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Why do states provide sensitive nuclear assistance to nonnuclear-weapon states? The author argues that states provide international nuclear assistance to constrain other more powerful states. The evidence suggests that the empirical pattern of nuclear assistance is best explained by a number of strategic preconditions: relative power, dependence on a superpower patron, and the nature of the nuclear recipient's security environment. This research speaks to a broader debate about the impact of nuclear proliferation on the international system. It shows that the costs of nuclear proliferation are most heavily borne by the international system's most powerful states.

Keywords: *Nuclear weapons proliferation; security; security guarantees; balance of power*

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Why do states provide sensitive nuclear assistance to nonnuclear-weapon states? The author argues that states provide international nuclear assistance to constrain other more powerful states. The evidence suggests that the empirical pattern of nuclear assistance is best explained by a number of strategic preconditions: relative power, dependence on a superpower patron, and the nature of the nuclear recipient's security environment. This research speaks to a broader debate about the impact of nuclear proliferation on the international system. It shows that the costs of nuclear proliferation are most heavily borne by the international system's most powerful states.

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Few topics in international relations have received as much scholarly attention as the nuclear revolution and its impact on the international system. In fact, one could argue that the academic field of security studies was founded in the post-World War II era attempt to better understand the emerging nuclear relationship between the world's two superpowers. Despite six decades of research, the literature on the nuclear revolution has focused almost exclusively on the impact of nuclear weapons on the international system writ large and has made very little headway in exploring the differential impact of nuclear proliferation on states in different structural positions in the international system.

This article argues for a contingent understanding of the impact of nuclear weapons on international politics. States with varying levels of conventional military power experience the international spread of nuclear weapons differently. The costs of nuclear proliferation are disproportionately borne by states with large force projection capabilities and, as such, these states are the most fervently opposed to the proliferation of nuclear weapons. On the other hand, less powerful states have less to lose from nuclear proliferation, and in certain circumstances, can even stand to benefit by promoting it.

To test this argument, I explore an issue area that clearly differentiates states' proliferation preferences: the export of sensitive nuclear technology. The export of sensitive nuclear technology presents a kind of strategic game between states with relatively low levels of conventional military power, which have incentives to provide sensitive nuclear assistance, and superpowers that refrain from providing sensitive nuclear assistance themselves and attempt to use their influence to dissuade other states from exporting sensitive nuclear technology. Using an original international nuclear assistance dataset, this article finds that the lower a state's level of conventional military power relative to the potential recipient, the more likely it is to provide sensitive nuclear assistance. It also finds that states, both potential suppliers and potential recipients, that are relatively insulated from superpower pressure, are more likely to engage in sensitive nuclear transactions, than are states that are dependent on a superpower patron.

This article proceeds in five sections. The first section reviews the literature on the impact of the nuclear revolution on the international system and sets out the argument that nuclear proliferation is most disadvantageous to the international system's most

powerful states. The second section turns to the specific problem of international nuclear assistance and develops a number of hypotheses to explain why states provide sensitive nuclear assistance to nonnuclear-weapon states. The third section develops the methodology and describes the data used to support my claims. The fourth section presents the evidence. The fifth and final section offers concluding remarks.

THE ASSYMETRIC EFFECTS OF THE NUCLEAR REVOLUTION

My argument stands in contrast to existing approaches to nuclear proliferation that assume that the effects of the nuclear revolution have been fairly even across different types of states in the international system. One prominent theory of nuclear proliferation states that the spread of nuclear weapons leads to greater international stability (Mearsheimer 1990, 1993; Posen 1993; Van Evera 1990/1991; Waltz 1995). States, wishing to avoid a nuclear exchange that could jeopardize their very existence, behave with extreme caution in a nuclear world. Representatives of this school argue, accordingly, that nuclear proliferation does not directly challenge state's core security interests because new nuclear states can be deterred. Not even rogue regimes, they maintain, would consider using nuclear weapons because the costs of nuclear retaliation would exceed any potential gains. These scholars go so far as to argue that powerful states, including the United States, can benefit from, and should promote, the gradual proliferation of nuclear weapons (Bueno de Mesquita and Riker 1982; Mearsheimer 1990, 1993; Posen 1993; Van Evera 1990/1991; Waltz 1995).

While it is plausible that nuclear proliferation induces stability at the systemic level, this school of thought is plagued by two fundamental problems. First, it has an

overly narrow view of the negative consequences associated with nuclear proliferation. This approach implies that as long as a state is safe from a bolt from the blue nuclear strike, nuclear weapons should provide no other cause for concern. Nuclear weapons, however, have many negative implications for powerful states even if they are never used. For example, nuclear weapons, while providing their possessors an effective security guarantee, also limit the ability of powerful states to use coercion as a tool of diplomacy over new nuclear states. Second, and related, this theory does a poor job of explaining the empirical record of state behavior. If states truly have little to fear from nuclear proliferation, why have so many states taken such a strong stand against the spread of nuclear weapons? Powerful states, like the United States and the Soviet Union, have not only refrained from promoting the gradual proliferation of nuclear weapons, they have used nearly every means at their disposal to prevent nuclear weapons from spreading.

Other scholars, while agreeing that nuclear weapons induce caution on the part of statesmen, argue that the spread of nuclear weapons has negative consequences for states in the international system because it increases the likelihood of a nuclear accident (Sagan 1993, 1995). "Normal accidents" should be expected in tightly coupled and complex systems like nuclear weapons arsenals. While the potential for accident exists even in advanced nuclear powers, the problem is exacerbated as nuclear technologies spread to new states with less experience in managing a nuclear arsenal.

Undoubtedly, as the number of nuclear weapons, and the number of states controlling them, increases, so too does the potential for a nuclear accident. Yet it seems implausible to chalk up all of the attention powerful states have devoted to nuclear

weapons proliferation over the past sixty years to the fear of an accidental detonation alone. This is especially true when one considers the full range of potential negative ramifications that nuclear weapons can have for the international system's most powerful states.

While existing approaches disagree as to whether the consequences of nuclear proliferation are positive because proliferation leads to international stability, or negative because proliferation increases the probability of an accidental nuclear detonation, they are united in assuming that the effects of nuclear weapons proliferation are roughly consistent across different types of states in the international system. In the words of Kenneth Waltz (1995, 45), these scholars maintain that their "statements hold for small as for big powers."

In contrast to previous approaches, this article argues that the impact of nuclear proliferation depends on a state's position in the international system. States with high levels of conventional military power have the most to lose from nuclear proliferation because proliferation constrains these states in a number of ways. It deters them from intervening in areas of strategic importance, reduces the effectiveness of threats as a tool of diplomacy, limits their influence over key allies by reducing the allies' need for external protection, distracts them by forcing them to devote greater levels of strategic attention to new nuclear states, and drags them into mediating regional nuclear crises. Superpowers, states with global force projection capabilities, like the United States and the former Soviet Union, suffer a relative loss when nuclear proliferation occurs anywhere in the international system.

On the other hand, states that lack a robust force projection capability do not pay these costs when nuclear proliferation occurs. Their weakness, with or without proliferation, precludes them from intervening in areas of strategic importance, from using coercion as a tool of diplomacy, and from providing security guarantees to client states. Their smaller spheres of influence, moreover, make it less likely that they will need to monitor new nuclear states or to become involved in regional nuclear standoffs. In other words, weaker states pay fewer opportunity costs when nuclear proliferation occurs. Nonsuperpowers, such as France, China, and Pakistan, may suffer relative losses when nuclear weapons spread to states over which they can project conventional military force, but they are not necessarily threatened when nuclear weapons are acquired by states beyond their own spheres of influence.

