entrap the great power if the challenger's nuclearization threatens to go beyond the great power's preferred division of the distribution of benefits.

In contrast, if $x_g < q$, indicating that G believes C to be too powerful within the dyad, the deterrent effect manifests itself principally against the challenger. A large portion of the domain of the dyadic commitment problem is eliminated by deterring C's nuclearization process in the first place. This is noted by the green section of Figure 6. C will nuclearize only when the equilibrium bargain $x^{*\prime}$ exceeds its *status quo* payoffs of q. However, two other conditions may hold. C chooses $N|A, \sim I$ when its *ex ante* payoff to the war lottery exceeds

its status quo, or when $p_0 > q + c_c \in x_g \pm c_i$. When the great power intervenes against C, the necessary condition for $N|A, I$—$x_g > q$—does not hold. The *status quo ex ante* is greater than any outcome that can be achieved through G's intervention; therefore, all such scenarios are removed from C's rational options. Only those circumstances that would not invite G's involvement may lead to preemptive warfare. However, small ranges of deterrence against preemption do exist under these conditions as well (noted again by the blue region of the figure), as they do when G favors C within the dyad.

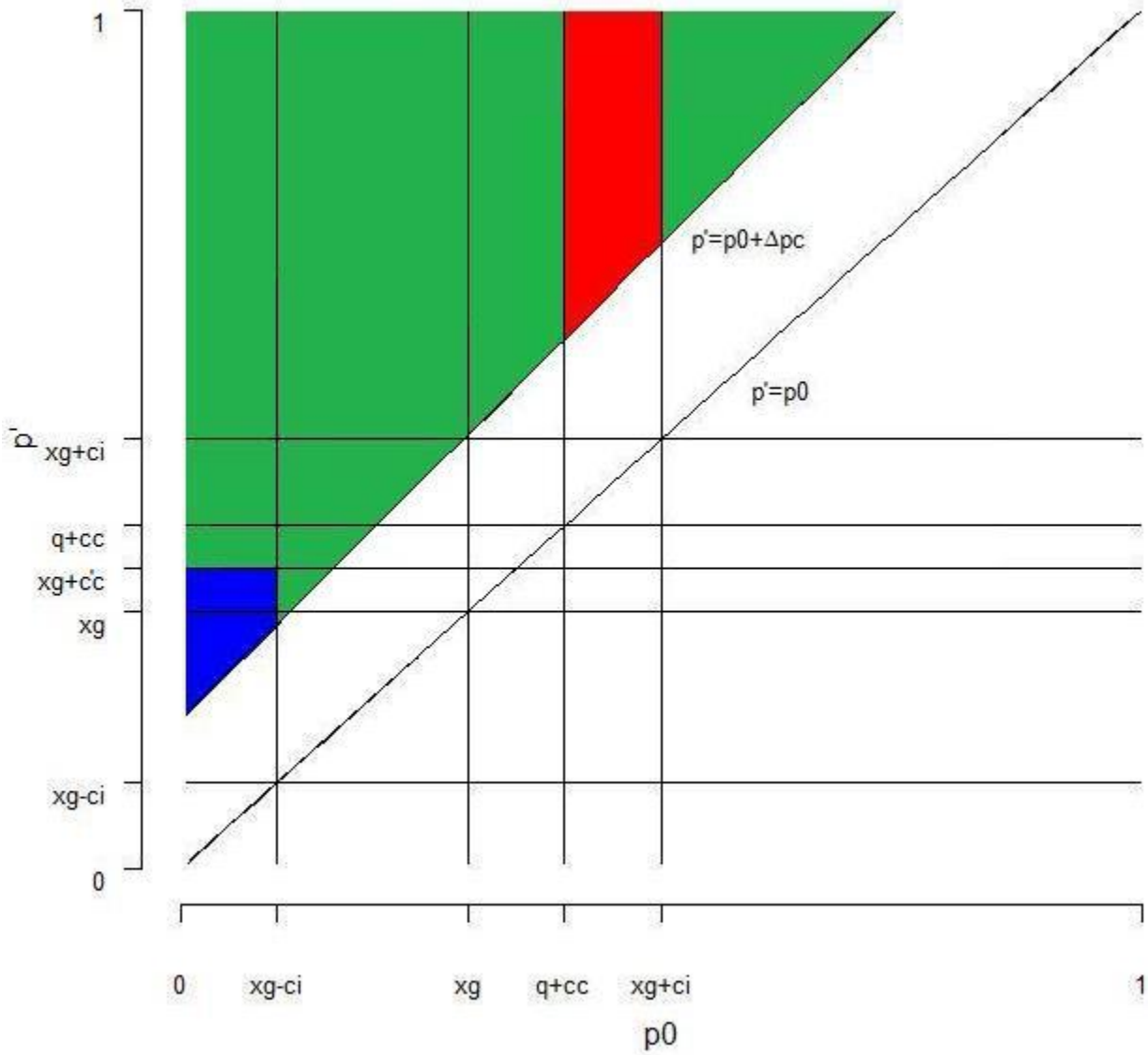
While this pattern appears empirically to be a non-event, one can see that the threat of intervention in favor of D renders nuclearization to be a detrimental choice for C, and, therefore, C is deterred entirely from attempting to nuclearize. The security guarantee that D enjoys removes any rationale for preemption from the dyadic environment.

