Evaluating the Nuclear Peace Hypothesis: A Quantitative Approach

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Abstract

Do nuclear weapons reduce the probability of war? This paper quantitatively evaluates the nuclear peace hypothesis. The results indicate that the impact of nuclear weapons is more complicated than is conventionally appreciated. Both proliferation optimists and pessimists find confirmation of some of their key claims. When a nuclear asymmetry exists between two states, there is a greater chance of militarized disputes and war. In contrast, when there is symmetry and both states possess nuclear weapons, then the odds of war precipitously drop. When combined, these findings provide support for the existence of the stability-instability paradox. Evidence suggests that while nuclear weapons promote strategic stability, they simultaneously allow for more risk-taking in lower intensity disputes.

"It may be that we shall by a process of sublime irony have reached a stage in this story where safety will be the sturdy child of terror, and survival the twin brother of annihilation."

-- Winston Churchill

From the vantage point of 1946, few were optimistic about the stability of emerging postwar order and the long-term prospects for peace. The interwar period (1918-1939) had shown the ineffectiveness of collective security, the fragility of the international political economy, and the danger of nascent democracies. As the wartime alliance between the United States and USSR deteriorated and each side implemented new strategic doctrines, many suspected that another great military contest was inevitable (Lippmann 1947). The fear of another world war was only compounded by the splitting of the atom and the spread of nuclear weapons.

Although the Cold War was often fierce, especially in the developing world where it frequently played out, it never managed to escalate to World War III. Indeed, with the benefit of hindsight, this has prompted some to argue that Cold War is better thought of as the "Long Peace" (Gaddis 1986; Gaddis 1987; Kegley 1991).[2] Despite the worries of some, the collapse of the Soviet Union and the end of bipolarity has not, or at least has not yet, undermined the Long Peace. Although violence has mutated into other forms (e.g., civil wars and terrorism), it is with great fortune that we can point to a long-term decline in deaths from interstate war (*Human Security Report 2005;* Lacina, Gleditsch, and Russett 2006).[3]

What is responsible for the absence of major wars among great powers over the last six decades? The three main approaches to international relations (IR) have each offered answers to this question.[4] The most widely cited explanation is that of neo-liberals. Building on Kant's

Perpetual Peace (1795), modern liberals point to democracy (Maoz and Russett 1993), trade (Keohane and Nye 1977), and international organizations (Keohane 1984) as key causes of peace. Similarly, constructivism views democracy, trade, and international organizations as important factors, but it parts company with neo-liberalism by attributing the root cause of the Long Peace to evolving norms and the social construction of identity (Katzenstein 1996; Wendt 1992; Wendt 1999).[5] Neo-realism, in contrast, is fundamentally at odds with both approaches and rejects the importance of the Kantian Tripod and evolving norms. Instead, the Long Peace during the Cold War is attributed to bipolarity and nuclear deterrence (Waltz 1979; Waltz 1990).[6]

In recent years, neo-liberal explanations of the Long Peace have received the most rigorous empirical scrutiny.[7] Realist explanations including the distribution of power, system polarity, and alliance systems have also received considerable attention.[8] Surprisingly, the nuclear peace hypothesis—one of the central tenants of realist explanations for the Long Peace—has received relatively little quantitative scrutiny. Scholars have employed case studies, counter-factual analysis, and formalized their arguments with game theory, but, with the exception of this issue (Gartzke and Jo, Horowitz, Beardsley and Asal, This issue), only a handful of studies have attempted to quantitatively evaluate the effects of nuclear weapons (Bueno de Mesquita and Riker 1982; Geller 1990; Asal and Beardsley 2007). Moreover, previous quantitative studies have exclusively focused on the relationship between nuclear weapons and crises, or between nuclear weapons and dispute escalation. The relationship between nuclear weapons and the probability of war remains quantitatively untested.

The central purpose of this paper is to offer an empirical answer to the question: do nuclear weapons reduce the probability of war? To answer this question, this project borrows

heavily from the last 15 years of work on democratic peace theory (DPT). Beginning with Maoz and Russett (1993), the dyadic DPT research design has been reproduced in dozens of articles and survived peer review in nearly every leading journal of political science and international relations. Building on Pevehouse and Russett (2006) and using the same key "control" variables, this study incorporates new data that allow for the quantitative evaluation of the nuclear peace hypothesis.

The results presented below indicate that the impact of nuclear weapons is more complicated than is conventionally appreciated. Both proliferation optimists (Waltz 1981) and proliferation pessimists (Sagan 1994) find confirmation of some of their key claims. As proliferation optimists contend, when two states possess nuclear weapons, the odds of war drop precipitously. However, in most other respects, proliferation pessimists find vindication of their position. In disputes where only one of two parties posses nuclear weapons, there is an increased chance of war. Moreover, nuclear weapons are generally associated higher likelihoods of crises, uses of force, and conflicts involving lower-levels of casualties. The findings of this article are consistent with the larger themes of the special issue, demonstrating that nuclear possession can enhance the security of their possessors by shifting conflict to the lower end of the intensity spectrum.

