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Exporting the Bomb: Why States Provide Sensitive Nuclear Assistance

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Why do states provide sensitive nuclear assistance to nonnuclear weapon states, contributing to the international spread of nuclear weapons? Using a new data set on sensitive nuclear transfers, this article analyzes the determinants of sensitive nuclear assistance. I first describe a simple logic of the differential effects of nuclear proliferation, which I use to generate hypotheses about the conditions under which states provide sensitive nuclear assistance. I then show that the strategic characteristics of the potential nuclear suppliers are the most important determinants of sensitive nuclear assistance. Explanations that emphasize the importance of economic motivations do not find support in the data. This article presents a new approach to the study of the spread of nuclear weapons, focusing on the supply side of nuclear proliferation.

Nuclear proliferation is widely considered to pose a grave threat to international peace and security. For this reason, politicians, policy makers, and academics worry that nuclear-capable states may provide sensitive nuclear assistance to other states or terrorist networks, further fueling the spread of nuclear weapons. For example, following North Korea's nuclear test in October 2006, George W. Bush threatened that "The transfer of nuclear weapons or material by North Korea to states or non-state entities would be considered a grave threat to the United States, and we would hold North Korea fully accountable of the consequences of such action."[1]

The empirical record provides justification for such concern. Although states, to the best of our knowledge, have never provided sensitive nuclear assistance to terrorists, they have repeatedly transferred sensitive nuclear materials and technology to other states. From 1959 to 1965, France provided Israel with sensitive nuclear assistance and, a mere two years after the end of French assistance, Israel is believed to have constructed its first nuclear weapon. This story about a state helping another state to develop nuclear weapons is neither unique nor confined to the distant past. China assisted Pakistan with its nuclear program in the early 1980s with a package that included uranium enrichment technology, weapons-grade uranium, and a nuclear weapon design. Shortly thereafter, Pakistan is believed to have assembled its first nuclear bomb. More recently, from 1987 to 2002, Pakistan, with the help of Pakistani nuclear scientist A.Q. Khan, distributed sensitive nuclear technology and materials to Iran, Libya, and North Korea.[2] Since the end of this cooperation in 2002, Libya has agreed to give up its nuclear program, but North Korea has already tested its first nuclear device, and Iran is making steady progress on its own nuclear capability. These are a few of the many important cases of sensitive nuclear assistance that have contributed to the proliferation of nuclear weapons.

Yet, there is significant variation in the patterns of sensitive nuclear assistance. Although some nuclear-capable states repeatedly provide sensitive nuclear assistance, many others refrain from providing sensitive nuclear assistance altogether. Indeed, it is puzzling that states would transfer materials and technology that could help other states acquire nuclear weapons, the world's most destructive weapons, and weapons that could one day threaten the suppliers' very existence. This raises an interesting question about the motivations of the nuclear suppliers: Why do states provide sensitive nuclear assistance to nonnuclear weapon states, essentially helping other states acquire nuclear weapons?

Scholars have explained why states want nuclear weapons (e.g., Sagan 1996/1997), the causes and consequences of conventional arms sales (e.g., Blanton 2000; Kinsella 1994), and the effect of nuclear proliferation on the probability of war and crisis behavior (e.g., Powell 1990; Sagan and Waltz 1995; Schelling 1960), but have not examined the supply side of nuclear proliferation.

I describe a simple logic of the differential effects of nuclear proliferation that is grounded in the nuclear deterrence literature. I argue that the spread of nuclear weapons is more threatening for relatively powerful states than it is for relatively weak states. From this

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[1] President Bush's Statement on North Korea Nuclear Test, October 9, 2006. www.whitehouse.gov/news/releases/2006/10/20061009.html. (December 6, 2008).

[2] Pakistani assistance to Iran, Libya, and North Korea from 1987 to 2002 was state sponsored according to any reasonable definition of the term. Senior government officials, including civilian heads of state and army chiefs of staff, actively supported the policy of nuclear transfer (Bhatia 2008; Corera 2006; Frantz and Collins 2007; Langewiesche 2007; Levy and Scott-Clark 2007; Sagan 2006, 53).

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basic insight, I derive three hypotheses about the conditions under which states will be more or less likely to provide sensitive nuclear assistance. First, the more powerful a state is relative to a potential nuclear recipient, the less likely it is to provide sensitive nuclear assistance. Second, states are more likely to provide sensitive nuclear assistance to states with which they share a common enemy. Third, states that are less vulnerable to superpower pressure are more likely to provide sensitive nuclear assistance.

Drawing on a new data set on the international transfer of sensitive nuclear materials and technology, I find support for this strategic theory of nuclear proliferation. I find little support for the idea that economic motivations determine the patterns of sensitive nuclear assistance. I find some empirical evidence that membership in international institutions shapes the behavior of the nuclear suppliers.

This article presents a new approach to the study of the spread of nuclear weapons, focusing on the supply side of nuclear proliferation.[3] The existing theoretical literature has paid overwhelming attention to the demand side of nuclear proliferation (e.g., Sagan 1996/1997) and has thoroughly examined the factors that lead states to pursue or abandon nuclear weapons programs. Understanding why states want nuclear weapons is important, but demand-side approaches only paint part of the proliferation picture. Other states take actions designed to assist or impede states as they attempt to develop nuclear weapons. Many states with nuclear arsenals and advanced nuclear weapons programs received some form of external assistance from more advanced nuclear states. Contrarily, other states were prevented from acquiring nuclear weapons because states applied pressure on them in the form of technology denial, sanctions, or preventive military strikes. If we are to understand how and why nuclear weapons spread, it is necessary to understand the supply side of nuclear proliferation. This article provides the first theoretical explanation and empirical test of the causes of sensitive nuclear assistance.

EXPLAINING NUCLEAR PROLIFERATION AND ARMS EXPORTS

The vast scholarly literature on the causes of nuclear proliferation has thoroughly examined why states pursue or abandon nuclear weapons programs (e.g., Campbell, Einhorn, and Reiss 2004; Hymans 2006; Quester 1973; Sagan 1996/1997; Solingen 1994, 1998, 2007). In recent years, scholars have performed statistical analyses on new data sets to further our understanding of the causes of nuclear proliferation (Jo and Gartzke 2007; Singh and Way 2004). Unlike this analysis, however, these studies do not explore why states assist other states with their nuclear programs. Individual case studies have chronicled the development of national nuclear weapons programs (e.g., Cohen 1998; Holloway 1994; Lewis and Litai 1988; Perkovich 1999), including instances of sensitive nuclear transfer, but this material has not been analyzed in a cross-national, or a theoretical, perspective.

