The Nuclear Balance and International Conflict

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Abstract
There is reason to believe that the nuclear balance between states is an important determinant of international conflict, but recent international relations scholarship either ignores nuclear weapons altogether or treats nuclear possession exclusively as a characteristic of individual states. Scholars have not articulated a clear logic linking a strategic nuclear advantage to deterrence outcomes, nor have they systematically analyzed the relationship between the nuclear balance and international conflict. We argue that a nuclear advantage, by increasing the expected costs of conflict, improves a state’s ability to deter potential adversaries. Using a new data set on nuclear force posture, which includes information on nuclear arsenal size and delivery vehicles from 1945 to 2001, we show that states that enjoy nuclear superiority over their opponents are less likely to be the targets of militarized challenges. Arguments that contend that a minimum deterrent posture reduces the probability of militarized challenges find only qualified support in the data. This article brings the nuclear balance back into studies of international conflict.

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In 1956, Paul Nitze, a senior defense and foreign policy official in many U.S. presidential administrations, argued that it was “of the utmost importance that the West maintain a sufficient margin of superior capability…The greater the margin (and the more clearly the Communists understand that we have a margin), the less likely it is that nuclear war will ever occur.”¹ For over a half-century, politicians, policymakers, and defense intellectuals have argued that a favorable nuclear balance – an advantage in the size and sophistication of one’s nuclear arsenal relative to that of an opponent – provides a state with a deterrent advantage.² While many others claimed that the possession of a secure second-strike capability provided a sufficient deterrent, and that the pursuit of nuclear superiority was costly, unnecessary, and even dangerous, arguments about the benefits of nuclear superiority featured prominently in Cold War and post-Cold War debates about deterrence, nuclear force sizing, the nuclear arms race, and international arms control agreements in the United States and elsewhere.³ Consistent with this perspective, earlier scholarship examined the role that the nuclear balance of power may have played in specific historical cases.⁴ Indeed, at present, while the United States reduces the size of its arsenal, other countries around the world continue to pursue nuclear superiority over regional rivals in the apparent hope that a favorable nuclear balance may enhance their national security.⁵

There is good reason to suspect, therefore, that the nuclear balance between states may be an important factor in international politics. Yet recent international relations scholarship has not taken the nuclear balance seriously. Many exclude nuclear weapons altogether from their analyses of international conflict.⁶ Studies on the specific topic of nuclear deterrence have tended to assess simply whether or not a country possesses
nuclear weapons, but not the character of the nuclear balance between states. Indeed, this
narrow focus on nuclear possession is common to all of the major methodological
approaches to international relations and includes the leading quantitative, qualitative,
and formal theoretical studies.\(^7\) Even more sophisticated recent treatments of nuclear
posture detail the nuclear doctrines and capabilities of individual states, but not the
nuclear balance between states.\(^8\) This oversight is puzzling given that it is standard
practice for international relations scholars to account for the conventional military
balance between states in academic studies of international conflict.\(^9\)

The nuclear balance has likely been overlooked for four reasons: (1) a lack of
available data on the nuclear force posture of every country in every year made it difficult
to quantitatively analyze the nuclear balance between states; (2) scholars have developed
compelling arguments about why the mere possession of nuclear weapons, regardless of
the details of the strategic nuclear balance, provides an effective deterrent, (3) theorists
have not articulated a clear rationale as to why nuclear superiority might further reduce
the incidence of armed conflict; and (4) moral trepidation may have restrained scholars
from exploring the potential benefits of large nuclear arsenals. We show instead that the
incorporation of the nuclear balance into the analysis of nuclear deterrence is critical for
understanding the initiation of international conflict.

To examine the relationship between the nuclear balance and deterrence, we
propose an explanation, grounded in a nuclear brinkmanship theory framework, which
links nuclear superiority to the frequency of militarized challenges. We argue that a
strategic nuclear advantage increases the expected costs that a state can impose on a
challenger in the event of a conflict and, therefore, decreases the probability that a
country will become the target of militarized interstate disputes. A militarized challenge against a nuclear-armed state is not an unavoidable leap into nuclear war, but is rather “a threat that leaves something to chance.” In other words, there is a low, but nonzero probability that a conflict with a nuclear-armed rival could escalate into a nuclear exchange. The payoff of challenging a nuclear-armed state, therefore, is a function of a number of factors, including the expected cost of nuclear war. While the expected cost of any nuclear war is high, not all nuclear wars would necessarily be equally devastating. Countries that possess a nuclear advantage can inflict greater levels of damage on their adversaries, raising the expected costs of war. For this reason, states that possess nuclear superiority are, on average, less likely to become the targets of militarized challenges.

Drawing on a new data set of nuclear force posture of every state in the international system from 1945 to 2001, we examine the impact of nuclear superiority on the probability of becoming the target of a militarized interstate dispute. We find a powerful, negative relationship between the nuclear balance and the frequency of militarized challenges. Countries that enjoy nuclear superiority over their opponents are less likely to be targeted in militarized disputes. These findings hold after controlling for conventional military capabilities, the possession of a secure-second strike capability, and other confounding factors. The relationship between nuclear superiority and deterrence also holds in tests performed in a subsample of nuclear-armed states and even in a subsample of states with large nuclear arsenals. In addition, the results are robust to the exclusion of each individual country, alleviating concerns that the results are being driven by any single state.
We find qualified support for the idea that a minimum nuclear posture reduces the probability of military challenges. Countries that possess nuclear weapons, or a secure second-strike capability, are less likely to be the targets of militarized challenges, but this effect disappears when one controls for the nuclear balance between states. This suggests that the possession of a minimum deterrent reduces the probability of being challenged by nonnuclear weapons states or by nuclear weapon states with smaller nuclear arsenals, but that it does not decrease one’s chances of being challenged by nuclear weapon states with relatively larger nuclear arsenals. If one wishes to explain the probability of militarized challenges, therefore, one must look to the nuclear balance between states, not simply the nuclear capabilities of the target state.

By bringing the nuclear balance back into studies of international conflict, our contribution is fourfold. We develop a new theoretical explanation for how a nuclear advantage can reduce the probability of militarized interstate disputes through its effect on the expected costs of conflict. Next, we provide a new dataset on the nuclear capabilities of all states from 1945 to 2001 that can be employed by future scholars interested in examining the sources and consequences of nuclear force posture. Third, we suggest that a proper analysis of militarized interstate dispute initiation, and perhaps other aspects of international conflict, such as crisis escalation and crisis outcomes, requires a consideration of the nuclear balance of power between states. Fourth, these findings are highly relevant for policy debates about arms control, nuclear disarmament, and nuclear force sizing. Our research suggests that a nuclear advantage over a rival will reduce the probability that a country will become the target of a military challenge. One must be careful, however, before drawing any facile conclusions. The results presented here do
not imply that states should pursue nuclear superiority. As we elaborate in the conclusion of this article, there are also potentially many disadvantages to the possession of large nuclear arsenals and policymakers must carefully weigh the full range of costs and benefits before making any force sizing decisions.