Implication: Second-tier nuclearization is less likely to occur as the great power increasingly favors the defender.

Empirical Illustrations

While there are few historical cases of middle-power nuclearization that have come to fruition, they provide concrete support for overcoming the commitment problem by way of great-power deterrence. Israel, India, Pakistan, South Africa, and North Korea have all developed nuclear weapons capacities, in part dependent on the protective shadow of great-power intervention. However, seventeen other states (cf. Levite 2003) have had serious attempts at nuclear-weapons or dual-use research, but have not attempted to cross the threshold of nuclearization because of great-power pressure. The cases of Pakistan and Egypt reflect the two deterrent effects of great-power intervention on the commitment problem of nuclearization.

Figure 6: Effect of Great-Power Intervention on Bargaining Failure ($x_g < q$)



Red indicates $\{N, A\}$ in both dyadic and triadic games.
Blue indicates $\{N, A\}$ in dyadic game; $\{N, \sim A, I\}$ in triadic game (preemption deterred).
Green indicates $\{N, A\}$ in dyadic game, $\{\sim N, A, I\}$ (nuclearization deterred by G)
or $\{\sim N, A, \sim I\}$ (nuclearization deterred by D) in triadic game.

Pakistan: A Case of Preemption Deterred

Pakistan's interest in a nuclear program began shortly after its independence, with the 1954 US-sponsored "Atoms for Peace" program. While the program (and Pakistan's newly-formed Atomic Energy Commission) did have a legitimate interest in augmenting the country's insufficient conventional energy sector, the government remained ambiguous on its official policy vis-à-vis weaponization. While the military government initially vetoed the pursuit of a domestic nuclear weapons program, concerns about India (already the conventionally-superior military force in the region) led to a deterrence orientation by the late 1960s (Kapur 1987). Constrained by immediate military concerns in Kashmir, Pakistan did not make nuclearization a national priority until after the *Smiling Buddha* nuclear test in 1974 (Marwah 1981; Ahmed 1999). "After the Indian explosion, however, the nascent Pakistani weapons program had to move forward according to the realist view: facing a recently hostile neighbor with both nuclear weapons and conventional military superiority, it was inevitable that the government in Islamabad would seek to produce a nuclear weapon as quickly as possible" (Sagan 1997, 59).

The first signs of Pakistan's move toward weaponization came in 1977, as the United States and IAEA became aware of Pakistani reprocessing and enrichment activities.[12] By 1983, Pakistan was sufficiently-close to a weapons capability, which it probably acquired shortly thereafter. (Pakistan maintained a position of strategic ambiguity about its nuclear capability until it conducted test explosions in 1998, so it is uncertain when exactly it acquired its nuclear weapons capability.) This was achieved largely with the assistance of China, itself a nuclear weapons state and—like Pakistan—an adversary of India.[13] Since then, Pakistan has developed an arsenal of approximately sixty nuclear weapons with regional

[12]U.S. Embassy, Vienna, "[SECRET] Pakistan Nuclear Issue: Briefing of IAEA Director General Eklund." 9 July 1977. `http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB114/chipak-4.pdf` (accessed 17 February 2010). Government documents for this subsection are found in Burr (2004).

[13]U.S. Department of State, "[SECRET] The Pakistani Nuclear Program." 22 June 1983. `http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB114/chipak-11.pdf` (accessed 17 February 2010).

range, which is believed to be a larger arsenal than India's at approximately fifty weapons.[14]

Why then did India, which had achieved its first nuclear capacity at least ten years prior, not preempt the Pakistani nuclear program? According to Kapur (1987), India had sufficient conventional capabilities to suppress the Pakistani military, as it had in earlier conflicts (cf. also Arquilla 1997). However, it could not overcome the Chinese, who had aligned with Pakistan against India since the Sino-Soviet split in the 1960s. The 1962 Sino-Indian border war helped to confirm Pakistan's acknowledgment of China's aversion to the pro-Russian regime in Delhi.[15] Over the following twenty years, China provided both technical and material assistance to the Pakistani nuclear program, consisting of transfers of highly-enriched uranium and enrichment infrastructure, in the attempt to balance against India (Ahmed 1999).[16] China's position clearly indicated that Pakistani nuclearization would be beneficial for the regional alliance as well as for the furtherance of "revolutionary change that would work to the benefit of the Third World."[17] While Pakistan could not entice China to collaborate on the 1965 or 1971 Indo-Pakistani conflicts, the possibility of regional destabilization meant that the Chinese provided a latent deterrent while Pakistan developed its own nuclear capability (Arquilla 1997). Despite India's dyadic superiority, it was unable to overcome Pakistan's alliance with the superior Chinese forces.