What explains these results? For disputes between two nuclear powers, Snyder's (1965) seminal essay provides a possible answer: the stability-instability paradox identifies a link between strategic nuclear stability and more conflict at lower levels of escalation. The results reported in this study provide empirical support for this view. For disputes between a nuclear power and non-nuclear power, we have results in need of an explanation. Unfortunately, here the scholarly literature on nuclear deterrence is of considerably less value because it is largely

confined to situations of nuclear symmetry. Currently the field lacks a coherent theory (or theories) of nuclear asymmetry.

Along with contributing to our understanding of crisis diplomacy, nuclear deterrence theory, and the stability-instability paradox, this study has relevance for several ongoing policy debates. What are the likely consequences of nuclear proliferation? How do nuclear weapons affect crises at different levels of escalation? In addition to the continuing concern for nuclear proliferation, the United States government and other nuclear states will face tough choices stemming from an aging nuclear stockpiles. A lively debate is already emerging between the proponents of force modernization and those who are calling for the United States to take steps toward Non-Proliferation Treaty (NPT) commitments. A better understanding of the effects of nuclear deterrence will aid in assessing the costs and benefits of various policies.

This study is divided into five parts. The first section briefly overviews previous work on this subject. Section two lays out the logic of nuclear deterrence theory and deduces a number of testable hypotheses. Section three describes the research design, dataset, coding and testing procedures. The fourth section reports and interprets the findings. The final section offers a brief summary and discusses next steps in this research program.

Previous Quantitative Work

Unlike the proliferation of both formal and informal analytic work on nuclear deterrence, there are only a few efforts to statistically evaluate the nuclear peace hypothesis. Considering the importance of this question, the availability of new datasets and modern statistical software, and the trends in other areas of international relations and political science, it is surprising that this literature has generally not transitioned to more rigorous forms of empirical analysis. This is

particular striking when one considers the recent flurry of work on the democratic peace.

Geller (1990) and Asal and Beardsley (2007) represent two important exceptions to this trend. Geller's study, which uses the Correlates of War Interstate Disputes dataset, concludes that crises are more likely to escalate to higher levels when one or both parties possess nuclear weapons (p. 301). His study made good use of the data and methods that were available at the time, but the *t*-tests and cross-tabs of previous decades are now viewed with skepticism. The same can be said of earlier studies that quantitatively explore the effects of nuclear proliferation (Bueno de Mesquita and Riker 1982).

Making use of improved datasets and recent advances in statistical methods and software, Asal and Beardsley (2007, 139) examine the "relationship between the severity of violence in crises and the number of involved states with nuclear weapons." Using the International Crisis Behavior (ICB) dataset for the 1918-2001 period, the study concludes that nuclear weapons tend to decrease the likely level of violence in a crisis (p. 152). This is the opposite conclusion of the one reached by Geller.

Although not primarily focused on the issue of nuclear deterrence, Gartzke (2007) also weighs in on this debate. In the appendix of his study on the "liberal peace," he includes a broad array of control variables, including whether one or both parties to dispute (dyad) possess nuclear weapons. In contrast to the aforementioned studies, Gartzke finds no significant effect, neither positive or negative.

Considering the importance of this subject and the existence of equivocal empirical results, clearly more work is needed. The research design employed in this study improves on earlier work in two key ways. First, this study directly explores the relationship between nuclear weapons and the probability of war. In contrast, previous quantitative work has tended to explore

the relationship between nuclear weapons and militarized disputes or crises. Second, the results presented below control for potential selection effects that may be present in earlier studies. By focusing on year-by-year dyadic relations including non-events (e.g., no crisis or dispute), the results allow for direct estimation of the relationship between nuclear weapons, crisis, and war.

Theory and Hypotheses

From the early days of the nuclear revolution, proponents of nuclear deterrence have argued that atomic weapons have the capacity to reduce the probability of conventional war (Brodie 1946; 1947). Reflecting on the Cold War, some scholars argue that this is indeed what happened: despite dozens of crises and several proxy wars, the United States and USSR avoided a direct military conflict because each feared that matters might escalate to nuclear war (Gaddis 1986, 1987; Waltz 1990, 1993, 2000). Unlike conventional deterrence in previous eras, nuclear deterrence is extremely robust because even irrational or unintelligent leaders are likely to recognize the exceedingly high cost of nuclear war. Thus, proponents of nuclear deterrence claim with a high degree of confidence that "the probability of major war among states having nuclear weapons approaches zero" (Waltz 1990, 740).

Scholars who are critical of nuclear deterrence have generally avoided questioning whether nuclear weapons make war less likely. Instead, they usually take one of two approaches. "Safety critics" warn that the nuclear weapons pose a danger because of accidental detonations and inadvertent escalation (Sagan 1993). In contrast, "moral critics" argue that nuclear weapons should be eliminated because they violate international law, are immoral, or both (Falk and Lifton 1991). Oddly enough, neither safety critics nor moral critics tend to question whether nuclear weapons deter war. To the contrary, some critics have assumed that nuclear weapons do indeed reduce the chance of conflict, but argue instead that their deterrent value is outweighed by

safety concerns and the prospects of more proliferation (Sagan 1994).