**Explaining Nuclear Deterrence**

For decades during the Cold War, strategic thinkers argued that the nuclear balance between states was critical to maintaining a credible deterrent.\(^{11}\) They claimed that if one state would suffer significantly less damage in the event of nuclear war than its adversary, it might not be deterred. To account for this perspective, scholars in the past considered the possible effects of the nuclear balance in case studies of deterrence and deterrence failure, such as the Cuban Missile Crisis.\(^ {12}\)

Many other scholars, however, criticized those writing on the nuclear balance for failing to articulate a clear logic by which nuclear superiority might affect deterrence effectiveness. As Charles Glaser argues, “the logical case” for the argument that nuclear superiority enhances deterrence “is weak, proponents have done little to support their claims, and efforts to fill in the logical gaps in their arguments encounter overwhelming difficulties.”\(^ {13}\) Similarly, Robert Jervis claims that in a world of mutually assured destruction, “if one tries to argue…that denying the Russians any [nuclear] advantage contributes strongly to deterrence and may even be necessary for it—problems abound.”\(^ {14}\)

Over the past two decades, international relations scholarship has largely ignored the possible effects of the strategic nuclear balance on international politics. Scholars
have studied the effect of nuclear weapons possession, but not the nuclear balance between states. This is true of the leading scholarship in the quantitative, qualitative, and formal theoretical research traditions.

Many statistical analysis of international conflict exclude nuclear weapons from their analyses altogether.\textsuperscript{15} Other researchers include nuclear possession as a right-hand side variable, but do not account for the details of the nuclear balance in their studies.\textsuperscript{16} As Gartzke and Kroenig write in the introduction to a recent special issue on the quantitative study of nuclear weapons, “Nuclear weapons possession is a key independent variable. These articles seek to understand how the possession of nuclear weapons influences state behavior…We do not focus on increases in the number of nuclear warheads within nuclear-armed states.”\textsuperscript{17}

In the “optimism-pessimism” debate, analysts study cases of nuclear proliferation to examine whether the presence of nuclear weapons increases or decreases the likelihood of international conflict, but they do not analyze how the nuclear balance affects deterrence outcomes.\textsuperscript{18} While they tangle over many issues, scholars in this research tradition generally concur with Kenneth Waltz when he writes, “Given second-strike capabilities, it is not the balance of forces, but the possibility that they may be used that counts. The balance or imbalance of strategic forces affects neither the calculation of danger nor the question of whose will is stronger.”\textsuperscript{19} Similarly, in a special issue of \textit{World Politics}, leading theorists debated rational deterrence theory and the appropriate methodological strategies for assessing it, but did not consider how the nuclear balance between states affects deterrence outcomes.\textsuperscript{20} More recently, scholars have begun to incorporate more sophisticated understandings of nuclear posture into studies of
deterrence. Vipin Narang, for example, has analyzed how Pakistan’s nuclear doctrine and posture affects South Asian stability, and Keir Lieber and Daryl Press have tracked how developments in the Soviet nuclear arsenal affected U.S. nuclear war planning. These studies focus on the nuclear force posture of the defending state only, however, and do not consider how the nuclear balance between states affects patterns of militarized challenges. In addition, these qualitative studies are limited in both historical and geographic scope.

Similarly, game theorists have developed formal models of deterrence in which the distribution of capabilities plays an important role, but these scholars do not distinguish between conventional and nuclear capabilities, nor do they specifically discuss the nuclear balance. Even those focusing explicitly on nuclear competition do not include the nuclear balance in their models. Rather, they assume that both states possess secure, second-strike capabilities and that the cost of nuclear war is, therefore, equally devastating for both sides. These assumptions are made despite the fact that many nuclear-armed states do not possess second-strike capabilities and that many leading nuclear strategists have argued that an imbalance in nuclear forces, even among states with second-strike capabilities, can make nuclear war more costly for some states than for others.

In sum, the state-of-the-art research in international relations treats nuclear weapons possession largely as a dichotomous variable and as a monadic-level, not dyadic-level, characteristic. In other words, the literature does not explore how the balance of nuclear forces affects deterrence outcomes.
Theory: The Nuclear Balance and International Conflict

In this section we develop a theoretical framework linking the nuclear balance to patterns of international conflict. We argue that countries will be less likely, on average, to challenge states that possess a nuclear advantage because the expected costs of a full-scale war with a nuclear superior state are greater than the expected costs of a major war with other states.

We begin from a nuclear brinkmanship framework. Brinkmanship theorists recognize that states cannot credibly threaten a suicidal war against a nuclear-armed state, but they can make a “threat that leaves something to chance.” They can challenge a nuclear-armed adversary in the hope that the adversary will prefer to concede the contested issue before the crisis results in a costly nuclear war. Nevertheless, because a nuclear exchange could always result from accident or inadvertent escalation in the midst of a crisis, statesmen understand that such a challenge could, with some low, but nonzero probability, result in a nuclear exchange. Therefore, a state’s expected utility to initiating a military challenge is in part a function of the expected cost of fighting a full-scale war if the dispute escalates. There are, of course, a number of possible outcomes of a militarized dispute: the targeted state might back down, resulting in a victory for the initiator; the initiating state itself might submit and suffer a geopolitical defeat; the targeted state might reciprocate the dispute leading to the imposition of costs on the initiating state in the form of economic sanctions or limited military conflict; or, finally, the dispute might escalate into a full-scale war. As a state considers the initiation of a military challenge, therefore, it calculates the payoffs from, and the probabilities of arriving at, all of these possible outcomes. As the expected utility to be derived from
initiating a militarized challenge decreases, countries will be less likely to choose dispute initiation. The greater the expected costs of a full-scale war, holding other factors constant, the lower a state’s expected payoff to initiating a militarized challenge. The greater the costs of war against a particular state, therefore, the less likely other states will be to challenge it.

We hypothesize that states will be less likely, on average, to challenge nuclear superior states because wars against nuclear superior states carry greater expected costs. To aid in this task, we draw on two insights well developed in the nuclear strategy literature. First, nuclear strategists recognize that not all nuclear wars would be equally devastating. To calculate the varying effects of nuclear war, analysts consider factors such as total number of deaths and casualties, economic destruction, expected length of time for society to recover from war, and all of these factors relative to an opponent. As Herman Kahn argued, “Few people differentiate between having 10 million dead, 50 million dead, or 100 million dead. It all seems too horrible. However, it does not take much imagination to see that there is a difference.” For Kahn, nuclear war scenarios in which a country suffers 10 million deaths and requires 5 years to regain prewar levels of economic output versus one with 80 million deaths and 50 years of economic recuperation are “tragic, but distinguishable” outcomes.

Nuclear strategists also draw distinctions between postwar outcomes often considered to be in the realm of mutually assured destruction. For example, at the height of the Cold War, defense analysts argued that even if the Soviet Union could destroy all major U.S. cities in a nuclear attack, it might be prevented from killing U.S. citizens living in small and medium-sized cities as well as rural and outlying areas, and that the
United States had both a strategic incentive and a moral responsibility to protect these lives.  