Factions within the Indian political establishment—while recognizing Pakistan as an enduring rival—were most concerned about the expansionist role of China in South Asia (Hedrick 1999; Karnard 2002; Bajpai 2007). China and India had been involved in a rivalry for regional dominance since 1949, as the only two large states in south and south-east Asia.

[14]Federation of American Scientists, "Status of Nuclear Weapons States and their Nuclear Capabilities." `http://www.fas.org/nuke/guide/summary.htm` (accessed 16 October 2009).

[15][SECRET] Letter from Thomas Hughes, Director of Intelligence and Research, U.S. State Department, to William F. Raborn, Director of Central Intelligence. 21 July 1965. `http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB114/chipak-1.pdf` (accessed 3 March 2010).

[16]See also U.S. Embassy, Beijing, "[SECRET] Cable to Secretary of State." 18 December 1982. `http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB114/chipak-9.pdf` (accessed 17 February 2010).

[17]U.S. Department of State, "[SECRET] Classified Report to Congress on the Non-Proliferation Policies and Practices of the People's Republic of China." 18 September 1997. `http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB114/chipak-26.pdf` (accessed 3 March 2010).

The Indo-Pakistani conflict, derived from the 1947 partition, was initially unrelated to the Sino-Indian rivalry; however, the two became linked in the context of regional balancing: China's assistance to and cover for the Pakistani nuclear program is, in hindsight, a clear sign of that intent. Given the intimate connection between the Pakistani nuclear program and China's patronage, India could not disentangle its two rivals. To risk preemptive action against the nascent Pakistani program would entail bringing the Sino-Pakistani relationship to the conflict's front (Garver 2001). As a result, India largely conceded to Pakistan the development of a nuclear arsenal. The one time that India did threaten action (the 1987 exercise named "Brasstacks," the largest military maneuver since World War II), it was too late to effect change. Through both diplomatic channels and public media, Pakistan acknowledged its nuclear weapons capability, a shocking response to the Indian strategy of regional intimidation (Ahmed 1999).[18] This news brought Brasstacks to an abrupt conclusion—the window of opportunity had passed India by.

The Pakistani case provides illustration that pressure by a great power can deter attempts to preempt middle-power nuclear programs. Whereas Pakistan had been militarily inferior to India since the partition of the former British colony, China had a clear interest in expanding Pakistan's power vis-à-vis their common enemy. This interest manifested itself not only in the assistance provided to the Pakistani nuclear program, but in the protection that China gave to its client, via the threat of intervention in an Indo-Pakistani conflict. Unable to resolve the realignment by use of overwhelming force, India was forced to accept a degree of increased Pakistani influence in the region. Though it had been dominant in the first forty years of their dyadic relationship, since 1987 India has been forced into a scenario that more closely resembles the mutual nuclear deterrence of the great powers.

[18]Kuldip Nayyar, "Pakistan Has the Bomb," *The Tribune* (1 March 1987).

Egypt: A Case of Nuclearization Deterred

Egypt also developed its interest in nuclear energy through its participation in the "Atoms for Peace" program during the 1950s, toward the beginning of the Nasser regime. However, military applications were not Egypt's principal concern until 1960, when the regime became aware of Israel's Dimona reactor and the military direction of its neighbor and rival's nuclear program (Quester 1983; Rublee 2006). The Egyptian nuclear weapons program was therefore a direct challenge to that of the Israelis, who had bested the combined Arab armies during the 1948 war. The defeat of the Egyptians—who were for centuries the political center of the Muslim world—moved the regime toward a militarized perspective on nuclear energy in an attempt to reclaim the mantle of political importance (Gerges 1995; Levite 2003; Rublee 2006).

However, the Egyptian nuclear weapons program was plagued by early failures. By the 1967 war, Cairo was no closer to developing a weapon than it was seven years earlier (Rublee 2006). The Israelis, on the other hand, were believed to have already created a number of nuclear weapons and had solidified the domestic production of such weapons.[19] Furthermore, the United States came to ally itself with Israel only in the aftermath of the 1967 war (Ben-Zvi 2007). As the CENTO initiative to contain Soviet influence in the Middle East fell through, the United States came to focus more on its alliances with Israel and Iran, while fearing the revolutionary pan-Arabism of the Nasser regime.

The traditional framework of mutual deterrence would indicate that Egypt would further expand its nuclear weapons program, given its inability to defeat the Israelis conventionally. However, American involvement in the Middle East—biased as it was in the context of Cold War containment—led the Sadat regime to renounce its militarized nuclear program (Siler 1992; Levite 2003). While the United States was biased toward the Israelis, it had hoped to resolve the regional conflict so as to turn its attention toward the Soviet Union. Bar-

[19]Special National Intelligence Estimate 4-1-74, "[TOP SECRET] Prospects for Further Proliferation of Nuclear Weapons." 23 August 1974. `http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB240/snie.pdf` (accessed 8 March 2010). This document is found in Burr (2008).