Research on conventional arms sales has examined the effect of military transfers on regional stability (e.g., Kinsella 1994; Kinsella and Tilemma 1995; Sanjin 1999) and the causes of conventional arms exports in specific supplier states. For example, Blanton (2000, 2005) has studied the link between democracy, human rights, and U.S. arms sales. Fuhrmann (N.d.) has examined U.S. exports of dual-use commodities that could be used in legitimate civilian applications or in weapons of mass destruction (WMD) programs; and Donaldson and Donaldson (2003) have explained a 2001 Russian-Chinese military cooperation agreement. This literature has not, however, systematically analyzed the causes of conventional military assistance across the entire universe of supplier states, or examined the specific problem of sensitive nuclear assistance.

The literature on the consequences of nuclear proliferation has explored how nuclear weapons affect crisis behavior and has debated the effects of nuclear proliferation on the stability of the international system. Nuclear deterrence theorists argue that states will be reluctant to use military force against nuclear-armed states for fear of nuclear retaliation (e.g., Achen and Snidal 1989; Brodie 1946; Jervis 1989; Knorr 1962; Powell 1990; Schelling 1960, 1966). Studies on U.S. foreign policy concur that the United States will be more likely to back down in confrontations with adversaries, when those adversaries possess nuclear weapons (e.g., Betts 2000; Glaser and Fetter 2001, 69; Posen 2000; Powell 2003; Waltz 1995). Building on the insights of the nuclear deterrence theorists, "proliferation optimists" have argued that the spread of nuclear weapons actually leads to greater international stability because nuclear weapons deter military aggression (e.g., Bueno de Mesquita and Riker 1982; Mearsheimer 1990, 1993; Waltz 1979, 1995). "Proliferation pessimists" counter that nuclear proliferation decreases international stability because greater numbers of states in possession of greater numbers of nuclear weapons increases the likelihood of preventive wars, crisis instability, and accidental nuclear detonation (e.g., Blair 1994; Feaver 1993; Sagan 1993, 1995; Thayer 1994). Yet, these scholars do not explain why states provide sensitive nuclear assistance, or explicitly propose an explanation for why states vary in their responses to nuclear proliferation in other states.

Others have suggested explanations for why some states may oppose proliferation more fiercely than others. Pilat (1985) and Quester (1983) argue that established nuclear weapon states should be more likely than nonnuclear weapon states to take a strong stance against the spread of nuclear weapons because they have an interest in limiting the size of the nuclear club to maximize the relative advantage of nuclear weapons possession. Other scholars (e.g., Jabko and Weber 1998; Potter 1982, 1990), and many journalists and policy analysts, attribute state behavior on nuclear proliferation issues to economic incentives. According to the economic logic, states will be unlikely to take measures to stop nuclear proliferation when

[3] Forthcoming research on the supply side of nuclear proliferation includes: Gartzke and Kroenig (N.d.); Kroenig (N.d.); Fuhrmann (N.d.).

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doing so is contrary to their economic interests. States in certain circumstances may even export sensitive nuclear materials and technology in search of economic gains. Unlike the analysis presented here, however, these authors look to nuclear weapons possession, or economic incentives, not conventional military power, as the key to unlocking proliferation preferences.

A STRATEGIC THEORY OF NUCLEAR PROLIFERATION

Drawing on the nuclear deterrence literature, I extract implications about the differential effects of nuclear proliferation on states with varying levels of conventional military power. From these insights, I develop a new, strategic theory of nuclear proliferation that I apply to the specific problem of sensitive nuclear assistance.

Theories of nuclear deterrence maintain that nuclear weapons deter states from using large-scale, conventional military force to pursue their interests (e.g., Achen and Snidal 1989; Brodie 1946; Jervis 1989; Knorr 1962; Powell 1990; Schelling 1960, 1966).[4] If this is correct, we should expect that the spread of nuclear weapons is most disadvantageous to states that have the option to use conventional military power. States with the ability to project conventional military power over a particular state have much to lose when that particular state acquires nuclear weapons.

I define *power-projection capability* over a particular state as the ability to fight a full-scale, conventional, ground war on the territory of that particular target state.[5] I define relatively powerful states as states that have the ability to project power over a particular state, as defined previously. Relatively weak states are states that lack such a force projection capability.[6]

In interactions with a nonnuclear weapon state, relatively powerful states can use their conventional military power to their advantage; they can threaten or contribute to the security of the other state. Once the other state acquires nuclear weapons, however, this source of strategic advantage is certainly placed at risk and may be fully lost. The spread of nuclear weapons deters relatively powerful states from using conventional military power to their advantage.

There are many other costs associated with nuclear proliferation for these relatively powerful states. Nuclear proliferation may reduce the effectiveness of their coercive diplomacy. It raises the possibility that they could be pulled into mediating nuclear crises. It may distract them from other strategic goals as they devote greater levels of strategic attention to new nuclear weapon states. Even if nuclear weapons are acquired by friendly states, nuclear proliferation can entail strategic costs for relatively powerful states. Nuclear-armed allies may enjoy a greater degree of security independence (Weber 1991), reducing the strategic advantages that relatively powerful states can gain by offering military protection.

In contrast, states that are unable to project conventional military power over a particular state do not incur these strategic costs to the same extent when that particular state acquires nuclear weapons. These relatively weak states are not in a position to threaten or protect the security of that particular state, so they do not forfeit a strategic advantage as nuclear weapons spread. They are too weak—to intervene militarily, to use coercive diplomacy effectively, to mediate a nuclear crisis, to devote significant levels of strategic attention beyond their own limited spheres of influence, or to extend security guarantees.

In short, when a new state acquires nuclear weapons, the strategic costs are borne disproportionately by the states that once enjoyed the ability to project conventional military power over that state. States that are better able to operate their conventional military forces against a particular state should fiercely oppose nuclear proliferation to that state because, in that instance, nuclear proliferation will constrain their conventional military power. The United States generally opposes nuclear proliferation to other states, for example, and U.S. foreign policy makers and intelligence analysts assess that nuclear proliferation threatens the United States in part because it constrains U.S. military freedom of action (see, e.g., Richelson 2006). States that are less able to use conventional military power against a particular state, however, do not incur as many strategic costs when nuclear weapons spread to that particular state, and will be less likely to vigorously oppose nuclear proliferation to that state. When asked how nuclear proliferation in North Korea would affect Pakistan's security environment, Jehangir Karamat, Pakistan's Ambassador to the United States from 2004 to 2006 and former chief of the army staff, replied, "North Korean nuclear capability does not threaten us directly."[7]

Applying this logic to the problem of sensitive nuclear assistance, we should expect that nuclear supplier states will be reluctant to provide sensitive nuclear assistance in situations that would have the effect of constraining their own military freedom of action. In other words, the greater a state's strategic advantage over a particular state, the less likely it will be to provide sensitive nuclear assistance to that state. This logic gives rise to the first hypothesis:

[4] Advocates of the stability–instability paradox (e.g., Snyder 1965) have argued that the spread of nuclear weapons may actually increase the likelihood of conventional military conflict at lower levels. The stability–instability paradox has been also contested, however, by scholars (e.g., Kapur 2005; Powell 1990) on both theoretical and empirical grounds.