Second, nuclear strategists recognize that nuclear superiority reduces the expected costs that a country would incur in the event of nuclear war. As Charles Glaser elaborates in his study of U.S. nuclear strategy, analysts in the “damage limitation school” maintain that U.S. nuclear “superiority would reduce the cost to the United States in an all-out nuclear war.”  

States plan for counterforce nuclear targeting, i.e., using nuclear weapons to destroy the nuclear weapons of an opponent, in an attempt to limit the damage that the opponent could impose in a nuclear attack. According to then U.S. Secretary of Defense Harold Brown, “we have always considered it important, in the event of war, to be able to attack the forces that could do damage to the United States and its allies.” States that enjoy nuclear superiority are expected to perform better in counterforce exchanges because they have more firepower with which to blunt the retaliatory capability of their opponents.

In sum, strategic nuclear analysts and defense planners assess that some nuclear wars might be more devastating than others, and that nuclear superiority limits the expected damage that a country would incur in the event of a nuclear exchange.

Incorporating these insights into the expected utility framework of militarized challenges elucidated above, we should expect that the costs of challenging a nuclear superior state are greater than the expected costs of challenging other states for two reasons. First, in a complete nuclear exchange, a country in a position of nuclear inferiority will absorb more nuclear strikes than its nuclear superior opponent because it possesses a smaller nuclear arsenal. At present, for example, it is estimated that China
possesses only about 20 nuclear warheads capable of reaching the United States,\textsuperscript{37} while the United States maintains roughly 1,550 deployed nuclear weapons that could be delivered to targets in China.\textsuperscript{38} It is clear that while both sides would strongly prefer to avoid nuclear war, in the event of a Sino-U.S. nuclear exchange, China would suffer disproportionately.

Second, because a nuclear inferior state has fewer weapons with which to conduct a counterforce campaign, it will have less ability to blunt the firepower of its opponent, further increasing its expected costs of conflict. In sum, the expected costs of challenging a nuclear superior state are greater than the expected costs of challenging other states. We should expect, therefore, that, on average, states would be less likely to challenge countries that possess a strategic nuclear advantage. This logic leads us to our first hypothesis:

Hypothesis 1: States that enjoy nuclear superiority over opponents are less likely to become the targets of militarized challenges.

The degree and not simply the existence of nuclear superiority, however, might also affect deterrence outcomes. The greater the degree of nuclear superiority a target state possesses over a potential challenger, the greater the expected costs of a nuclear exchange for the challenger. A larger degree of nuclear superiority enhances a state’s ability to conduct a counterforce nuclear war and increases the damage that it could impose on its adversary. This discussion brings us to our second hypothesis:
Hypothesis 2: The greater the degree of nuclear superiority states possess over their opponents, the less likely those states are to become the targets of militarized challenges.

There is strong evidence that throughout the Cold War, U.S. policymakers believed that some nuclear wars would be worse than others, that a nuclear advantage translated into an ability to inflict greater levels of damage on one’s adversary, and that maintaining nuclear superiority was, therefore, critical to deterring the Soviet Union. For example, a secret White House memorandum from 1972 claimed that Washington must maintain a large enough nuclear arsenal “to ensure that the United States would emerge from a nuclear war in discernibly better shape than the Soviet Union.”  

Similarly, then Secretary of Defense Melvin Laird argued that avoiding a position of nuclear inferiority vis-à-vis Moscow was necessary for “preventing the Soviet Union from gaining the ability to cause considerably greater urban/industrial destruction than the United States would in a nuclear war.” In 1977, then Secretary of Defense Donald Rumsfeld testified, “if the Soviet Union could emerge [from a nuclear war] with superior military power, and could recuperate from the effects more rapidly than the United States, the U.S. capability for assured retaliation would be considered inadequate.” Finally, then Secretary of the Air Force Harold Brown argued that “even 25% casualties might not be enough for deterrence if U.S. casualties were disproportionately higher—if the Soviets thought they would be able to recover in some period of time while the U.S. would take three or four times as long, or would never recover, then the Soviets might not be deterred.”
In sum, deductive logic and illustrative historical evidence suggest that countries with nuclear superiority over their opponents possess a more effective nuclear deterrent and will be less likely to be challenged militarily.

The strongest counterargument to these claims is that a minimum deterrent posture, or a secure second-strike capability, is sufficient to deter militarized challenges. Scholars in the minimum deterrence school argue that countries will be extremely unlikely to initiate a militarized dispute against a nuclear-armed state because any nuclear exchange would carry unacceptable costs.\(^{43}\) Therefore, they argue, the possession of nuclear weapons is sufficient to deter a potential military challenger. Other scholars in the same basic tradition place the bar for successful nuclear deterrence slightly higher.\(^{44}\) They argue that a country can successfully deter military challenges once it possesses a secure, second-strike capability – the ability to absorb a nuclear attack from an opponent and maintain enough survivable nuclear forces to launch a devastating counterattack. Again, the logic is similar. No country would choose to initiate a military conflict that could potentially result in unacceptable nuclear retaliation. According to this perspective, nuclear-armed states should rarely become the targets of militarized challenges, regardless of whether they possess a nuclear advantage over their opponents.

There are, however, reasons to be skeptical that a minimum nuclear posture provides an absolute deterrent. While nuclear weapons raise the costs of war, they do not eliminate political competition among states.\(^{45}\) States still seek to coerce nuclear-armed adversaries. While they cannot threaten to launch a suicidal nuclear war, they can “make a threat that leaves something to chance.”\(^{46}\) States can initiate a process, the nuclear crisis, in an attempt to force a less resolved opponent to back down. States, therefore, will
be willing to challenge nuclear-armed states if they believe that the benefits of such a challenge (e.g., that the nuclear-armed target will likely capitulate rather than fight over the contested issue) outweigh the costs (including the damage from a nuclear war scaled by some low, but nonzero probability that nuclear war will occur). Thus, approaching nuclear deterrence from a brinkmanship framework casts doubt on claims that a minimum nuclear posture provides an unimpeachable deterrent against every potential challenger.

Nevertheless, to test these ideas, we control for both a minimum deterrent posture and a secure second-strike capability in the empirical analysis. There are a number of other factors that have been identified as potential causes of interstate conflict. We discuss these variables in the next sections, in which we describe the data and examine the evidence for the previous hypotheses.

**Nuclear Force Posture Data**

To examine the effect of nuclear posture on deterrence outcomes, we construct an original nuclear force posture data set. The data set contains yearly information on nuclear weapon status, nuclear arsenal size, and second-strike capabilities for every state in the international system from 1945 to 2001.\textsuperscript{47} The unit of analysis is the directed-dyad year. Directed-dyads make it possible to distinguish between the behavior of the initiator and the target, providing additional information about causal processes.\textsuperscript{48} Because many states in the international system do not have a meaningful opportunity to fight one another, we focus our analysis on politically-relevant dyads.\textsuperscript{49}

The dichotomous dependent variable is *Militarized challenge*.\textsuperscript{50} Drawing from the
Correlates of War (COW) Militarized Interstate Disputes (MID) data set, this variable is coded 1 if a country in a directed-dyad year is the target of a MID from a potential challenger state, and 0 otherwise. 51 MIDs include threats to use force, shows of force, uses of force, and war. A total of 1,534 MIDs were initiated between 1945 and 2001, with 1,258 MIDs initiated in that same time period among the subset of politically-relevant dyads.