Joseph (1982) argues that the Soviet Union was similarly not interested in escalating the Arab-Israeli conflict toward nuclear war. "Sadat knew that any alliance with the United States would require complete abandonment of the nuclear program. *The expectations and diplomacy of global powers can make a difference*, if the state in question values the alliance more than the nuclear weapons program" (Rublee 2006, 561, emphasis added). Through the use of selective incentives, both positive (a security guarantee vis-à-vis Israel) and negative (threats to withhold economic assistance, as well as technological embargoes), the United States was able to deter Egypt from the escalatory path of nuclearization (Levite 2003).

The 1973 war was the final blow to Egypt's designs for a nuclear weapons program. During this war, the United States came to the support of Israel despite the threat of Soviet escalation and an Arab oil embargo. This show of resolve to keep Israel at the top of the Middle Eastern hierarchy led Sadat to view the nuclear program as a one-time bargaining chip rather than as an instrument for increasing Egypt's share of the dyadic distribution of power (Rublee 2006). The lengths to which the United States risked its own interests to support Israel (cf. Blechman and Hart 1982) made it clear that the (highly-difficult) process of nuclearization would not result in concessions from Israel, but in further violence. After losses in 1967 and 1973, as well as the "war of attrition" in 1970, the cumulative costs of war and the observance of direct US assistance to Israel led Egypt to abandon this method of technological growth. Rublee notes:

> Sadat decided that it was in Egypt's best interest to give up the nuclear program and used it as a tool to bargain with the United States after the 1973 war with Israel. Sadat promised to ratify the NPT and give up Egypt's nuclear ambition for good if the United States would aid Egypt—a deal that Washington accepted. From 1974 to the present, Egypt has remained true to its promise, embracing the nuclear nonproliferation regime and energetically participating in it, hoping to force Israeli movement on the nuclear issue (2006, 556).

While unable to reverse the distribution of power entirely, Sadat was able to garner enough American support through this diplomacy to regain the Sinai peninsula from Israel in 1979, and to cement Egypt's position as the leader of the Arab negotiating bloc vis-à-vis Israel for

a generation.

The theory of great-power intervention provides support for why Egypt ended its nuclear weapons program after thirteen years. As the United States moved from Egyptian ally during the 1950s to an aloof observer in the 1960s to the advocate of Egypt's regional enemy from 1967 onwards, the opportunities to revise the distribution of power away from Israel began to falter. Part of this was due to direct interdiction efforts (cf. Gregory 1995); however, the political intent to nuclearize was clearly present until the United States had signaled its willingness to absorb costs to maintain a pro-Israel *status quo*. Having suffered severe costs during each attempted revision, Egypt was rationally incentivized to avoid provocation and accept the distribution of power as it was, while exploiting available opportunities to marginally alter the distribution of benefits.

Conclusion

The nuclearization of a state presents a shock to the international distribution of power, one with consequences for the distribution of benefits among states. Fearon (1998) and Powell (2006) have shown that, in the shadow of such a systemic shock, preemption becomes a viable option to preserve more-powerful actors' positions in the face of shocks to the distribution of power. Newly-nuclear states cannot commit to the *status quo* as the distribution of power shifts in their favor, so those states positioned to lose the most take action while they can to prevent such a revision. Despite this explanation, outright preemption of a nuclear program has occurred only by Israeli airstrikes against the Iraqi (1981) and Syrian (2007) nuclear programs. The reason for the empirical rarity of preemption is deterrence resulting from the threat of great-power intervention. As larger states have the ability to interfere in middle-power dyadic relationships, their interests affect the behavior of smaller states in their own relationships. This research has shown that—when a great power desires a change in the *status quo* in favor of a challenger—the threat of intervention is enough to overcome the

commitment problem under a variety of circumstances. Unwilling to accept a great-power intervention, defending states concede to a "lesser of two evils" resulting from the challenger's nuclearization.

These conclusions present a number of options for policymakers seeking to deal with the current generation of nuclear proliferation. Absent efforts by great powers to curb proliferation through coercive diplomacy, rival states will take matters into their own hands and counterproliferation will be a violent endeavour marked by preemptive warfare. However, a strong commitment by the great powers can reduce the likelihood of militarized conflict resulting from this cause in one of two ways. If the nuclearizing state is supported by the great powers, the domain of nuclear states will grow; but in such a way as to avoid preemptive war from occurring. However, if the nuclearizing state is opposed by the great powers in favor of a rival, the process of nuclearization can itself be deterred. The greatest threat of warfare exists where the great power is either unable or unwilling to commit its resources to a party within the dispute. Pacifying the nuclear proliferation issue requires continuous and intense great-power involvement.