[5] The term *force projection*, or *power projection capability*, is often used in the U.S. defense community to mean the possession of an aircraft carrier. I do not use force projection capability in this sense.

[6] States may have the ability to fight a conventional war against a particular state due to geographic proximity (most states have the ability to wage war against a state with which they share a common land border) or because they have the ability to project power across great distances. For example, in relation to North Korea, both South Korea (due to geographic proximity) and the United States (due to global force projection capabilities) are relatively powerful states. In contrast, Pakistan is relatively weak in relation to North Korea because Pakistan could not conceivably fight a full-scale, conventional ground war on North Korean territory.

[7] Interview with the author, April 2006.

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Hypothesis 1: *The more powerful a state is relative to a potential nuclear recipient state, the less likely it will be to provide sensitive nuclear assistance to that state.*

It is also possible, however, that the opposite relationship between relative power and sensitive nuclear assistance holds. Relatively powerful states, because they may be better able to defend against, or deter, a nuclear attack, may be less threatened by nuclear proliferation and may, therefore, be more likely to provide sensitive nuclear assistance. This counterhypothesis rests on the premise, however, that capable nuclear suppliers believe that nuclear recipients would likely use nuclear weapons, not just to deter foreign invasion, but to launch a nuclear attack. This premise is in tension with much of the nuclear weapons literature, which maintains that nuclear weapons are useful for deterring foreign invasion, but are largely ineffective instruments of warfighting (e.g., Betts 1987; Glaser 1991; Powell 2003; Schelling 1960, 1966). Still, this is a matter that cannot be definitively settled in the theoretical realm and is further evaluated in the empirical analysis.

Because nuclear proliferation entails costs for relatively powerful states, other states may actually welcome the spread of nuclear weapons in certain situations. The spread of nuclear weapons may be advantageous to states when it imposes strategic costs on other, rival states. Applied to the problem of sensitive nuclear assistance, we should expect that nuclear supplier states can provide sensitive nuclear assistance in order to impose strategic costs on rivals.[8] For example, from 1959 to 1965, France provided sensitive nuclear assistance to Israel, then Egypt's key rival, to constrain Egypt's growing military power in the Middle East (e.g., Cohen 1998). China's sensitive nuclear assistance to Pakistan in the early 1980s was widely seen as a means of imposing strategic costs on India and diverting New Delhi's strategic attention away from Beijing (e.g., Corera 2006; Paul 2003). If states are to provide sensitive nuclear assistance to constrain rival states, we should expect them to provide sensitive nuclear assistance to states with which they share a common enemy. These are precisely the situations in which sensitive nuclear assistance can impose strategic costs on a rival state. This logic leads to the second hypothesis:

Hypothesis 2: *States will be more likely to provide sensitive nuclear assistance to states with which they share a common enemy.*

States that are most disadvantaged by nuclear proliferation act to prevent it. The differential effects of nuclear proliferation invite superpower intervention. Superpowers, states with global force projection capabilities, suffer a loss in their strategic position when nuclear proliferation occurs anywhere in the international system. For this reason, superpowers are particularly opposed to nuclear proliferation, and they attempt to establish a hegemonic nonproliferation order to prevent the spread of nuclear weapons.[9] It was the superpowers that led the establishment of the multilateral institutions of the nuclear nonproliferation regime, including the Nuclear Nonproliferation Treaty (NPT) and the Nuclear Suppliers Group (NSG).[10] Moreover, in individual cases of nuclear proliferation, it is often superpowers at the forefront, putting together packages of carrots and sticks to rollback the spread of nuclear weapons. Superpowers use their power and influence to dissuade other states from exporting sensitive nuclear technology. Their success in inducing restraint depends on the potential supplier state's vulnerability to superpower pressure. States that depend on a superpower to provide for their own security are likely to judge that the potential costs of jeopardizing a relationship with a superpower patron outweigh the potential gains of providing sensitive nuclear assistance.[11] For example, Argentina, a state in a formal defense pact with the United States, conceded to U.S. pressure and canceled a proposed sale of plutonium reprocessing technology to Libya in 1985 (Jones et al. 1998, 224). In contrast, states that are less dependent on a superpower patron will be more likely to provide sensitive nuclear assistance, despite superpower opposition. China, a

[8] At this point, one may ask, "If the active promotion of nuclear proliferation can benefit some states, why is it not more common?" Taking seriously the argument presented here provides the answers to this question. First, there are only nineteen states that are capable nuclear suppliers and thus a limited number of states that have the opportunity to provide sensitive nuclear assistance. Second, many of the nuclear-capable states also have the ability to project power over potential nuclear recipients (see hypothesis 1) or are vulnerable to superpower pressure (see hypothesis 3). Third, states provide sensitive nuclear assistance to constrain rival states (see hypothesis 2), but there is a finite number of situations in which a potential supplier shares a common enemy with a potential recipient. Fourth, states have tools at their disposal, other than nuclear assistance, to impose costs on rival states. With these conditions in mind, it is possible to think of some, but not many, cases in which the theory predicts sensitive nuclear assistance, but sensitive nuclear assistance does not occur. These cases are the subject of in-depth case studies being performed as part of a larger project.

[9] Hegemonic stability theory (e.g., Keohane 1984; Krasner 1976) focuses on the interests of powerful states in maintaining an open international economic system. The concept of a hegemonic proliferation order, in contrast, highlights a hegemon's interest in thwarting the proliferation of nuclear weapons.

[10] The NPT, established in 1968, is the cornerstone of the nuclear nonproliferation regime. The NSG is a nuclear cartel founded in 1975 and composed of states with advanced nuclear capabilities. On the creation of the nonproliferation regime, see, e.g., Spector (1984, 7–9) and Potter (1985).