Scholars have also examined the theoretical underpinnings of nuclear deterrence from a number of other perspectives. Using game theory and other formal methods, scholars have examined crisis stability, various deterrent strategies, the credibility of threats, and the consequences of proliferation (Berkowitz 1985; Brito and Intriligator 1996; Bueno de Mesquita and Riker 1982; Harvey and James 1996; Intriligator and Brito 1981; Langlois 1991; Nalebuff 1988; Powell 1985; 1987; 1988; 1989a; 1989b; 1990; Schelling 1960, 1966; Wagner 1991; Zagare and Kilgour 2000). Others have scrutinized the psychological underpinnings of deterrence and the assumption of rationality (Jervis 1984; 1989; Jervis, Lebow, and Stein 1985). Despite the potential problems associated with nuclear deterrence, the pacifying effects of nuclear weapons are seldom challenged. In these and other studies, the concern is generally for the potential *failure* of nuclear deterrence, not for the *irrelevance* of nuclear deterrence. Thus, with only a few caveats and exceptions, the literature on nuclear deterrence makes a rather unambiguous prediction.[9]

Hypothesis 1: The probability of major war between two states will decrease if both states possess nuclear weapons.

For levels of conflict short of war, there is much more ambiguity in the literature. Beginning with Snyder's (1965) seminal essay on what was later dubbed the stability-instability paradox, scholars have widely recognized that while nuclear weapons might reduce the chance of major war, it is unclear what they mean at lower levels of escalation, in proxy wars, or other contests that do not challenge vital national interests or state survival. While Snyder's essay was

the first to give the stability-instability paradox detailed treatment, he was certainly not the first to recognize its existence. B.H. Liddell Hart (1954), for example, speculated that the effects of nuclear weapons might prevent another world war, but might nevertheless generate more local aggression and small conflicts. Waltz (1959, 236) also warned that while nuclear weapons might reduce the chance of major war between nuclear powers, they could produce "a spate of smaller wars." The difficulty of predicting the effects of strategic nuclear stability on lower levels of conventional conflict also received extensive treatment by Jervis (1984; 1989). Building on Snyder, Jervis and other proponents of the stability-instability paradox, we can readily deduce a hypothesis for lower levels of conflict.

Hypothesis 2: The probability of crisis initiation and limited uses of force between two states will increase when both states possess nuclear weapons.

Next let us turn to situations where only one of two disputants has nuclear weapons. What are the effects of nuclear asymmetry? Unfortunately, the literature on nuclear deterrence is virtually silent on this point. The Cold War era focus on US-Soviet relations and Mutually Assured Destruction (MAD) largely crowed out discussions of nuclear asymmetry. Might we extrapolate or tease out predictions for nuclear asymmetry from theories that examine nuclear symmetry? Doing so is difficult. Most theories contain enough ambiguity and porousness that, depending on the additional assumptions, one could readily deduce hypotheses that make antithetical predictions. This is clearly an area that would benefit from more research, particularly from formalization. In lieu of a solid theory or theories of nuclear asymmetry, this study uses the basic intuition of formal rational choice to generate the following two hypotheses:

Hypothesis 3: The probability of major war between two states will decrease or remain constant if one state possesses nuclear weapons.

The same can be said of lower levels of escalation:

Hypothesis 4: The probability of lower level conflicts will decrease or remain the same if one state possesses nuclear weapons.

These two hypotheses are generated by considering what formal rational choice theory generically has to say about the relationship between the probability of war and (1) the distribution of power and (2) the costs of war. First, The basic intuition behind these hypotheses is that changes in the distribution of power will lead to subsequent changes in what states' demand or are willing to accept when bargaining in the shadow of war. Thus, within the context of strategic interaction, changes in the distribution of power will lead disputants to make mutually offsetting demands and concessions that leave the probability of war unchanged. This prediction is consistent with Wittman's (1989) seminal study, and mirrors later work such as Fearon's (1995) exposition of formal rationalist explanations of war, and Powell's (1996) explanation of why studies have historically yielded equivocal results when examining the relationship between the distribution of power and the probability of war.

When evaluating the effects of nuclear weapons on the costs of fighting, the predictions—although different—are equally unambiguous. The use of nuclear weapons will drive up the costs of fighting for one or both players. It is difficult to imagine a situation where

nuclear weapons would reduce the net costs of fighting.[10] Thus, if nuclear weapons impact the expected cost of fighting, one can conservatively deduce that nuclear asymmetry should make crises and wars less likely. Needles to say, with different assumptions about preferences over outcomes, information, or the structure of a game, one could certainly deduce alternative hypotheses. Therefore the tests performed below are not intended to "prove" or "disprove" the rationalist paradigm—they should merely generate further discussion. When the game of chicken was found to be a poor fit for explaining nuclear brinksmanship, Schelling did not abandon game theory, but instead invented one of the key concepts in rational deterrence theory (1960; 1966). While the field has developed a deep understanding of nuclear symmetry, our understanding of nuclear symmetry remains in the world of 2x2 games.