In fact, to the degree that it constrains a more powerful rival state, nuclear proliferation to a third state can provide weak states with a relative gain in power. While all states face a loss of power relative to the new nuclear state, the size of that loss is a function of a state's force projection capability. Nuclear proliferation constrains powerful states more than it constrains weak states. Under certain circumstances, weak states have strategic incentives to drag their feet on a nuclear proliferation crisis or even to aid in the proliferation of another state.[1]

This contingent theory of nuclear proliferation faces a difficult test in the international provision of sensitive nuclear assistance. Providing sensitive nuclear technology to another state is the most direct way in which a state can contribute to another state's nuclear ambitions and, thus, most at odds with current realist understandings of relative gains as a motivation for state behavior.[2] The remainder of

this article will be devoted to testing this contingent theory of proliferation with regard to the international provision of sensitive nuclear assistance.

TOWARD A THEORY OF NUCLEAR ASSISTANCE

Why do states provide sensitive nuclear assistance to nonnuclear-weapon states? Commercial transactions for civilian nuclear purposes and scientific exchanges are quite common, can be accounted for convincingly by a variety of political and economic rationales, and do not fundamentally challenge the tenets of international relations theory. Sensitive nuclear assistance, however, is more difficult to explain. States that transfer weapons-grade fissile material, that assist in the construction of facilities to produce weapons-grade fissile material, or that provide assistance in the design and construction of nuclear weapons, are knowingly helping another state to develop a nuclear weapons arsenal or, at the very least, are providing the state with the latent capability to become a nuclear power. States voluntarily transferring the means to produce a weapon so powerful that it could one day threaten their own existence challenges dominant theoretical assumptions about relative gains and survival as the primary motivations of state behavior (Waltz 1979).

Nevertheless, as we can see in Table 1, since the dawn of the nuclear age, the interstate transfer of technology, designs, equipment, and materials necessary for the production of nuclear weapons has been a regular feature of the international system. (Insert Table 1 here). Most analysts are aware of Pakistan's recent export of uranium enrichment technology and nuclear bomb designs to Iran, Libya, and North Korea. It is often forgotten, however, that large-scale nuclear assistance has been quite common

historically, and that many of the current nuclear powers received substantial outside assistance for their own nuclear weapons programs. In fact, the bomb design recently shopped around by Pakistan was originally a gift from China in the early 1980s. And Israel's nuclear arsenal was constructed with active French cooperation. Understanding what drives states to export sensitive nuclear capabilities is historically important and has become increasingly critical amid recent threats from Iran and North Korea to export sensitive nuclear technologies.[3]

Despite empirical frequency and geopolitical and theoretical importance, the topic of nuclear assistance has received little scholarly attention. In fact, even as nuclear assistance has occurred repeatedly, scholars have tended to ignore its very occurrence, arguing from first principals and holding that "it runs against the grain of state behavior to transfer military power to others" (Mearsheimer 1990, 39). The vast literature on nuclear proliferation has explained why states want nuclear weapons and the strategic implications of the nuclear revolution, but has not yet addressed the supply side of nuclear proliferation.[4] Historical studies have chronicled the development of individual nuclear weapons programs, including instances of sensitive nuclear transfer, and policy studies have considered the problem of nuclear assistance, but this material has not been analyzed in a comprehensive theoretical framework.[5]

Yet, the provision of nuclear assistance is actually quite consistent with realist approaches to international politics. States with advanced nuclear capabilities can proliferate nuclear technology as a way to constrain other more powerful states. In other words, nuclear sharing is an unconventional tool of statecraft used for conventional ends. Nuclear sharing is one of a number of means by which weak states seek to leverage their

power vis-à-vis more powerful actors. On the other hand, powerful states, those states most likely to pay the costs of nuclear proliferation, assiduously avoid the international provision of nuclear assistance.

States are more likely to provide sensitive nuclear assistance when a number of strategic conditions hold. States with the ability to project conventional military power over a potential recipient will be extremely reluctant to provide sensitive nuclear assistance because nuclear proliferation would neutralize their conventional military superiority. States do not want to handcuff themselves. On the other hand, a state that lacks the ability to project force over the potential recipient can achieve relative gains by providing nuclear assistance that constrains other more powerful states. The smaller a state's force projection capability relative to a potential recipient the more likely it will be to provide sensitive nuclear assistance.

Superpowers, those states with a global force projection capability, are the least likely suppliers of sensitive nuclear assistance because their freedom of action is limited by each and every case of proliferation. Superpowers not only refrain from providing assistance themselves, but they seek to prevent other states from engaging in sensitive nuclear transactions. They can take a number of actions to influence other states such as threatening to cut military aid or to withdraw a security umbrella. Their success in inducing restraint in both potential suppliers and potential recipients depends largely on the state's vulnerability to pressure. States that are dependent on a superpower's protection wish to avoid antagonizing a powerful patron and will refrain from engaging in international nuclear transactions. Contrariwise, states that are not reaping the benefits

of a close relationship with a superpower patron can afford to absorb the costs of superpower displeasure and can choose to proceed with nuclear transactions.

The broader strategic environment of the recipient also shapes the supplier's incentive structure. Potential suppliers will be more likely to provide nuclear assistance to states engaged in an intense security competition. Of course, threatened states will have a high demand for nuclear protection, but these states are also attractive recipients from the supplier's point of view. To the degree that states provide nuclear assistance to constrain other more powerful states, we should expect states to direct assistance to situations in which timely nuclear assistance can shape the local balance of power.

In sum, this article will test the following strategic hypotheses about the causes of sensitive nuclear assistance:

Hypothesis 1A: The smaller a state's force projection capability relative to a potential recipient, the more likely it will be to provide sensitive nuclear assistance.

Hypothesis 1B: States that are dependent on a superpower patron will be less likely to provide, or receive, sensitive nuclear assistance.

Hypothesis 1C: States will be more likely to provide sensitive nuclear assistance to states engaged in an intense security competition.

INTERNATIONAL NUCLEAR ASSISTANCE DATA

To test this strategic theory of nuclear assistance, I constructed two original international nuclear assistance datasets. These datasets were built using a variety of studies on the proliferation of nuclear weapons and histories of countries' nuclear weapons programs.[6] The first monadic dataset contains yearly information for all

capable nuclear suppliers in the international system from 1945-2002. Capable nuclear suppliers are states that could conceivably transfer sensitive nuclear materials and technology to other states. States are coded as capable nuclear suppliers if they have a nuclear weapons capability or if they have operated a domestic plutonium reprocessing or uranium enrichment facility (See appendix A). This group of states includes nuclear powers such as France, Pakistan, and the United States, as well as states such as Brazil, Germany, and Japan that have mastered parts of the nuclear fuel cycle, but have not developed nuclear weapons themselves. The second dyadic dataset contains yearly information for all capable nuclear suppliers and potential nuclear recipient dyads in the international system from 1945-2002. Potential nuclear recipients are all nonnuclear-weapon states in the international system. States with a nuclear weapons capability are not included as potential recipients because the theoretical puzzle motivating this study concerns the motivations leading states to arm nonnuclear-weapon states.