We construct independent variables to test the hypotheses explicated previously. To assess whether countries that enjoy nuclear superiority over their opponents are less likely to become the targets of militarized disputes, we generate *Nuclear superiority*. This dichotomous variable indicates whether a potential target state possessed a larger number of nuclear warheads than a potential challenger state in a directed-dyad year. To begin the construction of this variable, we gathered detailed information on the size of nuclear arsenals in each nuclear weapon state in every year from 1945 to 2001. A list of nuclear-armed states from 1945 to the present is available in Table 1. Appendix A provides information on the coding rules and sources used to calculate nuclear arsenal sizes. Among those states possessing nuclear weapons, the size of nuclear arsenals ranges from a low of one (e.g., South Africa in 1979) to a high of 40,723 (Soviet Union in 1986). Using this information, we code a binary variable to indicate whether a potential target state had more nuclear weapons than a potential challenger state in each directed-dyad year.

(Insert Table 1 here)
These data aim to provide an objective assessment of the number of nuclear weapons that a country possessed at any given time. In the realm of deterrence, however, what might be most important is not the actual nuclear balance, but an adversary’s perception of the nuclear balance. Fortunately, there is very good reason to believe that there is a tight correspondence between the actual and the perceived nuclear balance. While policymakers might not possess information about the exact number of nuclear warheads in a rival state, they generally understand which state enjoys the strategic advantage and the rough size of that advantage. Even during the now notorious Cold War debates about a possible “bomber gap” and a “missile gap” with the Soviet Union, U.S. policymakers possessed fairly accurate information about the actual nuclear balance. Fears of a gap, which later turned out to be incorrect, were based on projections of the future, not the contemporary, nuclear balance and were the result of faulty assessments about the rate at which the Soviet Union was expanding its strategic forces. In sum, an objective count of nuclear arsenal size and thus the strategic nuclear balance provides a reasonable measure of how states perceived the nuclear balance at any given time.

Nuclear analysts often consider additional factors when calculating the nuclear balance between states, including: total megatonnage of the nuclear arsenal, nuclear weapon yields, numbers of delivery vehicles, accuracy of delivery vehicles, and the ability of command and control systems to execute war plans in a crisis. Aggregating these factors into a nuclear superiority index might be desirable, but detailed information on these variables is not available for every nuclear weapon state in every year. Moreover, nuclear arsenal size, the variable measured in this study, is generally regarded as the most important element of any country’s nuclear force posture. Finally, there is
good reason to believe that simple warhead counts and more complicated assessments of nuclear capabilities are highly correlated. For example, according to almost any measure, the United States enjoyed nuclear superiority over the Soviet Union from 1945 until the mid-1970s, at which point Moscow achieved parity with, and arguably gained a strategic edge over, Washington.53

To examine the idea that the greater the level of nuclear superiority a country possesses over its opponent the less likely it will be challenged, we construct Nuclear ratio. Nuclear ratio is calculated as the number of nuclear weapons possessed by the potential target divided by the total number of nuclear weapons in the combined arsenals of the potential target and the potential challenger. The theoretical and empirical range of this variable is from 0 to 1.

To test the idea that a minimum nuclear posture, or a secure, second-strike capability, reduces the probability of military challenges, we create two variables. The first, Nuclear possession, is a dichotomous variable gauging whether a country possesses nuclear weapons. Drawing on nuclear proliferation dates from Gartzke and Kroenig, we code this variable 1 for each year in which a potential target state possesses at least one deliverable nuclear weapon, and 0 otherwise.54

To give the minimum deterrence argument its fullest possible test, we create a second variable. Second strike is a dichotomous variable assessing whether a country has the ability to absorb a nuclear attack from an opponent and maintain enough reserve nuclear forces to respond with a devastating nuclear counterattack. We code a country as possessing a secure, second-strike capability if it possesses either SLBMs, mobile missiles with ranges capable of reaching the territory of an “enduring rival,” or maintains
nuclear-armed aircraft on continuous airborne alert.\textsuperscript{55} To code this variable, information was taken from a variety of sources, including \textit{The Bulletin of the Atomic Scientists}, the Federation of American Scientists, the National Resources Defense Council, and the Nuclear Threat Initiative. Countries that developed a secure, second-strike capability between 1945 and 2001, according to this definition, include: the Soviet Union, 1956;\textsuperscript{56} the United States, 1960;\textsuperscript{57} Great Britain, 1968;\textsuperscript{58} Israel, 1970;\textsuperscript{59} France, 1973;\textsuperscript{60} China, 1986;\textsuperscript{61} Pakistan, 1995;\textsuperscript{62} and India, 1995.\textsuperscript{63}

We also include a number of control variables. To control for differences in scale and possible aggregation biases, we include a lower-order term, \textit{Total nuclear weapons}, that counts the total number of nuclear weapons within a dyad.\textsuperscript{64} Countries with a conventional military advantage might be better able to deter militarized challenges.\textsuperscript{65} To gauge the conventional military balance between states, we generate \textit{Capabilities}. We employ a power ratio variable, which assesses the capabilities of the potential target state, divided by the total combined capabilities of both the potential target and the potential challenger.\textsuperscript{66} \textit{Capabilities} is a composite index containing information on total population, urban population, energy consumption, iron and steel production, military manpower, and military expenditures. Data for this variable are drawn from the Correlates of War composite capabilities index, version 3.02, and extracted using EUGene.\textsuperscript{67}

Countries in threatening security environments may be more likely to experience militarized disputes. To control for the severity of a state’s security environment and to correct for potential autocorrelation in the dependent variable, we generate \textit{Security}.\textsuperscript{68}
This variable provides a running average of the number of MIDs a state experiences per year.\textsuperscript{69}

The democratic peace hypothesis holds that the presence of joint democracy drastically reduces the probability of conflict.\textsuperscript{70} To measure \textit{Joint democracy}, we use Polity scores, drawn from the Polity IV data set.\textsuperscript{71} The binary variable codes whether both states in a given dyad possess a Polity score of seven or greater.\textsuperscript{72}

States in close geographic proximity are more likely to fight with one another.\textsuperscript{73} To control for the confounding effect that geography may have on the likelihood of MID initiation, we create \textit{Contiguity}, an ordinal variable identifying geographic proximity on a six-point scale.\textsuperscript{74} We also code a \textit{Distance} variable, which measures distance in miles between countries in a dyad.

The commercial peace literature contends that trade dependence has a dampening effect on the onset of conflict.\textsuperscript{75} To capture this factor, we include in our models \textit{Trade dependence}.\textsuperscript{76} This variable measures the sum of a potential challenger’s exports and imports with a potential target, divided by the potential challenger’s gross domestic product (GDP).