[11] In theory, capable nuclear suppliers that lack nuclear weapons and that are dependent on a superpower could acquire nuclear weapons as a means of shifting the terms of dependence with the superpower. Research on the demand side of nuclear proliferation has demonstrated, however, that states in a defense pact with a nuclear power are less likely to acquire nuclear weapons (e.g., Singh and Way 2004). This relationship is at least partly the result of superpower dependence as the United States and the Soviet Union attempted, and largely succeeded, to prevent their close allies from acquiring nuclear weapons. Thus, it appears that, in practice, the same superpower dependence that makes states reluctant to provide sensitive nuclear assistance also makes them reluctant to acquire nuclear weapons themselves.

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state that was not in a formal alliance with either the United States or the Soviet Union, and that enjoyed the security independence afforded by a national nuclear weapons arsenal, exported sensitive nuclear materials and technology to Pakistan and Iran in the 1980s, despite U.S. objections (Jones et al. 1998, 52–3). This leads us to the third hypothesis:

Hypothesis 3: *States that are dependent on a superpower patron will be less likely to provide sensitive nuclear assistance.*

The strongest challenge to these hypotheses is that economic incentives drive states to provide sensitive nuclear assistance. I therefore control for a wide set of economic factors. Scholars (Chestnut 2007; Horowitz 2004/2005) have argued that economic underdevelopment and low levels of economic growth in North Korea could encourage Pyongyang to transfer sensitive nuclear technology in order to earn much-needed hard currency. Others (e.g., Orlov and Vinnikov 2005) have argued that poor economic conditions in post–Soviet Russia may have motivated Moscow to export civilian nuclear facilities to Tehran. This logic suggests two hypotheses. First, less developed states may be more likely to provide sensitive nuclear assistance. Thus, among potential suppliers, lower levels of economic development may be associated with a higher propensity to export sensitive nuclear technology and materials. Second, states experiencing low rates of economic growth may be more likely to take extreme measures, such as the export of sensitive nuclear technology and materials, to improve their economic circumstances.

There are other potential economic explanations for the patterns of sensitive nuclear assistance. Scholars have argued that states that are open to the international economy may be less likely to seek nuclear weapons because they are reluctant to risk international trade and investment on controversial foreign policies (Paul 2000; Solingen 1994, 1998, 2007). Correspondingly, states that are open to the international economy may be less likely to provide sensitive nuclear assistance to avoid jeopardizing their international economic relationships. Contrariwise, Jabko and Weber (1998) have argued that, due to its dependence on international trade, France may be more likely than other states to export civilian nuclear technologies. We may expect, therefore, that states that are more open to the international economy will be more likely to provide sensitive nuclear assistance. Blanton (2000, 2005) has found that the United States is more likely to export conventional arms to states with which it has a close trade relationship. Similarly, states that are dependent on a particular trading partner may be more likely to provide sensitive nuclear assistance to that state to avoid undermining an important trade relationship.

There are clearly other plausible, alternative explanations for why states may provide sensitive nuclear assistance. I discuss these in the next sections in which I describe the data and examine the evidence for the previous hypotheses.

SENSITIVE NUCLEAR ASSISTANCE DATA

To test this strategic theory of nuclear assistance, I construct an original sensitive nuclear assistance data set. The data set contains yearly information for all capable nuclear suppliers and potential nuclear recipient dyads in the international system from 1951 to 2000. The unit of analysis is the directed-dyad year. Capable nuclear suppliers are states that could conceivably transfer sensitive nuclear materials and technology to other states. States are coded as capable nuclear suppliers beginning in the first full year in which they successfully operate a domestic plutonium reprocessing or uranium enrichment facility (Table 1). 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. Potential nuclear recipients are all nonnuclear weapon states in the international system.[12] States with a nuclear weapons capability are not included as potential recipients because the puzzle motivating this study concerns the motivations leading states to provide sensitive nuclear assistance to nonnuclear weapon states.

The dichotomous dependent variable is *sensitive nuclear assistance*. It measures whether a capable supplier state provided sensitive nuclear assistance to a potential nuclear recipient in a given year.[13] I define sensitive nuclear assistance as the state-sponsored transfer of the key materials and technologies necessary for the construction of a nuclear weapons arsenal to a nonnuclear weapon state. Sensitive nuclear assistance takes three forms. States provide sensitive nuclear assistance when they assist nonnuclear weapon states in the design and construction of nuclear weapons, transfer significant quantities of weapons-grade fissile material to nonnuclear weapon states, or assist nonnuclear weapon states in the construction of uranium enrichment or

[12] It is difficult to define precisely when some states acquired the capability to become a nuclear supplier and thus when exactly a state should enter the analysis as a potential supplier state. It is also a challenge to specify exactly when some countries acquired nuclear weapons and thus drop out of the analysis as potential nuclear recipients. For example, it is widely believed that North Korea possessed enough fissile material to produce a nuclear weapon in the early 1990s, but experts disagree over when, or even if, North Korea produced a functioning nuclear device. North Korea tested a nuclear weapon in October 2006, but many experts considered the test a failure and evidence that North Korea lacks the capability to produce a functioning nuclear warhead. Alternate codings of the North Korea case, and others like it, reveal that the results reported as follows are not sensitive to the definition of the universe of cases.

[13] My theoretical interest is in the occurrence of sensitive nuclear assistance, not just its onset. For this reason, I code as ones all years in which sensitive nuclear assistance occurs. As a robustness check, I also constructed an onset of sensitive nuclear assistance variable. For this variable, I coded as one the first year in which a sensitive nuclear transfer occurs within a dyad and then drop the dyad from the subsequent analysis. Using this alternate measure of sensitive nuclear assistance did not change the core findings reported as follows.