DEPENDENT VARIABLE

The dichotomous dependent variable, nuclear assistance, measures whether a capable supplier state provided sensitive nuclear assistance to another state in year t.[7] Sensitive nuclear assistance includes: assistance in the construction or design of a nuclear weapon; transfer of weapons-grade fissile material; and assistance in the construction of a facility to produce weapons-grade fissile material.[8] Sensitive nuclear assistance occurs in 66 of the 677 country years in the monadic data and 74 of the 100,822 dyad years in the dyadic data.[9]

EXPLANATORY VARIABLES

To test my hypotheses, I construct independent variables indicating the strategic factors outlined in the above theoretical discussion. I also include variables that control for other institutional, economic, and demand-side factors that could potentially shape patterns of sensitive nuclear assistance.

Strategic Variables

Relative power. Relative power, a supplier state's ability to project power over a potential recipient, is measured as the capability of the recipient state subtracted from the capability of the supplier state discounted by distance. Capability is a composite index containing information on total population, urban population, energy consumption, iron and steel production, military manpower, and military expenditures. Capability is discounted by distance using the formula advanced by Bueno de Mesquita (1981).[10]

Superpower dependence. To measure a state's vulnerability to superpower pressure, I construct two different superpower dependence variables. The first proxy variable measures the similarity of states' voting behavior in the United Nations General Assembly (UNGA) with the voting behavior of the nearest superpower. [11] A state that is vulnerable to superpower pressure is likely to vote with, rather than against, its patron. The United States (1945-2002) and the Soviet Union (1945-1989), are coded as superpowers. From 1945-1989, this variable measures the similarity of states' voting behavior with the superpower that has the most similar voting profile in each year. From 1990-2002, this variable measures the similarity of states' voting behavior with the United States. An alternative superpower dependence variable measures whether a state relies on a superpower security guarantee. States that lack a nuclear weapons capability

and are in a defense pact with a superpower are vulnerable to superpower pressure because they are shielded from attack by the superpower's nuclear umbrella. Following Singh and Way (2004), I only count defense pacts, and not ententes or neutrality agreements, as providing a significant security guarantee. Drawing on version 3.0 of the Correlates of War alliance data set (Gibler and Sarkees 2002) and on Singh and Way's (2004) coding of nuclear-weapon states, I create a dichotomous variable indicating whether a state is in a defense pact with a superpower and lacks its own nuclear weapons capability.

Security environment. To test the hypothesis that states provide nuclear assistance to influence an ongoing security competition, I use two variables that indicate the nature of the recipient's security environment. The dichotomous rivalry variable from Singh and Way (2004) indicates whether a recipient state was involved in one or more enduring rivalries in a given year.[12] The disputes variable, also from Singh and Way (2004), is a 5-year moving average of the number of militarized interstate disputes per year in which a recipient state is involved and draws on version 3.0 of the militarized interstate dispute (MID) data set (Ghosen and Palmer 2003).

Institutional Variables

In order to analyze the strategic factors motivating nuclear assistance, it is crucial to control for other potential factors that influence states' proliferation decisions. The domestic political institutions of a state, or the international institutions to which a state belongs, could have a systematic effect on its propensity to provide sensitive nuclear assistance.

Regime type. Democracies may be less likely to provide sensitive nuclear assistance for two reasons. First, from a normative perspective, democratic states may be more likely to abide by international norms against the proliferation of nuclear weapons. Second, democratic states have internal decision making characteristics, such as popular participation and institutional veto points, which could make controversial state policies, such as the export of sensitive nuclear technology, less likely. To measure regime characteristics, I use the polity score which ranges from -10 (most autocratic) to +10 (most democratic) from the Polity IV data (Jaggers and Gurr 1995).

International Institutions. To the degree that international institutions constrain state behavior, states that are members of the major institutions in the nonproliferation regime may be less likely to supply or to receive sensitive nuclear transfers. I construct two dichotomous variables that measure whether a state is a member of the Nuclear Nonproliferation Treaty or the Nuclear Suppliers Group, respectively.[13]

Economic Variables

While the direct economic rewards to exporting sensitive nuclear facilities are significantly less than those associated with the provision of civilian nuclear assistance (Potter 1982), economic factors could potentially play a motivating role in cases of sensitive nuclear assistance. To test the generalizability of economic motivations on state decisions to provide sensitive nuclear assistance, I include a number of economic variables.

Economic development. Less developed states that are potential suppliers may be more likely to provide sensitive nuclear assistance as part of a program to develop their own nuclear industries or to earn needed foreign exchange. Among potential suppliers,

lower levels of economic development may be associated with a higher propensity to export sensitive nuclear technology. I include a variable for level of economic development, which is measured as a country's per capita gross domestic product (GDP) in constant 1996 dollars.[14]

Economic growth. States that are experiencing low or negative economic growth rates may be more likely to take extreme measures, such as the export of sensitive nuclear technology, to improve their economic circumstances. Economic growth is calculated as Growth= log (GDP_t)- log (GDP_{t-1}).[15]

Openness. States that rely on international trade may be more likely to sell sensitive nuclear technology on the international marketplace. A state's exposure to the international economy is calculated as a state's trade ratio, total trade (imports plus exports) divided by GDP.[16]

Trade dependence. States that are economically dependent on a trade relationship with a particular partner may not wish to risk an important trade relationship by refusing requests for sensitive nuclear assistance from that partner. Following Oneal and Russet (1997), I measure trade dependence as total trade (imports plus exports) between state1 and state 2 as a percentage of the GDP of state1.[17]

Demand Variables

In order to isolate the factors motivating supply, I also control for factors influencing the demand-side of nuclear transactions. Previous quantitative work on nuclear proliferation has found that states are more likely to pursue nuclear weapons once they have reached a certain level of economic development (Singh and Way 2004). The

complex technology required to build nuclear weapons is more easily mastered by economically advanced states. Scholars have also argued that states that are open to the international economy, or that are in the process of trade liberalization, are less likely to seek nuclear weapons (Solingen 1994, 1998; Paul 2000; Singh and Way 2004). Open and liberalizing states do not wish to jeopardize international trade and investment on uncertain and risky activities, such as the pursuit of a nuclear weapon. Previous policy work on international nuclear trade has also suggested that states may prefer geographically proximate suppliers because they are more reliable (Sands 1990). Even technologically advanced states can encounter difficulties constructing nuclear facilities on their own soil and the scientific challenges inherent in constructing sensitive nuclear facilities are compounded by distance. Measures for economic development and openness have already been discussed.

Liberalization. To measure trade liberalization, I use a variable from Singh and Way (2004) that gauges the movement toward greater openness by calculating the change in the trade ratio over time spans of 3, 5, and 10 years.

Distance. To control for geographic distance, I use a measure for the number of miles between capital cities.[18]

METHOD AND FINDINGS

Rare event logit (ReLogit) models are employed to test claims about the correlates of international nuclear assistance (King and Zeng 2001). ReLogit models offer several advantages of particular relevance to the research question and data. Sensitive nuclear assistance is a rare event occurring in only .097 percent of the observations in the

monadic data and .0007 percent of the observations in the dyadic data. ReLogit is able to model dichotomous dependent variables and to correct for biased estimates in rare events. I employ Beck, Katz, and Tucker's (1998) approach to correct for temporal dependence in the dependent variable. Robust standard errors are adjusted for clustering by country in the regressions on the monadic data and by dyad in the dyadic data.