This study also provides an avenue for the future integration of research on intervention and the commitment problem. While this study has modeled a single great power with rational preferences, the real world acknowledges several great powers with differing—and often conflicting—interests. How does great power plurality affect the bargaining dynamic of middle-power dyads? Gent (2007) shows that similar great-power interests may cause intervention—a public good—to be underprovided when needed, undermining the deterrent effect described above. However, interest divergence may cause second-tier dyads to become an extension of great-power competition. How great- and middle-powers interpret these effects will have severe consequences for the future of the international nonproliferation regime.

Appendix

A.1 Proof of the Preemption Condition

C and D begin at time $t = 0$ with *status quo* payoffs of q and $1-q$, respectively. At time $t = w$, C develops nuclear weapons. This changes the fundamental conditions p and c which are denoted p' and c' after the systemic shock. Given the increased p, C demands a revision of the status quo to the level $x^{*\prime} = (p' - c'_c)^{\rho_c}$. The expected utility of the revised bargain is:

$$EU_C(\text{Revision}) = \sum_{t=0}^{w-1} \delta^t q^{\rho_c} + \sum_{t=w}^{\infty} \delta^t x^{*\prime} \tag{10}$$

$$EU_D(\text{Revision}) = \sum_{t=0}^{w-1} \delta^t (1-q)^{\rho_d} + \sum_{t=w}^{\infty} \delta^t (1 - x^{*\prime}) \tag{11}$$

However, given C's inability to credibly commit not to revise the status quo at $t = w$, D has the incentive to preempt C's nuclearization. This settles the bargaining process at its *ex ante* probability $(1 - p_0)$. Since p_0 is not as preferred as the *status quo* distribution of power q, D chooses to preempt the shock at the last clear chance (the last period prior to the systemic shock, ie. $t = w - 1$). This results in the following expected utilities, which are *ex post* inefficient for the dyadic whole:

$$EU_C(\text{Preemption}) = \sum_{t=0}^{w-2} \delta^t q^{\rho_c} + \sum_{t=w-1}^{\infty} \delta^t (p_0 - c_c) \tag{12}$$

$$EU_D(\text{Preemption}) = \sum_{t=0}^{w-2} \delta^t (1-q)^{\rho_d} + \sum_{t=w-1}^{\infty} \delta^t (1 - p_0 - c_d) \tag{13}$$

D prefers to preempt C's nuclearization if its expected utility of preemption exceeds its expected utility of the revision to occur after the shock. Since the expected utility of each is equal prior to the period before the last clear chance ($t \in [0, w-2]$), comparing the utilities

can begin at $t = w - 1$. From this point, D prefers to preempt if:

$$\sum_{t=0}^{\infty} \delta^t (1 - p_0 - c_d) \geq (1-q)^{\rho_d} + \sum_{t=1}^{\infty} \delta^t \left[1 - (p' - c_c')^{1/\rho_c}\right] \tag{14}$$

Remembering that the infinite sum is solved $\sum_{t=0}^{\infty} \delta^t y = y/(1-\delta)$, the inequality can be rewritten in a simpler form:

$$\frac{1 - p_0 - c_d}{1-\delta} \geq (1-q)^{\rho_d} + \frac{\delta \left[1 - (p' - c_c')^{1/\rho_c}\right]}{1-\delta}$$

Multiplying all sides by the factor $1 - \delta$, the inequality is rewritten

$$1 - p_0 - c_d \geq (1-\delta)(1-q)^{\rho_d} + \delta \left[1 - (p' - c_c')^{1/\rho_c}\right]$$

Next, p'—one of the quantities of interest—is isolated on the left side of the inequality and the remainder of the inequality is simplified.

$$\begin{aligned}
1 - p_0 - c_d \geq & (1-\delta)(1-q)^{\rho_d} + \delta - \delta(p' - c_c')^{1/\rho_c} \\
\delta(p' - c_c')^{1/\rho_c} \geq & (1-\delta)(1-q)^{\rho_d} + \delta - [1 - p_0 - c_d] \\
(p' - c_c')^{1/\rho_c} \geq & \frac{(1-\delta)(1-q)^{\rho_d} + \delta - 1 + p_0 - c_d}{\delta} \\
p' - c_c' \geq & \left[\frac{(1-\delta)(1-q)^{\rho_d} + \delta - 1 + p_0 + c_d}{\delta}\right]^{\rho_c} \\
p' \geq & \left[\frac{(1-\delta)(1-q)^{\rho_d} + \delta - 1 + p_0 + c_d}{\delta}\right]^{\rho_c} + c_c' \\
p' \geq & \left[\frac{p_0 + c_d + (1-\delta)(1-q)^{\rho_d} - (1-\delta)}{\delta}\right]^{\rho_c} + c_c' \\
p' \geq & \left[\frac{p_0 + c_d + (1-\delta)\left[(1-q)^{\rho_d} - 1\right]}{\delta}\right]^{\rho_c} + c_c' \\
p' \geq & \left[\frac{p_0 + c_d - (1-\delta)\left[1 - (1-q)^{\rho_d}\right]}{\delta}\right]^{\rho_c} + c_c'
\end{aligned} \tag{15}$$