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TABLE 1. Capable Nuclear Suppliers

Country	Year
Argentina	1969[a]
Belgium	1966[b]
Brazil	1988[c]
China	1964[d]
France	1958[e]
Germany	1969[f]
India	1964[g]
Israel	1966[h]
Italy	1970[i]
Japan	1977[j]
Netherlands	1971[k]
North Korea	1993[l]
Norway	1961[m]
Pakistan	1986[n]
USSR/Russia	1949[o]
South Africa	1977[p]
United Kingdom	1951[q]
United States	1945[r]
Yugoslavia/Serbia	1966[s]

[a] Argentina operates hot cells for plutonium reprocessing at Ezeiza (Spector 1984, 203).
[b] Eurochemic center for reprocessing technology begins operation. See *The Decommissioning of the Eurochemic Reprocessing Plant*, www.belgoprocess.be/03_act/docs/BP02_Eurochemic.pdf. (December 6, 2008).
[c] Brazil inaugurates its enrichment facilities (Albright, Berkhout, and Walker 1997, 374–5).
[d] China begins uranium enrichment (Lewis and Litai 1988, 136, 186–9).
[e] France's first reprocessing plant begins at Marcoule. See World Nuclear Association website: http://www.world-nuclear.org/info/info40.html.
[f] Germany begins operating enrichment facilities. See World Nuclear Association website: http://world-nuclear.org/info/inf43.html.
[g] India begins plutonium reprocessing (Jones et al. 1998, 112, 129).
[h] Israel begins plutonium reprocessing (Cohen 1998, 231).
[i] Italy begins plutonium reprocessing. See *Decommissioning of Nuclear Installations in Italy (Jan 2006)*, www.nea.fr/html/rwm/wpdd/italy.pdf. (December 6, 2008).
[j] Japan's first reprocessing facility goes online (Reiss 1988, 113).
[k] Netherlands begins operating enrichment facilities. See URENCO Company History, http://www.urenco.com/content/16/History.aspx.
[l] North Korea begins plutonium reprocessing (Jones et al. 1998, 147).
[m] Pilot-scale reprocessing begins in Norway. See *Decommissioning in NEA Member Countries, Current Status: Norway*, www.nea.fr/html/rwm/wpdd/norway.pdf. (December 6, 2008).
[n] Pakistan begins uranium enrichment (Jones et al. 1998, 132).
[o] The Soviet Union begins enrichment and reprocessing (Holloway 1994, 188).
[p] South Africa begins uranium enrichment (Jones et al. 1998, 243–4).
[q] The British begin the operation of sensitive fuel-cycle facilities domestically (Gowing 1974).
[r] This study begins at the dawn of the nuclear era when the United States used nuclear weapons against Japan in 1945.
[s] Pilot-scale plutonium reprocessing begins in Yugoslavia (Nichol and McDaniel 1982, 354–6).

plutonium reprocessing facilities that could be used to produce weapons-grade fissile material.[14]

Sensitive nuclear assistance includes sensitive nuclear transfers regardless of whether they are provided under international safeguards. International safeguards allow for the monitoring of nuclear facilities to detect and report the diversion of fissile materials. States have, however, used the technological expertise gained at safeguarded facilities to develop parallel, unsafeguarded nuclear programs, circumvented safeguards provisions, expelled international inspectors, and subsequently withdrawn from safeguards. Transfers of sensitive nuclear materials and technology increase the recipient's technical capability to produce nuclear weapons, regardless of whether they are provided under international safeguards, and are, therefore, included in this definition of sensitive nuclear assistance.

Sensitive nuclear assistance excludes other types of nuclear cooperation less relevant to the development of a nuclear weapons program. The provision of civilian nuclear assistance, such as scientific exchanges, assistance in the surveying and mining of natural uranium, the provision of reactor fuel and services, and the construction of research and power reactors, do not qualify as sensitive nuclear assistance.[15] Why states decide to help other states develop the platforms that could be used to deliver nuclear weapons, such as bombers and ballistic missiles, is an interesting question, but beyond the scope of this article. Sensitive nuclear assistance also excludes transfers of sensitive nuclear technology to established nuclear weapon states or transfers that do not materially advance a state's nuclear program.[16]

[14] International Atomic Energy Agency (IAEA) regulations assume that 8 kg of plutonium and 25 kg of highly enriched uranium are sufficient for the construction of a basic nuclear device. Assistance on fuel cycle facilities includes the construction of complete facilities or the transfer of key component parts for the construction of such facilities, such as centrifuges for uranium enrichment plants and hot cells for plutonium reprocessing plants. Assistance on uranium enrichment includes assistance on any of the various types of uranium enrichment processes, including jet nozzle, gaseous diffusion, gas centrifuge, and laser isotope enrichment. For a primer on nuclear weapons and their construction, see Jones et al. (1998, 317–22).

[15] The line between civilian and sensitive nuclear assistance is often fuzzy in practice, yet there is a fairly widespread scientific consensus that sensitive fuel cycle facilities, such as uranium enrichment facilities, represent a direct nuclear proliferation threat, whereas other less sensitive, civilian technologies are relatively resistant to proliferation. By drawing the line between civilian and sensitive nuclear assistance at sensitive fuel cycle facilities, my definition follows this preexisting consensus.

[16] The empirical and theoretical puzzle motivating this research centers on why states help nonnuclear weapon states acquire nuclear weapons. Why nuclear weapon states trade nuclear technology among themselves is an interesting question, but beyond the scope of this article. Similarly, assistance to a nonnuclear weapon state related to a sensitive nuclear technology that the nonnuclear weapon state has already mastered does not qualify as sensitive nuclear assistance because it does not advance that state's ability to produce nuclear weapons. For example, Japan began operating plutonium reprocessing facilities in 1977. Current French-Japanese cooperation on the construction of a new plutonium reprocessing facility in Japan is not counted as sensitive nuclear assistance because this assistance does not advance Japan's technical ability to produce nuclear weapons. French-Japanese cooperation related to nuclear weapon design, or

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TABLE 2. Selected Noncases of Sensitive Nuclear Assistance, 1951–2000

Capable Nuclear Supplier	Potential Nuclear Recipient	Years	Capable Nuclear Supplier	Potential Nuclear Recipient	Years
Argentina	Paraguay	1970–2000	Norway	Saudi Arabia	1962–2000
Argentina	Libya	1970–2000	Norway	Sweden	1962–2000
Belgium	Belarus	1992–2000	Netherlands	Egypt	1972–2000
Belgium	Denmark	1967–2000	Netherlands	Israel	1972–2000
Brazil	Argentina	1988–2000	Pakistan	Afghanistan	1987–2000
Brazil	Chile	1988–2000	Pakistan	Brazil	1987–2000
China	Japan	1965–2000	Pakistan	Canada	1987–2000
China	Taiwan	1965–2000	North Korea	Colombia	1994–2000
China	Vietnam	1965–2000	North Korea	Indonesia	1994–2000
France	Belgium	1959–2000	North Korea	South Korea	1994–2000
France	Italy	1959–2000	USSR/Russia	Australia	1951–2000
France	Spain	1959–2000	USSR/Russia	Finland	1951–2000
Germany	Bulgaria	1972–2000	Russia	Ukraine	1992–2000
Germany	Greece	1972–2000	South Africa	Iran	1978–2000
India	Bangladesh	1973–2000	South Africa	Libya	1978–2000
India	Pakistan	1965–1991	South Africa	Namibia	1978–2000
Israel	Egypt	1967–2000	United Kingdom	France	1952–1959
Israel	Poland	1967–2000	United Kingdom	Mexico	1952–2000
Israel	Syria	1967–2000	United Kingdom	Turkey	1952–2000
Italy	Switzerland	1971–2000	United States	Brazil	1951–2000
Italy	Iran	1971–2000	United States	China	1951–1963
Japan	North Korea	1978–2000	United States	East Germany	1955–1990
Japan	Venezuela	1978–2000	United States	Israel	1951–1967
Japan	Cuba	1978–2000	United States	Iraq	1951–2000
Norway	Czechoslovakia	1962–1992	United States	South Africa	1951–2000