Research Design

The research design employed in this study follows in the footsteps of studies on the democratic peace. More than two centuries after its publication, Kant's *Perpetual Peace* (1795) continues to inspire scholars working in this area.[11] Kant's contention that democracies are less war-prone has been proved false, but a variation of the democratic peace is now widely accepted. In its third and most recent incarnation, the democratic peace holds that democracies are *less likely* to fight one another.[12] According to one leading scholar, the current version of the democratic peace is "the closest thing we have to a law in international politics" (Levy 1988, 653).[13]

Beginning with work by Babst (1964, 1972) and Small and Singer (1976), the quantitative DPT research program has generated dozens of books and hundreds of articles. This study especially benefits from the line of research started by Maoz and Russett (1993), which has

grown to include nearly a dozen studies that add independent variables (e.g., trade and international organization membership), broaden the time span (1885-1992), and use more rigorous statistical methods.[14] This study modifies one of the more recent studies (Pevehouse and Russett 2006) with new data on nuclear weapons.

There are a number of reasons why this research design is a good fit for evaluating the nuclear peace. First, the questions are analogous. Asking whether two democratic states are less likely to fight one another is very similar to asking whether two nuclear states are less likely to fight one another. The dyadic structure of the dataset allows us to examine the effects of nuclear symmetry and nuclear asymmetry. Second, this research design is extremely well vetted. Scholars know a great deal about the research design, data and statistical models. Third, the results presented in this study are easy to compare with earlier work. The problem of two studies potentially "talking past" one another is avoided because variables are operationalized in the same way. Finally, this research design has advanced neo-liberal explanations of the "Long Peace." If neo-realist and rational deterrence theory find empirical support from a research design developed by neo-liberal scholars, then this represents somewhat of a hard test—it certainly mitigates against the concern that the research design was purposely created to privilege the hypotheses being tested.

Dataset

This study uses cross-section, time-series data. The unit of analysis is the dyad year. The basic dataset is generated using EUGene v.3.203, which integrates Correlates of War data (Small and Singer 1972; 1982; Sarkees 2000), Militarized Interstate Disputes data (MIDs) (Jones, Bremer, and Singer 1996) and a MIDs update (Maoz 2005).[15] The dataset used is this study is

largely consistent with Pevehouse and Russett (2006) and contains 611,310 dyad-years.[16] It should be noted that this includes "all dyads," not just "politically relevant" ones. This is especially important for the purposes of this study, because the subset of politically relevant dyads would represent a biased sample in which approximately 75% of the dyads would include at least one nuclear power.

As in Pevehouse and Russett (2006), dyad-years are drawn from the 1885-2000 period. While nuclear weapons did not exist before 1945, the 1885-1944 period is included so that readers can compare these findings with previous studies and know that the results differ only because of the addition of variables that measure the presence of nuclear weapons. Tests performed on a data-set restricted to the 1946-2000 period did not noticeably alter the statistical or substantive effects of nuclear weapons.

Dependent Variables

The dependent variable in this study is *conflict*. In the field of international relations, there is no generally accepted definition for conflict, or for its opposite, peace. Conflict can mean as little as an innocuous policy disagreement over fisheries to as much as thermonuclear war. Similarly, peace can mean as little as the absence of violence, or it can be defined as something much more stringent, such as the resolution of underlying grievances and complete concord between parties. To avoid this conceptual quagmire, the dependent variable is operationalized in four ways. As Figure 1 illustrates, each definition becomes more restrictive in terms of level of fatalities.[17]

MID is one of the two dependent variables used in Pevehouse and Russett (2006). It is a binary variable that equals one during the first year of a dispute in which one or both parties use

or threaten to use force. FATAL is a binary variable that equals one during the first year of a dispute in which there are any fatalities. FORCE is a new variable included in this study. It is a binary variable that equals one when one or both parties have used military force. I include the new indicator to capture a broader set of conflicts. Force includes all of the cases of fatalities, but captures a number of instances where a state uses force that, either by accident or design, does not result in any battle deaths.

For theoretical, methodological and substantive reasons, this study also adds a fourth dependent variable. WAR is a binary variable that equals one if a dispute escalates to war, which the Correlates of War project measures as 1000 military fatalities (sustained battle deaths) between regular combat forces (Singer and Small 1972). The 1000 deaths cutoff is the conventional threshold for this literature. While some criticize the 1000 deaths cutoff as arbitrary, and one might want to lower or raise the threshold in the future, the main point here is to focus attention on war as opposed to MIDs or limited uses of force.[18]

For theoretical reasons, it is very important to directly evaluate the relationship between nuclear deterrence and war. Most studies of nuclear deterrence focus specifically on war, not on lower levels of conflict. The methodological reason for including war is that it avoids potential selection effects posed by "easy" cases. For example, nuclear weapons may reduce the number of crises that emerge between dyads, or reduce the number of crises that lead to minor uses of force, but have no impact on preventing escalation to full-scale wars. Thus, the other three indicators may be registering easy cases. The main substantive reason for including war is the obvious point that policymakers, analysts, and the public are especially concerned about events that cause large numbers of fatalities.