By subtracting p_0 from both sides of the inequalities, the fundamental critical value of

interest, $\Delta p = p' - p_0$, can be determined (cf. Equation 6).

$$\Delta p \geq \left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right]^{\rho_c} + c_c' - p_0 \tag{16}$$

A.2 Inflection Point for p_0 in the Preemption Condition

Remembering that the critical value to justify preemption is

$$\Delta p_c = \left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right]^{\rho_c} + c_c' - p_0 \tag{17}$$

the first-order condition of this value with respect to p_0 can be written as

$$\frac{\partial(\Delta p_c)}{\partial p_0} = \rho_c \left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right]^{\rho_c - 1} \left(\frac{1}{\delta}\right) - 1 \tag{18}$$

The maximum of the curve is found at the inflection point, where $\frac{\partial(\Delta p_c)}{\partial p_0} = 0$. This is solved below:

$$\begin{aligned}
1 =& \frac{\rho_c}{\delta}\left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right]^{\rho_c - 1} \\
\frac{\delta}{\rho_c} =& \left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right]^{\rho_c - 1} \\
\left(\frac{\delta}{\rho_c}\right)^{1/(\rho_c - 1)} =& \left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right] \\
\left(\frac{\rho_c}{\delta}\right)^{1/(1-\rho_c)} =& \left[\frac{p_0 + c_d - (1-\delta)\left[1-(1-q)^{\rho_d}\right]}{\delta}\right] \\
p_0 =& \delta\left(\frac{\rho_c}{\delta}\right)^{1/(1-\rho_c)} - c_d + (1-\delta)\left[1-(1-q)^{\rho_d}\right]
\end{aligned} \tag{19}$$

A.3 Proof by Backward Induction: Effects of Great-Power Intervention on Challenger and Defender Behavior

Great Power

$$
\begin{aligned}
U_G(I) &= -\, c_i \\
U_G(\sim I) &= -\, |p_0 - x_g| \\
&\Rightarrow I \text{ iff } p_0 \notin x_g \pm c_i
\end{aligned}
\tag{20}
$$

Defender

$$
\begin{aligned}
U_{D,t=w-1}(A|I) &= \sum_{t=0}^{\infty} \delta^t (1 - x_g) = \frac{1 - x_g}{1 - \delta} \\
U_{D,t=w-1}(\sim A|I) &= \sum_{t=0}^{\infty} \delta^t (1 - x^{*\prime}) = \frac{1 - x^{*\prime}}{1 - \delta}
\end{aligned}
$$

Therefore, given fixed δ, D chooses $A|I$ iff $x_g < x^{*\prime}$.

Remembering Equation 3, ($x^{*\prime} = (p' - c'_c)^{1/\rho_c}$),

$$
A|I \text{ iff } p' > x_g^{\rho_c} + c'_c \tag{21}
$$

and $\sim A|I$ otherwise. As greater risk-aversion ($\rho_c \to 0$) causes this threshold to rise, the lowest threshold occurs at $x_g + c'_c$ for $\rho_c = 1$.

Under the conditions $\sim I$, D behaves as it would without the presence of G in the game. Therefore, for $p_0 \in x_g \pm c_i$, D chooses $A| \sim I$ iff $p' > p_0 + \Delta p_c$ (cf. appendix A.1 above).

Challenger

$$\begin{aligned} U_{C,t=w-1}(N|A,I) =& x_g \\ U_{C,t=w-1}(\sim N|A,I) =& q^{\rho_c} \\ \Rightarrow N|A,I \text{ iff } x_g > q^{\rho_c} \end{aligned} \tag{22}$$

$$\begin{aligned} U_{C,t=w-1}(N|\sim A,I) =& x^{*\prime} \\ U_{C,t=w-1}(\sim N|\sim A,I) =& q^{\rho_c} \\ \Rightarrow N|\sim A,I \text{ iff } p' > q^{\rho_c^2} + c_c' \end{aligned} \tag{23}$$

This condition (as does the condition, described below, for $N|\sim A, \sim I$) holds at the lower bound of $p' = q + c_c'$ for $\rho_c = 1$.