To begin the investigation, a model was estimated using the monadic international nuclear assistance dataset. Table 2 presents the estimates of the model featuring strategic, institutional, and economic variables. Model 1 reveals that superpower dependence has a strong and significant effect on the dependent variable. Consistent with the strategic theory of nuclear assistance, superpowers and states dependent on superpowers are less likely to provide international nuclear assistance (insert Table 2).

The next group of potential explanatory variables focuses on the institutional arrangements of potential nuclear suppliers. Contrary to the expectation that an open domestic political system, or membership in the key institutions of the nonproliferation regime may reduce instances of nuclear transfer, the variables measuring democracy, membership in the Nonproliferation Treaty, and membership in the Nuclear Suppliers Group, have positive coefficients and fail to achieve statistical significance.

The final group of variables taps economic determinants of international nuclear assistance. Per capita GDP and trade openness have negative coefficients and neither variable achieves statistical significance. Taken together this analysis suggests that strategic, and not institutional or economic, factors shape state decisions to provide sensitive nuclear assistance.

The analysis of the monadic data is only the first step, however. In order to analyze the characteristics of the recipients and the relationship between the supplier and the recipient, I turn to the dyadic international nuclear assistance dataset.

Table 3 presents the estimates of the ReLogit models using the dyadic data. Model 2 estimates a model using the disputes variable and the superpower dependence variables constructed from the Affinity of Nations index. Model 3 estimates the same model substituting the rivalry variable and the superpower dependence variables constructed with the alliance data. Model 4 presents a trimmed version of model 2 with the variables that were significant at better than the 10% level.

In these models, the findings are, once again, consistent with the strategic hypotheses. The coefficients for relative power, superpower dependence of the supplier, and disputes/rivalry of the recipient, are all in the expected direction and they are all statistically significant across all models. In models 2 and 4, the coefficient for the superpower dependence of the recipient is in the expected direction and is statistically significant (insert Table 3).

By contrast, the institutional variables do not perform nearly as well. The democracy and NPT variables do not reach statistical significance in any of the models. The variable for NSG membership is statistically significant in models 2 and 4 and has a positive coefficient suggesting that membership in the nuclear cartel may actually facilitate sensitive nuclear transfers. This result, however, is not robust across alternative specifications of the model. This variable fails to achieve statistical significance in model 3. Taken together, domestic and international institutions appear to have little effect on states' propensity to provide sensitive nuclear assistance.

The set of economic variables do not appear to offer much explanatory power either. The variables measuring openness and per capita GDP of the supplier do not attain statistical significance in any of the models. In models 2 and 4, the variable for economic growth is statistically significant. The sign on the coefficient is positive, however, contrary to the expectation that, among capable nuclear suppliers, states with lower levels of economic growth will be more likely to provide sensitive nuclear assistance. The coefficient for trade dependence is in the expected direction and is statistically significant in model 2 suggesting that states may be more likely to provide assistance to states with which they have an important trade relationship. These variables, however, are not robust across alternative specifications of the model. Neither the growth nor the trade dependence variable reaches statistical significance in model 3 and the trade dependence variable does not achieve statistical significance in the trimmed model.

The final group of variables controls for the demand-side factors that could influence patterns of nuclear assistance. Consistent with work by Singh and Way (2004), these models find that states that are open to the international economy are less likely to receive sensitive nuclear assistance. The coefficient on this variable is negative and statistically significant in all of the models. States may also be reluctant to seek sensitive nuclear assistance from geographically distant states. The coefficient on the distance variable is in the expected direction in all three models, but is statistically significant only in the trimmed model. Economic development and economic liberalization do not appear to influence states' propensity to receive sensitive nuclear assistance. In models 2 and 3, the coefficient for per capita GDP of the recipient is negative and does not reach

statistical significance. The sign on the coefficient for economic liberalization changes directions, from negative in model 2 to positive in model 3, and is not statistically significant in either model. This finding is not necessarily at odds with arguments that developed states (Singh and Way 2004) or closed states (Solingen 1994, 1998; Paul 2000; Singh and Way 2004) are more likely to pursue nuclear weapons. Developed or closed states could simultaneously be more likely to pursue nuclear weapons and less likely to receive sensitive nuclear assistance because they are more likely to produce nuclear weapons indigenously without seeking external support.

Although the strategic variables attain statistical significance, how significant are they substantively in shaping the likelihood that a sensitive nuclear transaction will occur? Table 4 interprets the substantive role played by the strategic variables for decisions to provide sensitive nuclear assistance. The entries represent the relative risks (King and Zeng 2001) that nuclear assistance will occur for a given change in the independent variable when all other variables are held at their mean.[19] For example, a state that lacks the ability to project conventional military power over a potential recipient is nearly three times more likely to provide nuclear assistance than a comparable state that has a force projection capability over the potential recipient. A state that is not dependent on a superpower patron is nearly fifteen times more likely to provide sensitive nuclear assistance than a similar state that is dependent on a superpower. And a state that is not dependent on a superpower patron is more than ten times more likely to receive sensitive nuclear assistance than a similar state that is dependent on a superpower. Furthermore, a state that is involved in an average of two militarized interstate disputes over a five year period is about two and a half times more

likely to receive international nuclear assistance than a comparable state that is not involved in a dispute.

The substantive importance of these variables is equally impressive when taken together. Sensitive nuclear assistance, a rare event, is extremely unlikely to occur under typical circumstances. In fact, the baseline probability that a nuclear transaction will occur in any given dyad year when all of the explanatory variables are held at their means is .00. When the four strategic variables are set to the worst case scenario (i.e., relative power and the superpower dependence variables set at their minimum and the disputes variable set at its maximum), however, and all other variables are held at their means, the probability of sensitive nuclear assistance skyrockets to .93. Taken together these examples indicate that strategic factors have not just a statistically significant but, also, a substantively significant effect on decisions to provide sensitive nuclear assistance.

ROBUSTNESS CHECK

Special attention to the robustness of the estimates of the coefficients and their variance is warranted because of the relatively small number of nuclear transactions and due to potential alternate codings of the universe of cases. I include states as potential suppliers from the time at which they first successfully operated a sensitive fuel-cycle facility until the end of the study. For example, France's first reprocessing facility went online in 1958 and France has continually operated reprocessing facilities to the present day. France is coded as a capable nuclear supplier from 1958-2002. Some supplier states, however, did not continually operate domestic fuel-cycle facilities. For example, Norway first operated a reprocessing facility in 1961 and decommissioned it in 1968. Yet, having already developed the technology required to produce a domestic

reprocessing facility, had Norway decided to provide basic international reprocessing assistance at anytime between 1968 and the present, it almost certainly retained a latent capability to do so. For this reason, Norway is coded as a capable nuclear supplier from 1961-2002. One could argue, however, that the ability to provide reliable nuclear assistance atrophies when a country decommissions its domestic fuel cycle facilities. To test the robustness of my findings, a series of models were estimated coding states as capable suppliers only while they were operating domestic fuel cycle facilities. For example, in this universe of cases, Norway is coded as a capable supplier from 1961-1968. Running models based on this coding reveals that the results are not very sensitive to an alternative definition of the universe of suppliers. An example is shown in Table 5, model 5. The coefficients for relative power, superpower dependence of the supplier, and disputes are in the expected direction and statistically signifigant. The coefficient for superpower dependence of the recipient is in the expected direction, but does not reach standard levels of statistical significance.