The international smuggling of sensitive nuclear technology by substate actors, such as individuals, firms, or bureaucracies, without the government's knowledge or approval is not sensitive nuclear assistance as I define it. This statecentric focus permits the study of nearly every case of sensitive nuclear assistance because the substate smuggling of sensitive nuclear materials and technology is empirically rare. There have been one or possibly two cases of sensitive nuclear assistance without direct state involvement.[17] This empirical finding supports the intuition that it is *prime facie* implausible that nuclear-capable states would not exert control over their most sensitive nuclear technologies and that substate actors could effectively conduct large-scale, sensitive nuclear transfers without the knowledge and approval of senior government officials.[18]

To code the sensitive nuclear assistance variable, I began with an online nuclear weapons database maintained by the Nuclear Threat Initiative (NTI). I also drew on prominent reviews of the proliferation of nuclear weapons and on historical studies of countries' nuclear weapons programs.[19] To be included in the data set, a case of sensitive nuclear transfer had to be verified by at least two sources. Appendix A lists the cases of sensitive nuclear assistance and explains the key coding decisions.[20] A selection of cases in which sensitive nuclear assistance did not occur can be found in Table 2 and in Appendices B and C.

other sensitive nuclear areas that Japan has not already mastered, however, would qualify as sensitive nuclear assistance.

[17] An analysis of these cases would be interesting, but beyond the scope of the present work. A description of these cases is available in Appendices B and C.

[18] There have been a number of instances in which individuals have attempted to smuggle small amounts of radioactive materials across international borders, but none of these cases involved significant quantities of weapons-grade fissile material. For a list of these cases of nuclear smuggling, see Government Accountability Office Report, *Nuclear Nonproliferation: U.S. Efforts to Help Other Countries Combat Nuclear Smuggling Need Strengthened Coordination and Planning*. May 2002.

[19] For a complete list of sources, see the citations in Appendices A, B, and C.

[20] I explored the sensitivity of the results reported here to alternate codings of the dependent variable. In the first test, I expanded the definition of sensitive nuclear assistance to include instances of nuclear cooperation listed in Appendix B that do not qualify as sensitive nuclear assistance, but that may have, nevertheless, contributed to nuclear proliferation. The additional cases of nuclear assistance include U.S. exports to India in 1955, Pakistan's transfer of uranium hexafluoride to Libya in 2000, Soviet aid to North Korea from 1956 to 1967, and Russia's provision of nuclear facilities to Iran from 1995 to the present. In a second test, I expanded the definition of sensitive nuclear assistance to include cases in which a capable nuclear supplier agreed to provide sensitive nuclear assistance, but, for whatever reason, did not execute the sensitive nuclear transaction. Cases of canceled sensitive nuclear transactions include Argentina's offer to transfer reprocessing technology to Libya in 1985, France's promise to export reprocessing facilities to South Korea in 1975 and 1976, the 1995 Russian-Iranian agreement on uranium enrichment technology, and Pakistan's offer to provide nuclear assistance to Iraq and Syria in the mid-1990s. Expanding the definition of sensitive nuclear assistance to include these additional cases and repeating the analysis did not alter the findings reported as follows.

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I construct independent variables to test the strategic hypotheses explicated previously. *Relative power*, a supplier state's ability to project power over a potential recipient, is measured as the capability of the supplier state, discounted by distance from the supplier to the potential recipient state, minus the capability of the potential recipient state. Capability is a composite index containing information on total population, urban population, energy consumption, iron and steel production, military manpower, and military expenditures. Data on capabilities are drawn from the Correlates of War composite capabilities index, version 3.01 (Singer, Bremer, and Stuckey 1972) and extracted using EUGene (Bennett and Stam 2000). Because a state's ability to project power over another state depends on the geographic distance between the two states, the capabilities of the supplier are discounted by distance using the formula advanced by Bueno de Mesquita (1981). I also construct an alternative *power ratio* variable, measured as the composite capability of the supplier state divided by the combined composite capability of the supplier and the recipient.

To measure whether the nuclear supplier and the nuclear recipient are threatened by a common rival, I construct *enemy*.[21] This dichotomous variable indicates whether the nuclear supplier and the nuclear recipient share a common rival. The variable draws on rivalry data from Klein, Goertz, and Diehl (2006), which defines a rivalry as a pair of states that engage in multiple, linked, militarized interstate disputes within a given time period.

I construct three variables to measure a state's vulnerability to superpower pressure. *Superpower pact* is a dummy variable, indicating whether a state relies on a superpower security guarantee. States that rely on a superpower security guarantee are those that lack a nuclear weapons capability and are in a defense pact with a superpower.[22] I code the United States, from 1951 to 2000, and the Soviet Union, from 1951 to 1989, as superpowers. Data on defense pacts and nuclear weapons possession are drawn from 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. An alternate measure, *superpower vote*, draws data from Gartzke's (2006) Affinity of Nations Index and measures the similarity of states' voting behavior in the United Nations General Assembly (UNGA) with the voting behavior of the nearest superpower. A state that is vulnerable to superpower pressure is likely to vote with, rather than against, its patron. From 1951 to 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 to 2000, this variable measures the similarity of states' voting behavior with the United States. For a final, alternate measure of superpower dependence, I draw on Singh and Way's (2004) coding of nuclear weapon states to create a dummy variable, *nuclear weapons*, indicating whether a country has a nuclear arsenal. Countries with a nuclear deterrent can better provide for their own security and should be less vulnerable to superpower pressure. It is also possible that nuclear weapon states may be more likely to provide sensitive nuclear assistance because the possession of nuclear weapons gives them confidence that they could deter attacks from new nuclear weapon states. Furthermore, nuclear weapon states may be more prolific nuclear suppliers because they are better able to provide nuclear assistance related to the design and construction of nuclear weapons. The inclusion of this variable also permits an evaluation of the alternative hypothesis that nuclear weapon states will be less likely to provide sensitive nuclear assistance because they have an interest in limiting the number of states in the nuclear weapons club.