Independent Variables

This study includes 10 independent variables. AYSMNUKE is a binary variable that equals one if one of the states in a dyad has nuclear weapons. SYMNUKE is a binary variable that equals one if both states in a dyad have nuclear weapons. Information on states with nuclear weapons was drawn from Gartzke and Kroenig (this issue). Figure 2 describes the years that states acquired and in some cases abandoned nuclear weapons. Since there is some ambiguity in assessments of what year states acquire nuclear weapons, tests were performed using alternative proliferation dates. Neither the statistical nor substantive results were affected by these alternative specifications.

All of the remaining variables and coding is consistent with Pevehouse and Russett, which can be consulted for a more detailed discussion of the data. DISTANCE is a continuous variable that measures the natural logarithm of the distance between capitals of two states, or for large states, the distance between nearest ports. CONTIG is a binary variable that equals one if the two states are contiguous. This includes being directly connected by land, or indirectly connected by less than 150 miles across water. Contiguity also includes contact with other states through colonial possessions. The dataset includes three variables that are intended to evaluate realist concerns. The variable MAJPOW equals one if one or both of the states in the dyad are major powers. ALLIANCE equals one if the two parties have a formal military alliance or non-aggression pact. CAPRAT measures relative distribution of power between states.

Three independent variables evaluate neo-liberal hypotheses. To control for the effects of regime type, DEMOC uses a scale that ranges from -10 (autocracy) to +10 (democracy). Each state's autocracy score is subtracted from its democracy score, and the least constrained state's score is included.[19] The effects of economic interdependence are measured by INTERDEP. All

of the data used for the period post World War II period is from Gleditsch (2002). Earlier data is collected through a variety of historical sources and estimating procedures (Russett, Oneal, and Berbaum 2003, 377; Pevehouse and Russett 2006). IGOMEM measures shared membership in intergovernmental organizations (Pevehouse and Russett 2006).

Testing Method

The relationship between nuclear weapons and conflict is evaluated with a generalized estimating equation (GEE) regression model (Liang and Zegar 1986).[20] GEE is a population-averaged method that was developed specifically for panel data. It makes full use of both cross-sectional and temporal information. For all of the tests performed in the next section, time dependency and autocorrelation are controlled for with first-order auto-regression (AR1) and robust standard errors.

Similar to studies on the democratic peace, this study faces a number of difficulties because of data limitations. When using dyad year data, of particular concern is time dependency: what happens between two states in period t is likely to affect t +1. There are a number of methods for controlling for time-dependency. Techniques used in the Democratic Peace Theory (DPT) literature include fixed effects models, models with distributed lags, and GEE. For the purposes of this study, GEE is selected because it allows us to deal with the problem of perfect separation. While states with nuclear weapons have engaged in MIDs and wars with non-nuclear states, and nuclear states have engaged in MIDs with one another, the dataset does not include any instances of two nuclear states engaging in war with one another.[21] Thus, there is a perfect correlation between the absence of war and dyads where both states possess nuclear weapons. In fixed effects, random effects, and distributed lag models, the perfect

correlation causes the symmetric nuclear variable to be dropped from the analysis. The intuition behind the math is that the coefficient is essentially negative infinity, which cannot be estimated, and the variable is therefore dropped. GEE overcomes this problem by using population averaging.[22] Instead of generating a unique slope for each observation, GEE creates a simple pooled model with a single intercept.

How reliable and robust is GEE? Fortunately, there is a side-by-side comparison of the three methods with a similar research design and data (Russett and Oneal, 2001).[23] The three sets of results, although not identical, show strong similarity. All three testing methods produce coefficients with the same sign for each independent variable. Moreover, major power status, alliances, contiguity, and democracy report nearly the same substantive effect for each method. Interdependence and capabilities all have the same sign, but the ratios between their coefficients and standard errors vary and leave some of the variables below the statistical significance threshold. Nevertheless, the overall similarity of the results allows Russett and Oneal (2001, 471) to conclude that "the three techniques produce robust, statistically significant evidence in support of the liberal peace." For another study that applies GEE and Logit to the liberal peace, and thereby allows for comparison of the two methods, see Gartzke (2007).

Findings

The results of the general estimating equation are presented in TABLE 1. Let us first turn our attention to the effects of nuclear weapons. As the results clearly indicate, nuclear weapons have statistically significant effects on the chance of conflict. This is true for both symmetric nuclear dyads where both states possess nuclear weapons, as well as for asymmetric dyads where only one of the states possesses nuclear weapons. The results are also substantively significant.

For a more detailed substantive interpretation of the data, all of the coefficients can be converted into odds ratios. For our purposes here, it is worth noting the sign of coefficients and the relative impact of the variables.

Substantively, all of the coefficients for asymmetric nukes and symmetric nukes are positive except for one. When two states have nuclear weapons, the negative coefficient indicates that they are less likely to go to war with one another. This coefficient has the strongest substantive effect of all the measures of nuclear deterrence, and the statistical significance is at the $p<.001$ level. In all other instances but this one, the coefficients are positive which indicates that states with nuclear weapons are more likely to engage in militarized disputes (crises), to use force, and to be involved in uses of force that result in fatalities. This is true for situations of nuclear symmetry as well as asymmetry, although the effect is more pronounced when both states possess nuclear weapons.