A second robustness check experimented with alternate codings of the universe on the recipient side. I do not address the provision of sensitive nuclear assistance to states that already have nuclear weapons, yet determining exactly when some states crossed the nuclear threshold is difficult. North Korea provides a paradigmatic case. While North Korea had enough fissile material to produce a nuclear weapon in the early 1990's, experts disagree as to whether North Korea has produced a functioning nuclear device. The coding of this case is particularly important because it determines whether Pakistan's assistance to North Korea from 1997 to 2002 is counted as a case of sensitive nuclear assistance to a nonnuclear-weapon state. This instance of assistance was initially

included in the study because Pakistan's assistance almost certainly materially contributed to North Korea's attempt to become a nuclear power. Nevertheless, to assess the influence of this coding decision, a series of models were run that exclude the Pakistani-North Korean transactions. The results are shown in Table 5, model 6. Again, the results are not sensitive to alternate codings of the universe of cases.

CONCLUSION

A better understanding of why states provide sensitive nuclear assistance is essential for policymakers who seek to stem the proliferation of nuclear weapons. Sensitive nuclear transactions, situations in which supplier states make a significant investment in the military capabilities of another state, also present a fundamental puzzle to international relations theorists.

This article argues that the provision of nuclear assistance is consistent with realist approaches to international relations theory. The issue of international nuclear assistance can be understood as a dynamic strategic game between powerful and weak states. The story told by the evidence presented here suggests that states with relatively low levels of conventional military power have incentives to provide international nuclear assistance and may even use international nuclear assistance as a way to constrain more powerful states. Superpowers have an interest in preventing nuclear proliferation and they leverage their influence to reign in the potential participants in international nuclear transactions. Their success in inducing restraint depends on the target state's vulnerability to superpower pressure. Nonaligned states can afford to absorb the costs of superpower displeasure and can choose to proceed with nuclear transactions, while states

closely aligned with one of the international system's superpowers wish to avoid antagonizing a powerful patron and refrain from engaging in international nuclear transactions.

This argument also speaks to the broader literature on nuclear proliferation. In contrast to preexisting approaches, this article argues that nuclear proliferation produces uneven effects. Because nuclear proliferation devalues conventional military power, powerful states have the most to lose from nuclear proliferation and will most vigorously oppose it. On the other hand, relatively weak states pay fewer costs when nuclear proliferation occurs and can actually benefit from targeted proliferation that constrains rival states.

If this argument is correct, we should expect to see systematic correlation between a state's conventional military power and its nuclear proliferation preferences across a wide variety of nonproliferation issue areas. For example, states with the ability to project conventional military power over a potential proliferator should not only be less likely to provide sensitive nuclear assistance to that state, they should also be more likely to consider preemptive military strikes on its nuclear facilities, and to take a hard line against its nuclear program in the International Atomic Energy Agency's Board of Governors and in the United Nations Security Council (UNSC). This argument is consistent with empirical patterns of nonproliferation behavior. For example, during the Cold War, both superpowers, the Soviet Union and the United States, considered preemptive strikes against China's nuclear weapons program in the 1960s (Gavin 2004/2005) and, it has been the United States, the most powerful of the permanent five

members of the UNSC, that has consistently taken the most forceful position in the recent standoff over Iran's nuclear weapons program.

Turning to U.S. foreign policy, this analysis concurs with those who warn that North Korea is a likely candidate to proliferate sensitive nuclear technology (Gertz 2004). Contrary, to the prevailing wisdom, however, this danger arises not from North Korea's economic circumstances, but its strategic environment. North Korea is a nuclear capable state that has a relatively limited conventional force projection capability and thus pays few opportunity costs when other states cross the nuclear threshold. North Korea's rogue status and its corresponding poor relationship with the United States leaves the international system's remaining superpower with few tools to influence Pyongyang's decision-making calculus. Furthermore, given North Korea's fear of U.S. power, Pyongyang could proliferate to a state in a distant region, such as Iran, as a way to reorient a share of America's strategic attention away from Northeast Asia. Pakistan and Russia are other states that continue to pose a proliferation threat according to a similar logic.

Since it is the states with which the United States has the least influence that are most likely to proliferate, the United States has few effective tools to reduce sensitive nuclear exports in the short term. The provision of security guarantees, however, has long been recognized as an effective tool in reducing states' demand for nuclear weapons. The findings presented here suggest that states protected under a superpower security umbrella are also less likely to supply nuclear assistance. Over the long term, the United States can seek to disincentivize proliferation by extending security guarantees and improving bilateral relationships with capable nuclear suppliers.

TABLE 1
(Available from the author upon request)

TABLE 2
ReLogit Regressions of
International Nuclear Assistance, Monadic data, 1945-2002

Independent Variable	Coefficient	(SE)	p-Value
Model 1			
Strategic			
Superpower dependence (supplier)	**-0.908**	**0.421**	**0.031**
Institutional			
Democracy	0.022	0.047	0.646
NPT membership (supplier)	0.411	0.473	0.385
NSG membership	0.838	0.982	0.394
Economic			
Openness (supplier)	-0.319	0.015	0.830
Per Capita GDP (Supplier)	-0.026	0.087	0.769
Constant	0.690	0.723	0.340

NOTE: Robust standard errors are adjusted for clustering by country. Coefficients that are significant at better than the 5% level are in bold. The model is estimated after including spline corrections for temporal dependence (Beck, Katz, and Tucker 1998). N=626.

TABLE 3
ReLogit Regressions of
International Nuclear Assistance, Dyadic data, 1945-2002

Independent Variable	Coefficient	(SE)	p-Value
Model 2[20]			
Strategic			
Relative power	**-35.547**	**12.758**	**0.005**
Superpower dependence (supplier)	**-3.764**	**0.872**	**0.000**
Superpower dependence (recipient)	**-1.749**	**0.669**	**0.009**
Disputes (recipient)	**0.515**	**0.084**	**0.000**
Institutional			
Democracy	0.043	0.039	0.279
NPT membership (supplier)	-0.943	0.767	0.219
NPT membership (recipient)	-0.526	0.493	0.286
NSG membership	**2.995**	**1.214**	**0.014**
Economic			
Per Capita GDP (supplier)	-0.101	0.084	0.226
Growth	**9.855**	**4.513**	**0.029**
Openness (supplier)	-0.565	0.831	0.497
Trade dependence	**32.298**	**6.401**	**0.000**
Demand Controls			
Per Capita GDP (recipient)	-0.028	0.038	0.459
Liberalization (recipient)	-0.014	0.019	0.471
Openness (recipient)	**-1.193**	**0.406**	**0.003**
Distance	-0.143	0.084	0.090
Constant	1.866	1.173	0.112
Model 3[21]			
Strategic			
Relative power	**-38.588**	**8.021**	**0.000**
Superpower dependence (supplier)	**-1.56**	**0.329**	**0.000**
Superpower dependence (recipient)	0.009	0.569	0.987
Rivalry (recipient)	**1.271**	**0.527**	**0.016**
Institutional			
Democracy	0.074	0.057	0.188
NPT membership (supplier)	0.238	0.612	0.697
NPT membership (recipient)	0.417	0.572	0.466
NSG membership	1.523	0.914	0.096
Economic			
Per Capita GDP (supplier)	-0.021	0.086	0.812
Growth	7.969	5.797	0.169
Openness (supplier)	0.314	0.990	0.751
Trade dependence	17.393	13.235	0.189
Demand Controls			