I also include a number of control variables. We may expect states, regardless of their level of conventional military power, to be reluctant to provide sensitive nuclear assistance to geographically proximate states. To control for this factor, I generate *distance*, a logged measure of the number of miles between capital cities, as calculated by EUGene (Bennett and Stam 2000). It is likely, however, that the relationship between distance and sensitive nuclear assistance is nonmonotonic. Previous analysis has suggested that logistical problems may make it difficult for states to transfer sensitive nuclear technologies to distant states (Sands 1990). To test for a nonmonotonic relationship between distance and sensitive nuclear transfers, I also include *distance squared*, a squared term of the distance variable.[23]

To assess the effects of economic motivations on state decisions to provide sensitive nuclear assistance, I include a number of economic control variables. *Economic development* is measured as a country's gross domestic product (GDP) per capita in constant 1996 dollars. *Economic growth* is calculated as growth = $\log(\mathrm{GDP}_t) - \log(\mathrm{GDP}_{t-1})$. Following Oneal and Russett (1997), I measure *trade dependence* as total trade (imports plus exports) between the two member states of a dyad as a percentage of the GDP of the first state. *Openness* to international trade is calculated as a state's trade ratio, total trade (imports plus exports) divided by GDP. The openness variable draws on data from Singh and Way (2004). All other economic data are from Gleditsch (2002) and extracted using EUGene (Bennett and Stam 2000).

I also control for a number of institutional variables that could affect patterns of international nuclear trade. International institutions are believed to affect state behavior through the establishment of formal rules that regulate state action and through the creation of informal norms that shape understandings of appropriate conduct (e.g., Keohane 1984; Koremenos, Lipson, and Snidal 2001; Krasner 1983). The institutions of the nuclear nonproliferation regime set restrictions on the transfer of nuclear materials and

[21] For a discussion of "the enemy of my enemy" concept, see Maoz et al. (2007).

[22] Following Singh and Way (2004), I only count defense pacts as providing a security guarantee.

[23] Including a variable and its squared term in the model is a common method for testing for a nonmonotonic relationship (Ramsey and Schafer 2002, 244–5).

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technology, which may render member states less likely to provide sensitive nuclear assistance. To measure the effect of international institutions on sensitive nuclear assistance, I construct two dichotomous variables. *NPT* measures whether a supplier state is a member of the Nuclear Nonproliferation Treaty.[24] *NSG* measures whether the potential supplier is a member of the Nuclear Suppliers Group.[25] Previous research suggests that domestic regime type may affect a state's behavior on nuclear weapons issues (Singh and Way 2004). To measure *regime type*, I use polity scores which range from −10 (most autocratic) to +10 (most democratic) from the Polity IV data set (Jaggers and Gurr 1995).

One may expect that states will be more likely to provide sensitive nuclear assistance to allied states. Gowa (1994) has argued that states benefit from strong allies and that states engage in behavior, such as international trade, that empowers allied states. An alliance variable is not included in the models presented here, however, because contrary to the expectation of this alliance-building hypothesis, states have never provided sensitive nuclear assistance to a state with which they shared a formal alliance.[26]

I also control for factors that influence the demand side of nuclear transactions. Previous research (e.g., Jo and Gartzke 2007; Paul 2000; Sagan 1996/1997; Singh and Way 2004; Solingen 1994, 1998, 2007) suggests that economic development, openness to the international economy, economic liberalization, membership in the NPT, and threat environment shape a state's demand for nuclear weapons. It is likely, therefore, that these variables also shape a recipient's demand for sensitive nuclear assistance. We may also expect that, like nuclear supplier states, potential nuclear recipient states that are dependent on a superpower patron may be more vulnerable to superpower pressure and will be less likely to receive sensitive nuclear assistance. The indicators of economic development, openness, NPT membership, and superpower dependence have already been discussed. To measure *liberalization*, I use a variable from Singh and Way (2004) that gauges the movement toward greater trade openness by calculating the change in openness over time spans of 3, 5, and 10 years. *Disputes* is an indicator for the security environment of the recipient state. It is 5-year moving average of the number of militarized interstate disputes per year in which a recipient state is involved. The measure is from Singh and Way (2004) and draws on data from version 3.0 of the Militarized Interstate Dispute data set (Ghosen and Palmer 2003).

DATA ANALYSIS

My central hypotheses concern the importance of relative power between the nuclear supplier and the nuclear recipient, the existence of a shared enemy between the nuclear supplier and the nuclear recipient, and the superpower dependence of the nuclear supplier for understanding the causes of sensitive nuclear assistance. I employ Rare Events Logistic Regression (ReLogit) to test claims about the correlates of sensitive nuclear assistance (King and Zeng 2001).[27] ReLogit offers several advantages of particular relevance to the research question and data. Sensitive nuclear assistance is a rare event, occurring in about 1/1,000 of the observations in the dyadic data.[28] ReLogit is able to model dichotomous dependent variables and to correct for biased estimates in rare events. In particular, ReLogit is designed to analyze "binary dependent variables with dozens to thousands of times fewer" events than nonevents (King and Zeng 2001, 137). Robust standard errors are adjusted for clustering by dyad.

Several types of statistical analyses prove useful in exploring the evidence for or against each of the hypotheses described previously. To begin the investigation, I examine the simple bivariate relationship between the key strategic and economic variables and *sensitive nuclear assistance* (Table 3). For each measure, I also examine the bivariate relationship after the inclusion of cubic splines to control for temporal dependence in the dependent variable (Beck, Katz, and Tucker 1998). The bivariate analysis is only the first step, however. To control for potentially confounding factors, I then evaluate the effect of each of the explanatory variables, including both control variables and the cubic splines (Table 4).

[24] Information on membership in the NPT is from the Institute for Defense and Disarmament Studies, accessed online at www.idds.org/issNucTreatiesNPT.html.

[25] Information on membership in the NSG is taken from Strulak (1993, 1–10), the Nuclear Suppliers Group Web site at www.nuclearsuppliersgroup.org/, and the NTI Web site.

[26] The Correlates of War alliance variable (Gibler and Sarkees 2002) measures four types of alliance relationship: defense pact, entente, neutrality agreement, or no alliance. Of the 79 dyad-years of sensitive nuclear assistance, all 79 are between states in the no alliance category. Consistent with the strategic hypotheses presented previously, this finding suggests that relatively powerful states fear nuclear proliferation, even to allied states, and that states channel sensitive nuclear technology and materials, not according to whom they are helping, but according to whom they are constraining.