Under the conditions $\sim I$, C behaves as it would without the presence of G in the game. Therefore, for $p_0 \in x_g \pm c_i$, C behaves as follows:

$$\begin{aligned} U_{C,t=w-1}(N|A,\sim I) =& p_0 - c_c \\ U_{C,t=w-1}(\sim N|A,\sim I) =& q^{\rho_c} \\ \Rightarrow N|A,\sim I \text{ iff } p_0 > q^{\rho_c} + c_c \end{aligned} \tag{24}$$

$$\begin{aligned} U_{C,t=w-1}(N|\sim A,\sim I) =& x^{*\prime} \\ U_{C,t=w-1}(\sim N|\sim A,\sim I) =& q^{\rho_c} \\ \Rightarrow N|\sim A,\sim I \text{ iff } p' > q^{\rho_c^2} + c_c' \end{aligned} \tag{25}$$

These conditions lead to the deviations from Equation 6 under triadic conditions, as described in Figures 5 and 6.

REFERENCES

Ahmed, Samina. 1999. "Pakistan's Nuclear Weapons Program: Turning Points and Nuclear Choices." *International Security* 23(4):178–204.

Altfeld, Michael F. and Bruce Bueno de Mesquita. 1979. "Choosing Sides in War." *International Studies Quarterly* 23:87–112.

Arquilla, John. 1997. "Nuclear Weapons in South Asia: More May be Manageable." *Comparative Strategy* 16(1):13–31.

Bajpai, Kanti. 2007. "Pakistan and China in Indian Strategic Thought." *International Journal* 62:805–824.

Bar-Joseph, Uri. 1982. "The hidden debate: The formation of nuclear doctrines in the Middle East." *Journal of Strategic Studies* 5(2):205–227.

Beardsley, Kyle and Victor Asal. 2009. "Nuclear Weapons as Shields." *Conflict Management and Peace Science* 26(3):235–255.

Ben-Zvi, Abraham. 2007. *The Origins of the American-Israeli Alliance: The Jordanian Factor*. London: Routledge.

Bennett, D. Scott and Allan C. Stam. 2004. *The Behavioral Origins of War*. Ann Arbor: University of Michigan Press.

Blechman, Barry M. and Douglas M. Hart. 1982. "The Political Utility of Nuclear Weapons: The 1973 Middle East Crisis." *International Security* 7(1):132–156.

Bremer, Stuart. 1992. "Dangerous Dyads: Conditions Affecting the Likelihood of Interstate War, 1816–1965." *Journal of Conflict Resolution* 36:309–341.

Brodie, Bernard, ed. 1946. *The Absolute Weapon*. New York: Harcourt Brace.

Bueno de Mesquita, Bruce and William H. Riker. 1982. "An Assessment of the Merits of Selective Nuclear Proliferation." *Journal of Conflict Resolution* 26(2):283–306.

Burr, William, ed. 2004. *China, Pakistan, and the Bomb: The Declassified File on U.S. Policy, 1977–1997*. Washington: National Security Archive.

Burr, William, ed. 2008. *In 1974 Estimate, CIA Found that Israel Already Had a Nuclear Stockpile and that "Many Countries" Would Soon Have Nuclear Capabilities*. Washington: National Security Archive.

Ellsberg, Daniel. 1959. The Theory and Practice of Blackmail: Lecture at the Lowell Institute, Boston, March 10. In *Bargaining: Formal Theories of Negotiation*, ed. Oran R. Young. Urbana: University of Illinois Press.

Fearon, James D. 1994. "Domestic Political Audiences and the Escalation of International Disputes." *American Political Science Review* 88(3):577–592.

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

Fearon, James D. 1998. Commitment Problems and the Spread of Ethnic Conflict. In *The Spread of Ethnic Conflict: Fear, Diffusion, and Escalation*, ed. David A. Lake and Donald Rothchild. Princeton: Princeton University Press pp. 107–126.

Feldman, Shai. 1982. "The Bombing of Osiraq—Revisited." *International Security* 7(2):114–142.

Freedman, Lawrence. 2003. *The Evolution of Nuclear Strategy.* 3d ed. New York: Palgrave MacMillan.

Freedman, Lawrence. 2004. *Deterrence.* Cambridge: Polity Press.

Gaddis, John Lewis. 2005. *Strategies of Containment: A Critical Appraisal of American National Security Policy During the Cold War.* 2d ed. Oxford: Oxford University Press.

Garver, John W. 2001. *Protracted Contest: Sino-Indian Rivalry in the Twentieth Century.* Seattle: University of Washington Press.

Gent, Stephen E. 2007. "Strange Bedfellows: The Strategic Dynamics of Major Power Military Interventions." *Journal of Politics* 69:1089–1102.

Gerges, Fawaz A. 1995. "Egyptian-Israeli Relations Turn Sour." *Foreign Affairs* 74(3):69–78.

Gregory, Barbara M. 1995. "Egypt's Nuclear Program: Assessing Supplier-Based and Other Developmental Constraints." *Nonproliferation Review* 2:20–27.

Hedrick, Brian Kenneth. 1999. *The Balance of Power in South Asia: The Strategic Interests and Capabilities of India, China, and Pakistan.* Master's thesis, University of Texas at Austin.

Hotelling, Harold. 1929. "Stability in Competition." *Economic Journal* 39(153):41–57.