Per Capita GDP (recipient)	0.015	0.030	0.619
Liberalization (recipient)	0.009	0.020	0.653
Openness (recipient)	**-1.363**	**0.543**	**0.012**
Distance	-0.152	0.0776	0.050
Constant	-1.949	0.676	0.004
Model 4[22]			
Strategic			
Relative power	**-39.892**	**13.973**	**0.004**
Superpower dependence (supplier)	**-3.686**	**0.805**	**0.000**
Superpower dependence (recipient)	**-1.294**	**0.621**	**0.037**
Disputes (recipient)	**0.505**	**0.086**	**0.000**
Institutional			
NSG membership	**1.497**	**0.556**	**0.007**
Economic			
Growth	**9.855**	**4.513**	**0.029**
Trade dependence	11.466	17.966	0.523
Demand Controls			
Openness (recipient)	**-1.105**	**0.418**	**0.008**
Distance	**-0.170**	**0.073**	**0.019**
Constant	0.727	0.932	0.435

NOTE: Robust standard errors are adjusted for clustering by dyad. Coefficients that are significant at better than the 5% level are in bold. Each model is estimated after including spline corrections for temporal dependence (Beck, Katz, and Tucker 1998).

TABLE 4
Substantive Effects of Selected Strategic Explanatory Variables
On the Likelihood of International Nuclear Assistance

Variable	Relative Risks	95% Confidence Intervals
Relative power	2.707	1.330 to 5.652
Superpower dependence (supplier)	14.550	4.577 to 48.150
Superpower dependence (recipient)	10.415	1.950 to 59.852
Disputes	2.529	1.877 to 3.454

NOTE: These probabilities are calculated using the ReLogit estimates in model 2 of Table 2. All ratios represent the effects of a change in the independent variable from the 95th percentile to the 5th percentile with the exception of the disputes variable which represents the effects of a change from the 5th percentile to the 95th percentile. All other variables are held at their means.

TABLE 5
Robustness Check
ReLogit Regressions of
International Nuclear Assistance, Dyadic data, 1945-2002

Independent Variable	Coefficient	(SE)	p-Value
Model 5[23]			
Strategic			
Relative power	**-27.537**	**11.579**	**0.017**
Superpower dependence (supplier)	**-2.316**	**0.653**	**0.000**
Superpower dependence (recipient)	-1.135	0.711	0.110
Disputes (recipient)	**0.473**	**0.072**	**0.000**
Institutional			
Democracy	-0.032	0.039	0.359
NPT membership (supplier)	-1.081	0.651	0.097
NPT membership (recipient)	-0.425	0.512	0.406
NSG membership	**3.550**	**1.117**	**0.001**
Economic			
Per Capita GDP (supplier)	-0.102	0.071	0.150
Growth	**6.213**	**1.417**	**0.000**
Openness (supplier)	-0.839	0.700	0.231
Trade dependence	**26.506**	**4.649**	**0.000**
Demand Controls			
Per Capita GDP (recipient)	-0.102	0.071	0.150
Liberalization (recipient)	0.001	0.029	0.963
Openness (recipient)	**-2.565**	**0.785**	**0.001**
Distance	-0.209	0.108	0.054
Constant	1.988	1.013	0.050
Model 6[24]			
Strategic			
Relative power	**-34.375**	**13.811**	**0.013**
Superpower dependence (supplier)	**-3.115**	**0.473**	**0.000**
Superpower dependence (recipient)	**-1.685**	**0.682**	**0.013**
Disputes (recipient)	**0.512**	**0.083**	**0.000**
Institutional			
Democracy	0.049	0.041	0.228
NPT membership (supplier)	-0.757	0.759	0.319
NPT membership (recipient)	-0.560	0.496	0.258
NSG membership	**3.000**	**1.254**	**0.017**
Economic			
Per Capita GDP (supplier)	-0.104	0.091	0.251
Growth	**11.440**	**4.585**	**0.013**
Openness (supplier)	-0.409	0.865	0.637
Trade dependence	**34.130**	**6.173**	**0.000**

Demand Controls			
Per Capita GDP (recipient)	-0.104	0.091	0.251
Liberalization (recipient)	-0.015	0.019	0.428
Openness (recipient)	**-1.093**	**0.408**	**0.007**
Distance	-0.140	0.085	0.102
Constant	1.322	1.064	0.214

NOTE: Robust standard errors are adjusted for clustering by dyad. Coefficients that are significant at better than the 5% level are in bold. Each model is estimated after including spline corrections for temporal dependence (Beck, Katz, and Tucker 1998).

APPENDIX A

(Available from the author upon request)

REFERENCES

Albright, D., F. Berkhout, and W. Walker. 1997. *Plutonium and highly enriched uranium 1996: World inventories, capabilities, and policies.* Oxford: Oxford University Press.

Barbash, F. 2006. Iran says it would transfer nuclear technology. *Washington Post.* 26 April: A-19.

Beck, N., J. Katz, and R. Tucker. 1998. Taking time seriously: Time-series-cross-section analysis with a binary dependent variable. *American Journal of Political Science* 42(4): 1260-88.

Bennett, S.D. 1998. Integrating and testing models of rivalry termination. *American Journal of Political Science* 42: 1200-32.

Bennett, S.D. and A. Stam. 2000. EUGene: A conceptual manual (version 2.4). *International Interactions* 26: 179-204.

Bhatia, Shyam. 1988. *Nuclear rivals in the Middle East.* New York: Routledge.

Bueno de Mesquita, B. 1981. *The war trap.* New Haven: Yale University Press.

Bueno de Mesquita, B. and W. H. Riker. 1982. An assessment of the merits of selective nuclear proliferation. *Journal of Conflict Resolution.* 26 (2).

Cirincione, J. with J.B. Wolfsthal and M. Rajkumar. 2002. *Deadly arsenals: Tracking weapons of mass destruction.* Washington D.C.: Carnegie Endowment for International Peace.

Cohen, A. 1998. *Israel and the bomb.* New York: Colombia University Press.

Gartzke, E. 2006. *Codebook for the affinity of nations index, 1946-2002, version 3.0* accessed from http://www.columbia.edu/~eg589.

Gavin, F. J. 2005. Blasts from the past: proliferation lessons from the 1960s. *International Security*. 29 (1): 100-135.

Gertz, B. 2004. CIA report cites N. Korean proliferation threat *Washington Times* 27 November, accessed from http://washingtontimes.com/national/20041126-111219-4624r.htm

Ghosen, F. and G. Palmer. 2003. *Codebook for the militarized interstate dispute data, version 3.0*. Accessed from http://cow2.la.psu.edu.

Gibler, D.M. and M. Sarkees. 2002. *Coding manual for v3.0 of the Correlates of War formal interstate alliance data set, 1816-2000*. Unpublished manuscript.

Gleditsch, K. 2002. Expanded trade and GDP data. *Journal of Conflict Resolution* 46 (5): 712-24.

Gowing, M. 1974. *Independence and deterrence: Britain and atomic energy, 1945-1952.* London: The Macmillan Press.

Holloway, D. 1994. *Stalin and the bomb: The Soviet Union and atomic energy, 1939-1956.* New Haven: Yale University Press.

Jaggers, K. and T.R. Gurr. 1995. Tracking democracy's third wave with the Polity III data. *Journal of Peace Research* 32: 469-82.