How do these empirical results mesh with the hypotheses derived in section three? The hypotheses on nuclear symmetry find strong empirical support. The probability of major war between two states is indeed found to decrease when both states possess nuclear weapons (Hypothesis 1). Similarly, the probability of crisis initiation and limited uses of force between two states is found to increase when both states possess nuclear weapons (Hypothesis 2). When combined, these results suggest that the stability-instability paradox is reality, as opposed to a mere thought experiment. In contrast to the hypotheses on nuclear symmetry, the hypotheses on nuclear asymmetry perform poorly. Not only do the hypotheses on nuclear asymmetry find no empirical support in these results, the statistically significant coefficients have the opposite sign than is expected. For examples, dyads in which one state has nuclear weapons are associated with an increased chance of war. This is the opposite of what Hypothesis 3 predicts. Similarly,

Hypothesis 4 misses the mark in that asymmetric dyads are more prone to be involved in militarized disputes and conflicts that involve force or limited numbers of fatalities.

Although the main focus of this analysis is on nuclear weapons, it is worth noting that the results for the other independent variables in this analysis are largely consistent with Pevehouse and Russett (2006) and other work on DPT. The model for general MIDs and MIDs restricted to fatalities produces results with approximately the same statistical and substantive significance. Note, however, alliances now have statistically significant effects for MIDs and not for fatalities, where in their study, the opposite is true. The results for MIDs restricted to uses of force are similar to MIDs with fatalities, with the exception that alliances now register statistically significant results.

The story is much different for war. Here the substantive impact of variables is quite different. The effect of realist variables including relative capabilities, alliances, and the major power status is much more pronounced. Neoliberal variables have more mixed results. The positive effects of IGO membership on wars is greater than for MIDs, MIDs with uses of force, and MIDs with fatalities, but democracy does not fare as well, a finding that is consistent with Gartzke (2007). The effects of interdependence increase substantially, but of all the variables that are included, the interpretation of this variable requires some caution. Scholars worry about potential selection effects, the direction of causation, and the shadow that future wars may cast on trade relations.[24]

Conclusion

As many have noted, Jervis (1984, 31) provides one of the clearest definitions of Snyder's (1965) stability-instability paradox: "To the extent that the military balance is stable at

the level of all-out nuclear war, it will become less stable at lower levels of violence." A number of studies have sought to qualitatively test the stability-instability paradox. To date, these studies have generated equivocal results. Even when addressing the same case study, scholars have drawn opposite conclusions (Krepon 2003; Kapur 2005; Ganguly and Wagner 2004; Sagan and Waltz 2003). The results presented in this study represent one of the first efforts to quantitatively evaluate the relationship between strategic nuclear stability and conflicts at lower levels of escalation.

As the results presented in the previous section indicate, both proliferation optimists and proliferation pessimists find validation for some of their key claims. Kenneth Waltz and other proponents of nuclear deterrence find strong empirical support for their claims that nuclear powers are less likely to fight one another—nuclear weapons may indeed help explain the Long Peace. Nevertheless, Scott Sagan and other proliferation pessimists find support for their concerns. At lower levels of escalation, nuclear symmetry does not appear to have a pacifying effect. Worse yet, nuclear asymmetry is generally associated with a higher chance of crises, uses of force, fatalities, and war. On balance, however, these findings support the broader themes of this issue. Nuclear weapons do not affect the frequency of conflict, but they do affect the timing, intensity, and outcome of conflict. This study demonstrates that nuclear weapons tend to shift the intensity of disputes toward the lower end of the conflict scale.

The results presented in this study also point to an area that has been seriously neglected. In a post-Cold War world where mutually assured destruction between super-powers is no longer the main concern, it is time for the field to more fully explore the effects of nuclear asymmetry. Clearly the effects of nuclear asymmetry are more complicated than is conventionally appreciated.

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Table 1: Results*

	***MID* (I)**	***FORCE* (II)**	***FATAL* (III)**	***WAR* (IV)**
SYMNUKE	1.94*** (.50)	2.07*** (.43)	2.06*** (.41)	-14.81*** (.53)
ASYMNUKE	.71*** (.16)	.81*** (.18)	.85*** (.23)	.90 (.53)
CONTIG	2.59*** (.18)	3.20*** (.23)	2.29*** (.26)	2.94*** (.62)
DISTANCE	-.58*** (.07)	-.48*** (.08)	-.74*** (.10)	-.69*** (.15)
CAPABIL	-.30*** (0.05)	-21*** (.05)	-.41*** (.06)	-.64** (.19)
ALLIANCE	-31* (.15)	-.35* (.17)	-.35*** (.20)	-.44 (.37)
MAJPOW	1.81*** (.18)	1.25*** (.20)	1.53*** (.25)	2.35*** (63)
DEMOC	-.06*** (.01)	-.04*** (.01)	-.06*** (.02)	-.08* (.03)
INTERDEP	-.50.18*** (12.33)	-43.69*** (14.70)	-112.79*** (27.93)	-118.63* (54.76)
IGOMEM	-.01** (.00)	-.01** (.005)	-.02*** (.01)	-02* (.02)
CONSTANT	-1.49*** (.58)	-3.11*** (.67)	-1.09*** (.86)	-3.85*** (1.57)
Wald Chi 2 p <	2164.59 .00	1855.44 .00	1178.62 .00	2109.10 .00

Columns I though IV include information on each of the dependent variables. Rows include information on each of the independent variables. Statistically significant coefficients are indicated by asterisks (= $p<.05$, ** = $p<.01$, *** = $p<.001$). Robust standard errors appear within parentheses below the coefficients.