Some scholars argue that states that are economically open to the international system are less likely to fight,\textsuperscript{77} while others hold that global trade can increase violent conflict.\textsuperscript{78} We generate \textit{Economic openness} to gauge the potential challenger’s openness to the international economic system. The variable measures total trade (imports plus exports) of the potential challenger divided by the potential challenger’s GDP.\textsuperscript{79} Summary statistics are presented in Table 2.
Data Analysis

We employ probit models to test claims about the correlates of militarized challenges. Robust standard errors are adjusted for clustering by dyad to correct for interdependence of observations. We estimate each model after including cubic polynomials to account for temporal dependence in the dependent variable. Table 3 presents the results.

First, we explore the hypothesis that states that enjoy nuclear superiority over their opponents are less likely to be the targets of militarized challenges. Turning to Table 3, we find strong support for this hypothesis. We see that Nuclear superiority is negative and statistically significant in a fully-specified model (3), when nested in a model that includes Nuclear possession and Second strike (models 4 and 5, respectively), and in a trimmed model (6). The analysis reveals a strong empirical link between nuclear superiority and militarized challenges. Countries that enjoy nuclear superiority over their potential opponents are less likely to be the targets of militarized disputes.

Assessing the effect of a nuclear advantage over an opponent, however, is only the first step. Next we explore the hypothesis that the greater the degree of nuclear superiority that a country possesses over its opponent, the less likely it is to face militarized challenges. Turning to Table 4, we find strong support for this idea. The relationship between Nuclear ratio and Militarized challenge is negative and statistically
significant when *Nuclear ratio* is included in a fully-specified model (7), when nested in models with *Nuclear possession* and *Second strike* (models 8 and 9, respectively), and in a trimmed model (10). These findings demonstrate that as a state’s share of nuclear weapons within a dyad increases, it becomes increasingly less likely to be the target of a militarized challenge.

(Insert Table 4 here)

Using *Clarify*, we assess the substantive effect of shifting from a nuclear disadvantage to a nuclear advantage on the expected probability of being targeted in a MID, after controlling for other factors. Figure 1 plots the conditional effects of the nuclear balance on the expected probability that a state will be challenged, for states at varying levels of conventional military power relative to their opponents. At the left-hand side of the figure, we can see that the expected probability of being the target of a MID in a given directed-dyad year for a state that possesses 5% of the total number of nuclear weapons in the dyad, holding all other factors including the conventional military balance at their mean, is 0.006. As we move to the right of the figure, however, we see that an increase in the proportion of nuclear weapons that a state possesses within a dyad results in a corresponding decrease in the likelihood of being challenged. Indeed, at the far right-hand side of the figure, we can see that a country that possesses 95% of the total number of nuclear weapons within the dyad, holding other variables at their mean, has an expected probability of 0.001 of having a MID initiated against it. Therefore, states that possess only 5% of the total number of nuclear weapons within the dyad are roughly six
times more likely to be challenged in a MID than those states that possess 95% of the total number of nuclear weapons in the dyad.\textsuperscript{85} There is strong support for the hypothesis that countries with greater levels of nuclear superiority over their opponents are less likely to be the targets of MID initiation.

The figure also demonstrates that an increase in the nuclear balance of power reduces the probability of military challenges both for states with a conventional military advantage and a conventional military disadvantage relative to their opponents. Moreover, it shows that the deterrent benefit of conventional military power (illustrated by the gap between the probabilities of a challenge for states in a position of conventional superiority versus those in a position of conventional inferiority) decreases as a state’s share of nuclear weapons increases.

(Insert Figure 1 here)

The idea that states that possess a minimum nuclear posture are less likely to be challenged finds only qualified support in the data. In models 1 and 2, we see that Nuclear possession and Second strike are negative and statistically significant. This finding suggests that the possession of a minimum nuclear capability reduces the probability that a country will be challenged militarily. Turning to the other models, however, we see that this finding washes away when one takes into account the nuclear balance between states. Second strike is no longer statistically significant in models 5 and 9. Nuclear possession is statistically significant in models 4 and 8, but the sign on the coefficient is positive, suggesting that after the nuclear balance between states is taken into account, nuclear weapon states may be more, not less, dispute prone. Taken together,
these findings suggest that a minimum nuclear posture might reduce the probability of being challenged by nonnuclear weapon states, or by nuclear-armed states with smaller nuclear arsenals, but that a minimum nuclear posture does not reduce the probability that a country will be challenged by nuclear-armed states with larger nuclear arsenals.\textsuperscript{86}

We briefly comment on the control variables. \textit{Capabilities} is statistically significant and negative in every model, demonstrating that states that are militarily stronger relative to a potential challenger are less likely to be targeted in a MID. \textit{Security} is statistically significant and positive in every model in which it is included, suggesting that states in dangerous neighborhoods are more likely to become the targets of militarized disputes. In support of the democratic peace hypothesis, we find that dyads in which both states are democracies are less likely to see conflict than dyads that include at least one non-democratic state. The sign on the coefficient for \textit{Joint democracy} is negative and statistically significant in each and every model. \textit{Contiguity} is significant and negative in every model, providing support for the idea that territorially contiguous dyads are more conflict prone. As expected, \textit{Distance} is significant and negatively correlated with military challenges. \textit{Economic openness} is significant and positive in every model, suggesting that states with greater ties to the world economy are more likely to be the targets of militarized disputes. The other control variables do not reach statistical significance. \textit{Total nuclear weapons} and \textit{Trade dependence} do not appear to shape a state’s likelihood of becoming the target of a militarized challenge.

The analysis of the relationship between nuclear superiority and militarized challenges among all politically-relevant dyads is only the first step, however. Next, we conduct a similar analysis on the subset of nuclear-armed states. These tests will allow us
to further examine the central hypothesis of this article. If nuclear superiority provides states with a deterrent advantage, we should expect this relationship to also hold in an analysis of nuclear-armed states. This set of tests also permits us to explore the idea that a minimum nuclear posture provides a sufficient deterrent. If additional increases to the size of a state’s nuclear arsenal above and beyond a minimum deterrent are simply overkill, then we should expect to find no relationship between the nuclear balance and the probability of militarized challenges among a subset of nuclear-armed states. To test these ideas, we repeated the above analysis on a subsample of 1,028 directed-dyad years from 1945 to 2001 in which both states in the dyad possessed at least one nuclear weapon.

As we can see in Table 5, Nuclear ratio is negative and statistically significant in the subsample of nuclear-nuclear dyads. Among nuclear weapon states, the greater the level of nuclear superiority over a potential opponent, the less likely a country is to be challenged militarily. This finding provides strong support for the central hypothesis of this article. Nuclear superiority provides a deterrent advantage against nuclear as well as nonnuclear opponents. In contrast to the claims of those in the minimum deterrence school, the results indicate that increases in the size of a state’s nuclear arsenal above and beyond a minimum nuclear posture continue to reduce the probability of being challenged militarily by other nuclear-armed states.