Jervis, R. 1989. *The meaning of the nuclear revolution: Statecraft and the prospect of armageddon*. Ithaca NY: Cornell University Press.

Jo, D.J. and E. Gartzke. 2004. *Determinants of nuclear weapons proliferation*. Unpublished manuscript.

Jones, R.W., C. Merlini, J. F. Pilat and W. C. Potter, eds. 1985. *The nuclear suppliers*

and nonproliferation: International policy choices. Lexington Ma: Lexington Books.
Jones, R.W. and M.G. McDonough with T.F. Dalton and G.D. Koblentz. 1998. *Tracking nuclear proliferation: A guide in maps and charts.* Washington D.C. Carnegie Endowment for International Peace.
Kapur, S.P. 2005. India and Pakistan's unstable peace: Why nuclear South Asia is not like Cold War Europe. *International Security* 30 (2): 127-152.
Keohane, R.O. 1984. *After hegemony: Cooperation and discord in the world political economy.* Princeton NJ: Princeton University Press.
King, G., M. Tomz, and J. Wittenberg. 2000. Making the most of statistical analyses: Improving interpretation and presentation," *American Journal of Political Science* 44 (2): 341-355
King G. and L. Zeng. 2001. Logistic regression in rare events data. *Political Analysis* 9 (2).
Langeweische, W. 2005. The wrath of Khan. *The Atlantic Monthly*. November.
Lewis, J.W. and X. Litai. 1988. *China builds the bomb.* Stanford: Stanford University Press.
Mearsheimer, J.J. 1990. Back to the Future: Instability in Europe after the Cold War. *International Security.* 15, (1): 5-56.
----------. The Case for a Ukranian nuclear deterrent. *Foreign Affairs.* 72 (3): 50-66.
Mearsheimer, J.J. and Stephen Walt. 2003. An unnecessary war. *Foreign Policy*. 134: 50-59.
Montgomery, A. 2005. Ringing in proliferation: How to dismantle an atomic bomb network. *International Security* 30 (2): 153-187.
Nichol, J.P. and G.L. McDaniel. 1982. Yugoslavia. In Nuclear power in developing countries, edited by J.E. Katz and O.S. Marwah. Lexington MA: Lexington Books.
Oneal, J.R. and B. Russet. 1997. The Classical liberals were right: Democracy, interdependence, and conflict, 1945-1980. *International Studies Quarterly* 41 (2): 267-294.
Pape, R.A. 2005. Soft balancing against the United States. *International Security* 30 (5): 7-45.
Paul, T.V. 2000. Power versus prudence: Why nations forgo nuclear weapons. Montreal: McGill-Queen's University Press.
----------. 2003. Chinese-Pakistani nuclear/missile ties and balance of power politics. *The Nonproliferation Review* 10 (2): 21-29.
----------. 2005. Soft balancing in the age of U.S. primacy. *International Security* 30 (5): 46-71.
Perkovich, G. 1999. India's nuclear bomb: The impact on global proliferation. Berkeley: University of California Press.
Posen, B. R. 1993. The security dilemma and ethnic conflict. *Survival.* 35 (1): 44-45.
----------. 2006. We can live with a nuclear Iran. *New York Times.* 27 February.
Potter, W.C. 1982. Nuclear power and nonproliferation: An interdisciplinary perspective. Cambridge, UK: Oelgeschlager Gunn and Hain.
---------- ed. 1990. *International nuclear trade and nonproliferation: The challenge of*

the emerging nuclear suppliers. Lexington, MA: Lexington Books.
Powell. R. 1990. *Nuclear deterrence theory: The search for credibility.* Cambridge MA: Cambridge University Press.
----------. 1991. Absolute and relative gains in international relations theory. *American Political Science Review* 85 (4): 1303-1320.
Reiss, M. 1988. *Without the bomb: The politics of nuclear nonproliferation.* New York: Columbia University Press.
Rogers, B. and Z. Cervenka. 1978. *The nuclear axis: Secret collaboration between West Germany and South Africa.* New York: Times Books.
Sagan, S. D. 1993. *The limits of safety: Organizations, accidents, and nuclear weapons*. Princeton, NJ: Princeton University Press.
----------. 1995. "More Will Be Worse." In S.D. Sagan and K. N. Waltz. *The Spread of Nuclear Weapons: A Debate.* New York/London: W.W. Norton & Company.
----------. 1996/1997. Why do states build nuclear weapons: Three models in search of a bomb. *International Security* 21 (3): 54-86.
----------. 2000. Rethinking the causes of nuclear proliferation: Three models in search of a bomb? In *The coming crisis: Nuclear proliferation, U.S. interests, and world order,* edited by V.A. Utgoff, 17-50. Cambridge, MA: MIT Press.
Sands, A. 1990. Emerging nuclear suppliers: What's the beef? In W.C. Potter, ed. *International nuclear trade and nonproliferation.* Lexington, MA: Lexington Books.
Scheinman, L. 1965. *Atomic Energy Policy in France Under the Fourth Republic*. Princeton, N.J.: Princeton University Press.
----------. 2004. The nuclear fuel cycle: A challenge for nonproliferation. *Disarmament Diplomacy*. (76).
Schelling, T. 1966. *Arms and influence*. New Haven: Yale University Press.
Shuey, R. and S.A. Kan. 1995. Chinese missile and nuclear proliferation: Issues for Congress. *CRS Issue Brief*, 29 September: 9.
Singer, J.D., S. Bremer, and J. Stuckey. 1972. Capability, distribution, uncertainty, and major power war, 1820-1965. In *Peace, war, and numbers*, edited by B. Russett. Beverly Hills, CA: Sage.
Singh, S. and C. R. Way. 2004. The correlates of nuclear proliferation: a quantitative test. *Journal of Conflict Resolution.* 48 (6): 859-885.
Snyder, G.H. 1965. The balance of power and the balance of terror In *The balance of power*, edited by Paul Seabury. San Francisco: Chandler.
Spector, L. 1988. *Nuclear proliferation today*. Cambridge, MA: Ballinger Publishing.
----------. 1990. *Nuclear ambitions: The spread of nuclear weapons 1989-1990.* Boulder: Westview Press.
Solingen, E. 1994. The political economy of nuclear restraint. *International Security* 19 (2): 126-69.
----------. 1998. *Regional orders at century's dawn: Global and domestic influences on grand strategy.* Princeton, NJ: Princeton University Press.
Strulak, T. 1993. The Nuclear Suppliers Group. *Nonproliferation Review* 1(1):1–10.
Thomas, M.A. and R. Santanam. 2002. Government agencies investigated missing uranium, NUMEC. *Valley News Dispatch*, August 25.

Tucker, R. 1999. BTSCS: A binary time-series-cross-section data analysis utility (version 4.04, June 28). Cambridge, MA: Harvard University.
Van Evera, S. 1990/91. Primed for peace: Europe after the Cold War. *International Security.* 15 (3): 54.
Waltz, K. 1979. *Theory of international politics.* Reading, MA: Addison-Wesley.
----------. 1995. "More may be better." In S. D. Sagan and K. N. Waltz *The Spread of Nuclear Weapons: A Debate.* New York/London: W.W. Norton & Company.
Weber, S. 1991. Cooperation and interdependence. *Daedalus* 120 (2): 183-201.
Weissman S. and H. Krosney. 1981. *The Islamic bomb.* New York: Times Books.