Huth, Paul and Bruce Russett. 1984. "What Makes Deterrence Work? Cases from 1900 to 1980." *World Politics* 36:496–526.

Huth, Paul and Bruce Russett. 1988. "Deterrence Failure and Crisis Escalation." *International Studies Quarterly* 32:29–46.

Huth, Paul, Christopher Gelpi and D. Scott Bennett. 1993. "The Escalation of Great Power Militarized Disputes: Testing Rational Deterrence Theory and Structural Realism." *American Political Science Review* 87(3):609–623.

Huth, Paul K. 1988. "Extended Deterrence and the Outbreak of War." *American Political Science Review* 82(2):423–443.

Kapur, Ashok. 1987. *Pakistan's Nuclear Development*. New York: Croom Helm.

Karnard, Bharat. 2002. *Nuclear Weapons and Indian Security: The Realist Foundations of Strategy*. New York: Macmillan.

Kydd, Andrew. 2003. "Which Side are You On? Bias, Credibility, and Mediation." *American Journal of Political Science* 47:597–611.

Leeds, Brett Ashley and Burcu Savun. 2007. "Terminating Alliances: Why Do States Abrogate Agreements?" *Journal of Politics* 69(4):1118–1132.

Levite, Ariel E. 2003. "Never Say Never Again: Nuclear Reversal Revisited." *International Security* 27(3):59–88.

Lieber, Keir A. and Daryl G. Press. 2006*a*. "The End of MAD? The Nuclear Dimension of U.S. Primacy." *International Security* 30(4):7–44.

Lieber, Keir A. and Daryl G. Press. 2006*b*. "The Rise of U.S. Nuclear Primacy." *Foreign Affairs* 85(2):42–54.

Marwah, Onkar. 1981. "India and Pakistan: Nuclear Rivals in South Asia." *International Organization* 35(1):165–179.

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

Powell, Robert. 2004. "The Inefficient Use of Power: Costly Conflict with Complete Information." *American Political Science Review* 98(2):231–241.

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

Quester, George H. 1983. "Nuclear Weapons and Israel." *Middle East Journal* 37(4):547–564.

Rosenberg, David Alan. 1983. "The Origins of Overkill: Nuclear Weapons and American Strategy, 1945–1960." *International Security* 7(4):3–71.

Roth, Ariel Ilan. 2009. "Reassurance: A Strategic Basis of U.S. Support for Israel." *International Studies Perspectives* 10(4):378–393.

Rublee, Maria Rost. 2006. "Egypt's Nuclear Weapons Program: Lessons Learned." *Nonproliferation Review* 13(3):555–567.

Sagan, Scott D. 1997. "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb." *International Security* 21(3):54–86.

Sagan, Scott D. 2003. Nuclear Instability in South Asia. In *The Spread of Nuclear Weapons: A Debate Renewed*, ed. Scott D. Sagan and Kenneth N. Waltz. New York: W. W. Norton & Co. pp. 251–262.

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

Schwartz, William A., Charles Derber, Gordan Fellman, William Gamson, Morris S. Schwartz and Patrick W. Withen. 1990. *The Nuclear Seduction: Why the Arms Race Doesn't Matter—and What Does*. Berkeley: University of California Press.

Selten, Reinhard. 1975. "A Reexamination of the Perfectness Concept for Equilibrium Points in Extensive Games." *International Journal of Game Theory* 4:25–55.

Siler, Michael J. 1992. *Explaining Variation in Nuclear Outcomes Among Southern States: Bargaining Analysis of U.S. Nonproliferation Policies towards Brazil, Egypt, India, and South Korea*. PhD dissertation, University of Southern California.

Slantchev, Branislav L. 2003. "The Power to Hurt: Costly Conflict with Completely Informed States." *American Political Science Review* 97(1):123–133.

Snyder, Glenn H. and Paul Diesing. 1977. *Conflict Among Nations: Bargaining, Decision Making and System Structure in International Crises*. Princeton: Princeton University Press.

von Clausewitz, Carl. 1984. *On War*. Princeton: Princeton University Press.

Wagner, R. Harrison. 1991. "Nuclear Deterrence, Counterforce Strategies, and the Incentive to Strike First." *American Political Science Review* 85(3):727–749.

Wagner, R. Harrison. 2000. "Bargaining and War." *American Journal of Political Science* 44(3):469–484.

Waltz, Kenneth N. 2003. Nuclear Stability in South Asia. In *The Spread of Nuclear Weapons: A Debate Renewed*, ed. Scott D. Sagan and Kenneth N. Waltz. New York: W. W. Norton & Co. pp. 263–273.

Werner, Suzanne. 2000. "Deterring Intervention: The Stakes of War and Third-Party Involvement." *American Journal of Political Science* 44(4):720–732.

Zagare, Frank C. and D. Marc Kilgour. 2000. *Perfect Deterrence*. Cambridge: Cambridge University Press.