(Insert Table 5 here)

In turning to the control variables, it is worth noting that Capabilities does not reach
statistical significance. We saw above that the conventional military balance is an important determinant of conflict among all states, but this finding suggests that conventional military strength is less important than the nuclear balance for explaining military challenges among the subsample of nuclear-armed states.

**Robustness Tests**

This section presents the results of a number of robustness tests. First, we examined whether our results depended on the definition of the universe of cases. We performed the above analysis on politically-relevant dyads, but to assess whether the results were contingent on this choice, we repeated the above analysis using the entire universe of dyad-years. The negative relationship between nuclear superiority and the probability of a militarized challenge remained in tests among this broader sample.

Second, we tested whether our results were robust to the measurement of the dependent variable. The above tests examined the deterrent effect of nuclear weapons on the initiation of all MIDs, ranging from threats to use force to full-scale war. However, one could argue that the threat of nuclear war, and therefore the relationship between the nuclear balance and conflict, might be most relevant in higher-level military challenges. To examine this idea, we repeated the above analysis after defining a militarized challenge to include uses of force or full-scale war only. In all tests using higher-level militarized challenges as our dependent variable, *Nuclear superiority* and *Nuclear ratio* remained negative and statistically significant, indicating that a country with a nuclear advantage over an opponent is less likely to experience higher-level military challenges.
As might be expected, the substantive effect of Nuclear ratio on MID initiation was even slightly larger when looking at the most intense international disputes.  

Third, to assess whether the results were contingent on the inclusion or coding of any particular country, we removed each country in turn from the first position of the directed-dyad, the challenger position, and re-estimated the models. We then removed each country from the second position, the target position, and re-estimated the models. Next, we sequentially removed each state from the data set completely, from both the challenger and target positions, and re-estimated the models. Finally, to assess whether the results were being driven by the superpowers, we removed all observations including the United States and the Soviet Union from the data set and re-estimated the models, using only the observations among non-superpowers. In all of the above tests, the core results were unaltered. Nuclear superiority and Nuclear ratio were negative and statistically significant in each and every model. The core results are not being driven by any single country observation.

Finally, to ensure that the nuclear balance between states reduces the likelihood of militarized challenges when both states possess substantial nuclear arsenals, we estimate the full range of models on a subsample of directed-dyad years in which both states possess at least 100 nuclear weapons. Additionally, we re-estimate these models when restricting our sample to only those directed-dyad years between the United States and the Soviet Union. In both sets of tests, Nuclear superiority and Nuclear ratio were negative and statistically significant. The results are not being driven by observations in which the target state possesses a small and vulnerable nuclear arsenal.
Discussion and Conclusion

This article examined the relationship between the nuclear balance and international conflict. We found that states that enjoy nuclear superiority over their opponents are less likely to be the targets of militarized disputes. This finding held under a variety of model specifications and robustness tests. We derived a new theoretical implication of nuclear deterrence theory to account for the observed relationship between nuclear superiority and deterrence success. We argued that a nuclear exchange with a nuclear superior state is potentially more devastating than a major war with other states. While nuclear war is an unlikely outcome of a military challenge against a nuclear-armed state, there is some nonzero probability that a “threat that leaves something to chance” could result in a nuclear exchange. A nuclear advantage increases the expected cost of conflict for an opponent and, therefore, reduces the probability that one will become the target of a militarized challenge.

We find some support for the idea that a minimum nuclear posture reduces the probability of military challenges, but this effect disappears when one controls for the nuclear balance between states. This indicates that the possession of a minimum nuclear deterrent reduces the probability of being challenged by nonnuclear weapons states or by nuclear weapon states with smaller nuclear arsenals, but that it does not decrease one’s chances of being challenged by nuclear weapon states with larger nuclear arsenals. To understand international conflict, therefore, scholars must take into account the nuclear balance between states, and not simply the unilateral nuclear capabilities of a given state.

The argument of this article began with a simple insight, grounded in the nuclear deterrence literature, that nuclear superior states possess a deterrent advantage. For
decades, leading scholars have argued that nuclear weapons completely and irrevocably altered the nature of international conflict. Unlike in previous eras, when larger militaries translated into greater political influence, it was thought that the introduction of nuclear weapons brought about a “nuclear revolution” in military affairs. Once a state had acquired a secure-second strike capability, additional nuclear weapons were thought to be irrelevant to a state’s ability to deter adversaries. The empirical results of this article suggest that conflict in the nuclear age is in some ways very similar to competition in earlier eras: the balance of military power heavily shapes deterrence outcomes.

This research suggests a new approach to the study of nuclear deterrence, focusing on the nuclear balance between states. In doing so, it contributes to a growing scholarly literature that takes nuclear force posture seriously. The past, systematic, empirical research on the relationship between nuclear weapons and international conflict measured whether a country possessed nuclear weapons, but did not analyze the relationship between various types of nuclear postures and international conflict. Defense planners have long operated under the assumption, however, that not only the possession of nuclear weapons, but also the specific details of nuclear posture, including nuclear arsenal size, total megatonnage, survivability, range and accuracy of delivery vehicles, nuclear doctrine, missile defenses, and civilian defenses contributed to an effective deterrence policy. The approach adopted in this article begins to address the real-world concerns of nuclear strategists. Defense planners in nuclear weapon states do not often debate whether or not to maintain a nuclear arsenal, but they frequently consider what type of nuclear arsenal they should build and maintain. Future research can better
contribute to these real-world concerns by examining the effect of nuclear postures and nuclear doctrines on deterrence effectiveness.

Given that nuclear superiority improves deterrence effectiveness, it may appear puzzling that some countries refrain from building large nuclear arsenals. Although many countries, including the United States and the Soviet Union during the Cold War, and Pakistan today, arms race in order to avoid falling into a position of inferiority relative to a key rival, other countries, such as China, appear to be content with a minimum nuclear posture. There are a number of reasons why countries might choose a minimum posture despite the deterrent advantages of larger arsenals. Deterrence is only one of many factors that states take into consideration when sizing their nuclear forces and there might be some notable advantages to the possession of smaller nuclear arsenals, including cost savings, reduced likelihood of sparking a dangerous arms race with a rival, and a reduced cost of catastrophe should nuclear war occur. In addition, some countries might prefer a larger nuclear arsenal, but simply lack the ability to produce one. While scholars have traditionally argued that China’s minimum deterrent was rooted in the strategic thinking of Mao Zedong and Deng Xiaoping, for example, recent research suggests that growth in China’s nuclear arsenal was stunted by organizational and political pathologies. The present study examines the effects of nuclear force sizing, but future research could explore in more detail the causes, as opposed to the effects, of the nuclear balance.