END NOTES

[1] The argument that nuclear weapons devalue conventional military power is consistent with the foundational work on the nuclear revolution. Beginning with Thomas Schelling (1966), scholars have argued that when nuclear weapons are introduced into a strategic relationship, political conflicts of interests are transformed from a "competition in military capabilities" to a "competition in risk taking" (Schelling 1966, Jervis 1989, Powell 1990). According to the traditional model of warfare, political conflicts of interests are won by the states with the greatest military might, but in a world of mutually assured destruction, neither side can unleash its full military potential for fear of initiating a suicidal nuclear exchange. Instead, states play a game of brinksmanship, engaging in tactics that gradually escalate the risk of nuclear war in the hope that their rival will back down. Political conflicts of interest in a nuclear world are won, not by the most powerful state, but by the state with the highest level of resolve. While these scholars did not take the argument to the next step, it would follow that states with high levels of conventional military power have the most to lose from a transition to a nuclear world. In a relationship with nonnuclear states, the military capability of powerful states is a valuable currency. In a conflict with a nuclear power, however, conventional military power is largely irrelevant as powerful states are forced to concede to the demands of less powerful, but more highly resolved opponents. One could argue that mutually assured destruction increases the importance of conventional military power, but this argument rests on shaky theoretical and empirical grounds. According to the stability-instability paradox (Snyder 1965), high levels of stability at the strategic nuclear level create space for low levels of conventional conflict without the fear of escalation to nuclear war. From a theoretical perspective, however, the stability-instability paradox can be understood as nothing more than a special case of Schelling's (1966) brinksmanship model. What appears to be increased conventional conflict between new nuclear states is actually a game of brinksmanship as the states attempt to bid up the risk of war to force a less resolved opponent to back down (I thank Robert Powell for pointing this out to me). Scholars have also shown that the stability-instability paradox does a poor job of explaining the empirical record of relationships between nuclear powers (Kapur 2005).

[2] On relative gains see Powell (1991).

[3] See Barbash (2006) and Gertz (2004).

[4] On why states want nuclear weapons see for instance, Singh and Way (2004); Jo and Gartzke (2004); Sagan (1996/97); Solingen (1994, 1998); on the nuclear revolution see Schelling, (1966); Jervis (1989); Powell (1990); Sagan (1993, 1996/97); Waltz (1979, 1995); Weber (1991).

[5] For single country case studies of nuclear weapons programs see for instance, Cohen (1998); Holloway (1994); Lewis and Litai (1988); Paul (2003); Perkovich (1999); Scheinman (1965); For policy work on international nuclear trade see Potter (1982,1990); Jones, et al. (1985).

[6] For sources used in the construction of the dataset see Table 1 and notes 22-34.

[7] The level of official state involvement in cases of nuclear assistance can vary from high-level government to government agreements to smuggling activity by individuals without the state's awareness. Since this study is interested in factors motivating states to provide assistance, cases of pure smuggling were excluded. To be included in this dataset, high-level officials in the supplier state must have been aware of and condoned the nuclear transaction. Almost every case of nuclear assistance, including recent Pakistani assistance, is counted as state-sponsored by this definition. This definition excludes as few as one, and up to as many as three, cases of nuclear smuggling. A.Q. Khan's smuggling of enrichment designs and equipment from the Netherlands to Pakistan in the mid-1970s is excluded. It was a case of pure smuggling in which the Dutch government had no involvement (Langeweische 2005). There is also speculation, but no firm evidence, that a German firm assisted South Africa with uranium enrichment from 1968-1972 after the German cabinet explicitly prohibited the cooperation (Rogers and Cervenka 1978). Finally, in the mid-1960's weapons grade uranium disappeared from a nuclear facility in the United States. Again there is no firm evidence, though some have speculated that it may have been sold to the Israelis by a Jewish-American businessman. Several federal investigations turned up no evidence of wrongdoing. See Thomas and Santanam, **(**2002).

[8] Assistance in the construction and design of a nuclear weapon is unambiguously weapons related and should obviously be included in any measure of sensitive nuclear assistance. Nuclear weapons experts have long recognized, however, that the most difficult step to acquiring a nuclear weapons capability is the ability to produce weapons-grade fissile material. Uranium enrichment and plutonium reprocessing are the

two means by which one produces weapons-grade fissile material and given a certain level of technological infrastructure, it is quite easy for most states to transform a robust uranium enrichment or plutonium reprocessing capability into a nuclear weapon. States, then, that transfer weapons-grade fissile material to other states, or that assist other states in the construction of uranium enrichment or plutonium reprocessing facilities are knowingly enabling other states to leap over the tallest hurdle on their track to a nuclear weapons arsenal. While some of these fuel-cycle technologies can be used for peaceful purposes, once the recipient state has acquired the capability, there is no guarantee that the state will not, at some point, decide to use the capability to develop a nuclear weapons arsenal. This definition of sensitive nuclear assistance excludes other types of nuclear transactions including: the transfer of delivery vehicles, the provision of fuel-cycle services, assistance in the surveying and mining of natural uranium, and the construction of fuel fabrication facilities, uranium conversion facilities, and research and power reactors. Why states decide to help other states develop delivery vehicles such as long-range missiles is an interesting question, but beyond the nuclear focus of this study. The provision of fuel-cycle services, in which nuclear capable states enrich uranium or reprocess plutonium for other states, is not included in my measure of sensitive nuclear assistance because it does not assist, but rather impedes, the other state's nuclear weapons ambitions by obviating the need for them to construct their own domestic fuel-cycle facilities. Finally, the other types of civilian nuclear assistance listed could never result in a nuclear weapons capability if the recipient state lacks a uranium enrichment and a plutonium reprocessing capability.

[9] The difference in the number of instances of nuclear assistance in the monadic and dyadic data is due to cases in which the same supplier country provides sensitive nuclear assistance to multiple countries in the same year. For example, from 1997-2001 North Korea provided sensitive nuclear assistance to both Libya and North Korea.

[10] Data are from Correlates of War Composite Index Capabilities, version 3.01 (Singer, Bremer, and Stuckey 1972), extracted using EUGene (Bennet and Stam 2000).

[11] Data are from Eric Gartzke (2006) Affinity of Nations index. Scores range from -1(least similar) to 1 (most similar) Data are interpolated for missing values (There are no UNGA votes in 1964).

[12] This variable draws on Bennet's (1998) coding for enduring rivalries.

[13] Information on membership in the Nuclear Nonproliferation Treaty is from the Institute for Defense Disarmament accessed online at http://www.idds.org/issNucTreatiesNPT.html; Nuclear Supplier Group information is taken from Strulak (1993): 1-10.

[14] Data are from Gleditsch (2002), extracted using EUGene (Bennet and Stam 2000).

[15] Data are from Gleditsch (2002), extracted using EUGene (Bennet and Stam 2000).

[16] Data are from Singh and Way (2004).

[17] Data are from Gleditsch (2002) extracted using EUGene (Bennet and Stam 2000).

[18] Data are from Correlates of War and extracted using EUGene (Bennet and Stam 2000).

[19] Table 4 also reports the confidence bounds using the procedure developed by King, Tomz, and Wittenburg (2000).

[20] N=76215.

[21] N=82453.

[22] N=76310.

[23] N=64504. States are coded as capable nuclear suppliers only while they are operating domestic fuel cycle facilities.

[24] N=76089. North Korea is coded as nuclear power beginning in 1993.