Figure 1: Operationalizing Conflict

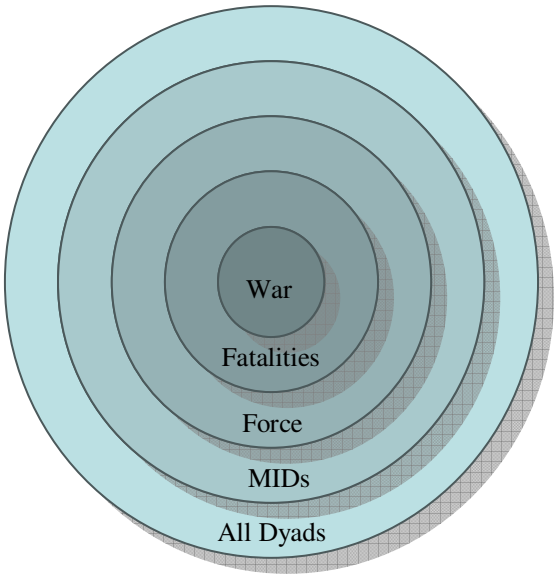
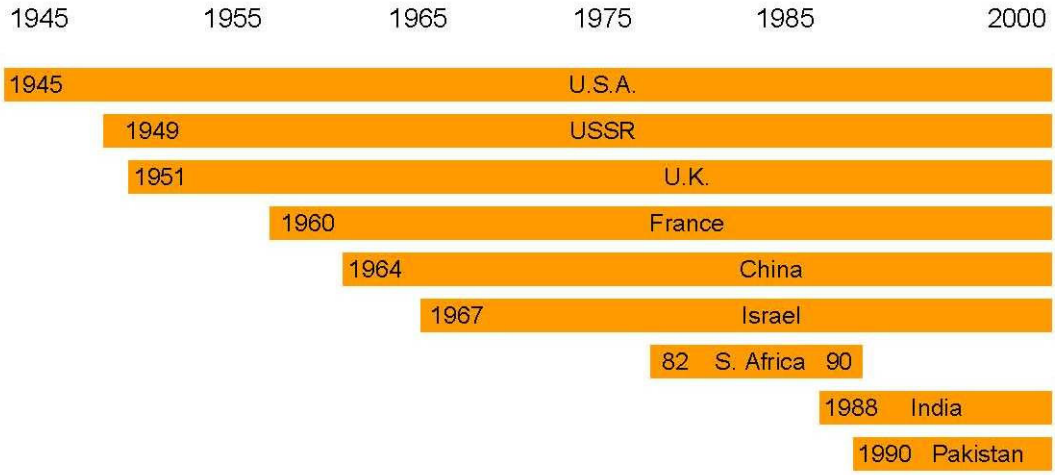


Figure 2: Nuclear Weapons States



Notes

[1] For helpful comments on earlier versions of this paper, the author would like to thank the authors in this special issue, Bruce Russett, and two anonymous reviewers. Replication data and an online appendix are available at http://jcr.sagepub.com/supplemental.

[2] For a critique of the Long Peace thesis, see Siverson and Ward (2002). Also see Brecher and Wilkenfield (1991) and Ray (1991) in Kegley's edited volume.

[3] Although battlefield deaths from inter-state war have been in decline since World War II, this is not true for most other forms of violence. Extra-state (colonial) wars increased sharply during the period of decolonization, then declined. Similarly, civil wars increased exponentially immediately after the end of the Cold War, and have since steadily declined. Deaths caused by terrorism have steadily increased since 1970s. See the *Human Security Report 2005* for more details.

[4] For a review of this debate, see Jervis (2002).

[5] For a proto-constructionist view on how changing identities may facilitate peace, see Deutsch et al. (1957). While not usually lumped under the heading of constructivism, Mueller (1988; 1989) makes a forceful argument that is completely consistent with this school.

[6] While classical realists disagreed about what type of polarity was most war prone, there was broad consensus among neo-realists that bipolar systems were less war prone than multipolar systems. Concerning unipolarity and the post-Cold War era, however, there is little consensus. Prior to Charles Krauthammer's (1990/1991; 2002/2003) coining of the term unipolarity, this constellation of power was not really considered. Most neo-realists expect unipolarity will be unstable, or at least short lived (Layne 1993; 2006; Waltz 1993; 2000). Gilpin's (1981) analysis of hegemony might lead one to believe that unipolarity is more stable than bipolarity.