On April 8, 2010, U.S. President Barack Obama and Russian President Dmitri A. Medvedev signed an historic arms control agreement, vowing to reduce the total number of deployed strategic nuclear warheads in each country to 1,550, down from a previous high of 2,200. Proponents celebrated the agreement as a step toward a safer world,
while critics argued that the reductions could weaken America’s nuclear deterrent. The findings of this article suggest that cuts in the size of the U.S. nuclear arsenal could increase the probability that the United States will become the target of militarized challenges from other countries. This does not imply, however, that the United States or any other country should pursue nuclear primacy. While this research suggests one advantage of nuclear superiority, there might be many other disadvantages to the maintenance of large nuclear arsenals. When designing a nuclear posture, therefore, policymakers must carefully assesses how the composition of nuclear forces could affect a number of possible outcomes in addition to deterring military challenges, including nuclear terrorism, nuclear and conventional arms races, nuclear proliferation decisions in other states, the credibility of security guarantees to allied states, the outcomes of nuclear exchanges, and the probability of nuclear war. There is good reason to believe that many national security objectives could best be met with smaller, as opposed to larger, nuclear arsenals.

Appendix A: Nuclear Arsenal Size

To assess a country’s nuclear arsenal size, we measure all nuclear warheads in the state’s arsenal. Data on nuclear arsenal size were drawn from a number of sources. Detailed annual information on the arsenals of the five countries recognized as nuclear weapon states by the Nuclear Nonproliferation Treaty (the United States, Russia, Great Britain, France, and China) is available from the National Resource Defense Council’s online nuclear database. After disabling its nuclear arsenal in 1990, the South African government released detailed information on the size of its nuclear arsenal. Data on the
size of South Africa’s nuclear arsenal from 1979 to 1990 were gathered from a variety of sources. There is less information available on the size of the nuclear arsenals in Israel, India, and Pakistan. Estimates of Israel’s arsenal size from the mid 1980s until the present vary anywhere from seventy to four hundred weapons. We used data from the Federation of American Scientists that estimates the size of Israel’s arsenal in every year from 1967 to the present based on the capacity of Israel’s nuclear facilities to produce weapons-grade fissile material. According to these estimates, Israel currently possesses roughly two hundred nuclear weapons. India and Pakistan are thought to maintain nuclear warheads de-mated from delivery systems. Estimates of the size of these countries arsenals, therefore, are denominated in nuclear weapon equivalents (NWEs). Estimates of India and Pakistan’s NWEs are available from a variety of sources and are based on the weapons-grade fissile material production capacity of the countries’ nuclear facilities. When sources provide an estimated range for a given year, or when multiple sources provide different point estimates, we take the mean of these estimates as the size of the country’s arsenal in that year. For years in which no estimate is available, we assume that the arsenal changed at a steady rate between the years for which point estimates are available, calculating the difference in arsenal size divided by the number of years between estimates. While these estimates may not be exact, they provide a more than adequate foundation for measuring whether a country has a larger nuclear arsenal than its opponent for the creation of the Superiority variable, and for gauging the rough size of that advantage for generating the Nuclear ratio variable. We do not code North Korea as a nuclear weapon state. Pyongyang possessed enough separated plutonium to produce one or two nuclear weapons in the early 1990s, but after two inconclusive tests in 2006
and 2009, experts doubt whether North Korea possesses the ability to produce a deliverable nuclear weapon to this day.\textsuperscript{99}
References


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Data on nuclear-armed states from Gartzke and Kroenig (2009). North Korea tested nuclear devices in October 2006 and May 2009, but experts disagree about whether the tests were successful and whether North Korea has a functioning nuclear device.
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* p<0.10 ** p<0.05 *** p<0.001

Note: Robust standard errors, adjusted for clustering by dyad, are in parentheses. All models limited to politically relevant dyads. All models correct for duration dependence using cubic polynomials.
Table 4. The Advantages of Increasing Levels of Nuclear Superiority

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<td></td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.018)</td>
<td>(0.018)</td>
</tr>
<tr>
<td>Trade dependence</td>
<td>-0.416</td>
<td>-0.371</td>
<td>-0.421</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.450)</td>
<td>(0.444)</td>
<td>(0.450)</td>
<td></td>
</tr>
<tr>
<td>Economic openness</td>
<td>0.048**</td>
<td>0.048**</td>
<td>0.046**</td>
<td>0.047**</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
<td>(0.021)</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.050***</td>
<td>-1.052***</td>
<td>-1.055***</td>
<td>-1.047***</td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.061)</td>
<td>(0.062)</td>
<td>(0.062)</td>
</tr>
<tr>
<td>N</td>
<td>59,876</td>
<td>59,876</td>
<td>59,876</td>
<td>59,876</td>
</tr>
<tr>
<td>Pseudo R-sq</td>
<td>0.236</td>
<td>0.236</td>
<td>0.236</td>
<td>0.236</td>
</tr>
</tbody>
</table>

Note: * p<0.10, ** p<0.05, *** p<0.001. Robust standard errors, adjusted for clustering by dyad, are in parentheses. All models limited to politically relevant dyads. All models correct for duration dependence using cubic polynomials.
<table>
<thead>
<tr>
<th></th>
<th>Model 11</th>
<th>Model 12</th>
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<tbody>
<tr>
<td>Nuclear ratio</td>
<td>-0.460**</td>
<td>-0.484**</td>
</tr>
<tr>
<td></td>
<td>(0.198)</td>
<td>(0.231)</td>
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<td>Total nukes in dyad</td>
<td>-0.903</td>
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<td></td>
<td>(0.654)</td>
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<tr>
<td>Capabilities</td>
<td>-0.390</td>
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<td></td>
<td>(0.634)</td>
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<tr>
<td>Security</td>
<td>0.416**</td>
<td>0.325**</td>
</tr>
<tr>
<td></td>
<td>(0.179)</td>
<td>(0.106)</td>
</tr>
<tr>
<td>Joint democracy</td>
<td>-0.022</td>
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</tr>
<tr>
<td></td>
<td>(0.377)</td>
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</tr>
<tr>
<td>Contiguity</td>
<td>-0.170***</td>
<td>-0.122***</td>
</tr>
<tr>
<td></td>
<td>(0.045)</td>
<td>(0.0355)</td>
</tr>
<tr>
<td>Distance</td>
<td>0.057</td>
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<td></td>
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<td>Trade dependence</td>
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<td></td>
<td>(3.655)</td>
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<tr>
<td>Economic openness</td>
<td>0.224</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.413)</td>
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</tr>
<tr>
<td>Constant</td>
<td>-0.822**</td>
<td>-0.916**</td>
</tr>
<tr>
<td></td>
<td>(0.348)</td>
<td>(0.335)</td>
</tr>
<tr>
<td>N</td>
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<td>1,028</td>
</tr>
<tr>
<td>Pseudo R-sq</td>
<td>0.399</td>
<td>0.394</td>
</tr>
</tbody>
</table>