[7] For quantitative work on the Democratic Peace Theory (DPT), see Babst (1964), Babst (1972), Pevehouse and Russett (2006), Gartzke (1998), Gartzke (2000), Lake (1992), Oneal and Russett 1997, Oneal and Russett (2001a), Oneal and Russett (2001b), Maoz (1997), Maoz (1998), Oneal, Oneal, Maoz, and Russett (1996), Risse-Kappen (1995), Russett (1993), and Small and Singer (1976). For a review of the literature, see Ray (1998) and Morrow (2002). For critiques of the democratic peace, see Gowa (1999) Layne (1994), Spiro (1994), Thompson (1996), and Thompson and Tucker (1997). Note also that the DPT has recently evolved into an evaluation of the Kantian Tripod, and therefore includes data on interdependence and international organizations. See Oneal, Russett, and Berbaum (2003), Pevehouse and Russett (2006), and Russett, Oneal and Davis (1998). For other recent work evaluating the relationship between war and trade, see Barbieri (1996, 2002), Gartzke (2003), Gartzke, Li, and Boehmer (2001) Gowa (1994), and Mansfield (1995).

[8] See, for example, Bueno de Mesquita (1981), Bueno de Mesquita and David Lalman (1994), Deutsch and Singer (1964).

[9] As later hypotheses make clear, there are some caveats to this claim. There is no consensus on the effects of nuclear weapons on lower levels of escalation. Hence this hypothesis does not say war in general, but restricts the claim to *major* wars. There is also debate as to the requirements of deterrence. This study adopts the stance of nuclear minimalism in keeping with Waltz (1980; 1991). While there is a general consensus among international relations scholars that nuclear weapons reduce the probability of *major* war, there are some scholars that categorically reject the deterrent value of nuclear weapons (Mueller 1988; 1989; Vasquez 1991). For example, Mueller's central argument is that while "nuclear weapons may have substantially influenced political rhetoric, public discourse, and defense budgets and planning," they have not "had a significant

impact on the history of world affairs since World War II" (1989, 56). Mueller's view is that the costs of World War II, new norms, and changes in identity have made major war obsolete. The Long Peace was therefore over-determined and would have happened even without nuclear weapons. In other words, nuclear weapons have no deterrent value because there is nothing to deter—no one wants to fight a large war.

[10] When one takes account of the costs of developing and fielding nuclear weapons, along with the likely political costs associated with their use, it is difficult to imagine a situation where they would reduce the costs of fighting in absolute terms. Perhaps thinking of costs in relative terms (i.e., opportunity cost compared to conventional war) might yield different results.

[11] For the essays that re-launched this debate, see Doyle (1983a; 1983b).

[12] The first democratic peace thesis—democracies are more pacific than autocracies—survived from ancient times to the 1980s. The second democratic peace thesis, advanced during the 1980s and 1990s, held that democracies *never* fight one another. This version was short lived. Historical examples and ongoing events at the time (e.g., Kargil, Kosovo, Ethiopia) showed that the claim was too strong. Some initially modified the democratic peace thesis to hold that *liberal democracies* have never fought one another, but most scholars moved toward the "*less likely"* formulation.

[13] For critiques of the democratic peace, see fn 6. It is worth noting that Levy stated the democratic peace is the *closest* thing that we have to a law. He is frequently misquoted as saying it is our only law.

[14] See fn. 7 for more recent studies by Oneal, Maoz, Russett and other scholars involved in this research program.

[15] Eugene stands for the Expected Utility Generation and Data Management Program, which is available from www.eugenesoftware.org. For published documentation on an earlier version of EUGene, see Bennett and Stam (2000).

[16] Consistent with previous studies, data with missing values are dropped. See Oneal, Russett and Berbaum (2003) for a detailed discussion of case selection.

[17] Note that for statistical purposes, it may be problematic to treat conflict as a series of discrete categories with ordinal rankings. Many would argue that conflict is best thought of as a multi-dimensional concept with only nominal categories. In some situations fatalities may be normatively worse than force because it involved loss of life. In other cases, force or MIDs may be worse than fatalities because an event like the Cuban Missile Crisis is more significant than the seizure of a fishing vessel that results in a few fatalities.

[18] Future studies may want to raise or lower the 1000 deaths threshold, or perhaps treat the number of fatalities at the dependent variable.

[19] This is called the weakest link constraint. The logic is that the democratic peace will rest on the least democratically constrained state.

[20] All tests are performed using the STATA/IC (v.10).

[21] Kargil, Sino-Soviet border disputes, etc., register under FATAL and FORCE, but not under WAR because of the limited number of casualties.

[22] For a broader discussion of the problem of perfect correlation and separation, see Zorn (2005).

[23] Also see Hu, Goldberg, Hedeker, Flay, and Pentz (1998) for a similar effort in epidemiology. For a critique of fixed effects models and a plea not to use them in the DPT literature because of dichotomous dependent variables, see Beck and Katz (2001).

[24] As Jervis (2002, 6) notes, critics "worry that interdependence may be more an effect than a cause, more the product than a generator of expectations of peace and cooperation." Despite efforts to control for this effect, such as Russett and Oneal's (2001) decision to lag the trade variable by one year, Jervis notes that they may not "get to the heart of the matter since trade the year before could be a product of expectations of future good relations" (Jervis 2002, 6). Indeed, in considering the Long Peace, trade may be a security externality that is a result of the Cold War (Gowa 1994).