Note: * p<0.10 ** p<0.05 *** p<0.001. Robust standard errors, adjusted for clustering by dyad, are in parentheses. All models limited to politically relevant dyads. All models correct for duration dependence using cubic polynomials.
Figure 1. Conditional effect of the nuclear balance on the probability of being challenged military, 1945-2001
Note: Estimates obtained from Model 8.
1 Nitze 1956, 191.
2 For a history of U.S. nuclear policy, see Kaplan 1991; Freedman 2003.
4 Trachtenberg 1985; Betts 1987.
5 DeYoung 2011.
7 For quantitative literature on nuclear possession and conflict, see Asal and Beardsley 2007; Beardsley and Asal 2009a, 2009b; Gartzke and Jo 2009; Horowitz 2009; Rauchhaus 2009. For qualitative studies of whether nuclear weapons increase or decrease conflict, see the voluminous literature on the optimism/pessimism debate, including Sagan and Waltz 2002 and Kapur 2007. For formal studies of nuclear deterrence see, for example, Powell 1990, 2003.
9 Bremer 1992; Oneal et al 1996; Gartzke 2000; Schultz 2001; Russett and Oneal 2001; Reiter and Stam 2002; Bennett and Stam 2004; Mansfield and Snyder 2005; Pevehouse and Russett 2006.
10 Schelling 1960, 187.
12 See, for example, Trachtenberg 1985; Betts 1987.
14 Jervis 1984, 127.
18 See, for example, Sagan and Waltz 2002; Kapur and Ganguly 2008.
20 See, for example, Achen and Snidal 1989; George and Smoke 1989; Lebow and Stein 1989; Downs 1989.
22 See, for example, Slantchev 2005; Leventoglu and Slantchev 2007; Trager 2010.
23 See, for example, Powell 1990.
24 For more on when states developed second-strike capabilities, see the Data section below. For a discussion of how the nuclear balance affects the cost of nuclear war, see the Theory section below.
25 Schelling 1960; Powell 1990.
26 Schelling 1960, 187.
27 For empirical support for the idea that nuclear war could occur due to accident see, for example, Blair 1993 and Sagan 2002.
For a thorough review of this literature, see Sagan 1989, 10-57; Glaser 1990; Kaplan 1991; and Freedman 2003.
Kahn 1960, 20.
Ibid.
See, for example, Glaser 1990, 211-212.
Glaser 1990, 133.
On the damage limitation approach to nuclear war, see also Kaplan 1991, 201-219; Freedman 2003, 117-130.
Brown 1980, 66.
See, for example, Glaser 1990, 133-165; Kaplan 1991, 201-219; Freedman 2003, 117-130.
Kristensen and Norris 2011.
Herken 1987, 266.
Laird 1972, 65.
Rumsfeld 1977, 68.
Brown 1968, 186.
See, for example, Schelling 1966, 1-34; Powell 1990, 1-32.
Schelling 1960, 187.
The final year for which data are available on the dependent variable, Militarized Interstate Disputes, is 2001.
Bennett and Stam 2000.
See, for example, Lemke 2001. Robustness tests performed on the universe of all states in the international system produced similar results.
The dependent variable is lagged, in line with the recommendations of Beck 2001.
Kaplan 1991, 155-175.
See, for example, Nitze 1976-77, 201-203; Betts 1987, 89; Freedman 2003, 342-354.
Defining second-strike capability according to whether a country possesses SLBMs only and repeating the analysis produced virtually identical results. On enduring rivalries see Diehl 1998.
The Soviet Union’s R-5 missile reached initial operational capability (IOC) in 1956. It was road mobile and capable of reaching strategic targets in Western Europe. The Soviet Union first developed SLBMs in 1958.
The United States first developed SLBMs in 1960. The Pershing I, the U.S.’s first mobile missiles capable of reaching the Soviet Union when deployed in West Germany, reached IOC in 1962. The United States, from 1961 to 1968, was the only country to have ever maintained a continuous airborne alert.
Great Britain developed SLBMs in 1968. It never developed mobile missiles capable of reaching an enduring rival.
Israel’s Jericho I is a mobile missile with a range capable of reaching several enduring rivals in the Middle East, including Egypt. It first reached IOC in 1970. It is possible that Israel deployed nuclear-armed cruise missiles on its Dolphin-class submarines beginning in 2000. Israel does not possess SLBMs.

France developed SLBMs in 1973. It never developed mobile missiles capable of reaching an enduring rival.

China’s DF-21 can be launched from a transporter-erector-launcher (TEL). It reached IOC in 1986. China deployed SLBMs on a single submarine in 1986, but there is some question as to whether the missiles are fully operational. The Pentagon characterizes China’s SLBMs as experimental.

Pakistan’s Hatf-III is a mobile missile capable of reaching Indian territory. It entered IOC in 1995.

India’s Prithvi I is a road-mobile missile capable of reaching Pakistani territory. It reached IOC in 1995. India is in the process of testing, but has not yet deployed, SLBMs.

The results presented below are robust to the exclusion of the Total nuclear weapons variable. On aggregation bias, see Signorino and Xiang 2011.

Mearsheimer 1985.

The correlation between Capabilities and Nuclear superiority among politically-relevant dyads is 0.772.

Singer, Bremer, and Stuckey 1972; Bennett and Stam 2000.


See, for example, Doyle 1986; Oneal and Russett 1997.

Jaggers and Gurr 1995.

We follow previous scholarship (e.g. Pevehouse and Russett 2006) in defining democratic states as those that receive a Polity score of seven or greater. Using six as the threshold for democracy does not change the core results reported below.


Using a dichotomous measure of contiguity did not affect the core results reported below.

Russett and Oneal 2001.

Data for Trade dependence are drawn from Russett and Oneal 2001. Models that include this variable have missing data after 1992. Removing this variable and rerunning the below tests on data from 1945 to 2001 does not change the core findings.


Martin et al. 2008.

Heston, Summers, and Aten 2002.

Using Rare-events Logit did not significantly alter the core results. See King and Zeng 2001.

Carter and Signorino 2010.

Tomz, Wittenberg, and King 2003. The conditional probabilities that follow are drawn from model 8. Control variables are held at their means.

The 95% confidence interval is 0.0042857 to 0.0080919.

The 95% confidence interval is 0.0004 to 0.002.
The odds ratio is 5.619. The odds ratio approximates the relative risk when the incidence of an outcome of interest in the study population is low (<10%), as it is in our data set. See Zhang and Yu (1998, 1690). The first difference when changing the nuclear ratio variable from 0.05 to 0.95 is -0.005, with a 95% confidence interval of -0.008 to -0.003.

As alternate measures of second-strike capability, we tried dummy variables indicating whether a country possessed at least 50, 100, and 150 nuclear warheads, respectively. The results were nearly identical.

A total of 1,534 MIDs were initiated between 1945 and 2001.

States that possess 5% of the nuclear weapons within a dyad are nearly twelve times more likely to be challenged in a higher-level MID than states with 95% of the nuclear weapons within a dyad, holding all other variables at their means. The first difference when changing the nuclear ratio variable from 0.05 to 0.95 is -0.001, with a 95% confidence interval of -0.002 to -0.0006.

See, for example, Jervis 1989.


Lewis 2007.

Fravel and Medieros 2010.

Shear 2010.

We assess that aggregate stockpile counts provide the best indicator of the nuclear balance between states. Moreover, due to data limitations, we are unable to produce separate counts of tactical and strategic weapons, or of deployed and non-deployed weapons, for each nuclear weapon state in each year.


Federation of American Scientists 2011.

See, for example, Shanker and Broad 2009.