[27] Using Logit or Complimentary Log Log instead of ReLogit did not alter the statistical significance, or the direction of the sign on the coefficients, of the core results reported here. I also reestimated the models using nonparametric, matching techniques, as recommended by Ho et al. (2007). I performed three separate matching analyses with each of the three key independent variables (*relative power*, *enemy*, *superpower pact*), taking a turn as the treatment. To include *relative power* as the treatment, I dichotomized the variable, recoding scores equal to or greater than zero as one and recoding scores less than zero as zero. To preprocess the data, one-to-one nearest neighbor matching with replacement was employed, using GenMatch (Sekhon 2008; Sekhon N.d.; Sekhon and Mebane 1998). I then repeated the parametric analysis, using ReLogit. The core findings were unaltered. Next, I applied a caliper that dropped observations that lacked sufficiently close matches, which I defined as observations that were more than one standard deviation away from their matched pair on any covariate. Again, I repeated the parametric analysis, and the key results were not affected.

[28] Sensitive nuclear assistance occurs in 79 of the 81,952 dyad-years. Due to the small number of positive cases, it is important to know whether the results reported here are driven by the nuclear export behavior of specific nuclear suppliers. To examine this possibility, I dropped dyads containing certain key countries and repeated the analysis. Sequentially removing the dyads containing China, France, Pakistan, and the United States, and reestimating the models, did not change the results.

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TABLE 3. Correlates of Sensitive Nuclear Assistance, 1951–2000: Bivariate Relationships with and without Cubic Splines

Independent Variable	Coefficient	Robust Standard Error	*N*	Model
Strategic Variables				
H1: Relative power	−53.371	3.396***	81,952	ReL
	−49.037	7.772***	81,952	CS
H2: Enemy	2.376	0.234***	81,952	ReL
	2.545	0.547***	81,952	CS
H3: Superpower pact	−0.961	0.248***	81,952	ReL
	−1.033	0.662	81,952	CS
H3: Superpower vote[a]	−0.384	0.275	81,127	ReL
	−1.160	0.399**	81,127	CS
H3: Nuclear weapon	0.752	0.242**	81,952	ReL
	1.192	0.606*	81,952	CS
Economic Variables				
A1: Economic development	−0.065	0.018***	81,952	ReL
	−0.002	0.063	81,952	CS
A2: Growth	5.239	3.011	81,952	ReL
	5.503	4.044	81,952	CS
A3: Openness	−0.007	0.002***	81,952	ReL
	−0.001	0.005	81,952	CS
A4: Trade dependence	12.020	1.886***	81,952	ReL
	16.872	4.361***	81,952	CS

Note: Each row in this table presents the results of a bivariate regression.
[a] *Superpower vote* and *superpower vote (recipient)* are based on United Nations General Assembly voting. Models that include these measures lose observations for dyads in which at least one of the countries was not a member of the United Nations (UN). These models do not drop any observations in which sensitive nuclear assistance occurs with two exceptions. The China seat in the UN was held by Taiwan until 1971 and by China from 1971 to the present. Models using this variable do not capture French assistance to Taiwan in 1975 and Soviet assistance to China from 1958 to 1960. The other models using alternate measures of superpower dependence capture all cases of sensitive nuclear assistance.
*$p < .05$.
**$p < .01$.
***$p < .001$.
The dependent variable is sensitive nuclear assistance coded from 0 (no assistance) to 1 (assistance). Robust standard errors are adjusted for clustering by dyad. For each independent variable, I report results for bivariate regressions with Rare-events Logit (ReL) and for bivariate regressions with Rare-events Logit after including spline corrections for temporal dependence (CS).

I first examine the hypothesis that relative power is negatively related to sensitive nuclear assistance. Hypothesis 1 states that the more powerful a state is relative to a potential recipient, the less likely it will be to provide sensitive nuclear assistance to that state. Turning first to the bivariate models, we see that the relationship between *relative power* and *sensitive nuclear assistance* is negative and statistically significant in both models. Next, an examination of the multivariate regressions reveals a similar pattern. Again, the sign on the coefficient is negative and statistically significant in each and every model.[29] There is strong empirical support for the causal significance of the relative power differential between the nuclear supplier and the nuclear recipient for understanding sensitive nuclear assistance. The counterhypothesis that relatively powerful states will be more likely to provide sensitive nuclear assistance because they can better deter a nuclear attack does not find empirical support.

The second hypothesis focuses on the existence of a shared rival as an incentive for nuclear supplier states to provide sensitive nuclear assistance. By providing nuclear assistance to a state with which they share a common enemy, nuclear suppliers can impose strategic costs on rival states. As a reminder, we should expect a positive relationship between the existence of a shared enemy and sensitive nuclear assistance. Turning first to the bivariate models, we find support for this hypothesis. The relationship between *enemy* and *sensitive nuclear assistance* is positive and statistically significant in both bivariate models. The inclusion of control variables does not alter this relationship. In the multivariate models, we again see that the sign on the coefficient for the *enemy* variable is positive and statistically significant in every model. The analysis reveals

[29] These results were robust when *power ratio* was substituted for *relative power*.

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TABLE 4. Correlates of Sensitive Nuclear Assistance, 1951–2000: Multivariate Results

Independent Variables		Model 1	2	3	4	5
Strategic	Relative power	−25.301*	−33.194***	−46.072***	−46.379***	−47.389***
		(11.307)	(9.895)	(13.099)	(14.246)	(9.728)
	Enemy	1.7429***	2.090***	1.986***	2.039***	1.497**
		(0.511)	(0.586)	(0.549)	(0.611)	(0.505)
	Superpower pact	−1.334***	−1.576**			
		(0.404)	(0.565)			
	Superpower vote			−1.314***	−1.261**	
				(0.323)	(0.420)	
	Nuclear weapon					1.101**
						(0.398)
Economic	Economic development	0.031		−0.034		−0.035
		(0.085)		(0.068)		(0.059)
	Growth	3.597		7.240*	9.701*	4.799*
		(3.345)		(2.896)	(3.899)	(2.447)
	Openness	−0.010		−0.094		−0.019
		(0.088)		(0.080)		(0.078)
	Trade dependence	44.420***	47.558***	50.160***	60.538***	53.275***
		(10.872)	(12.124)	(10.766)	(11.898)	(11.760)
Institutional	Regime type	−0.043		−0.059		−0.027
		(0.042)		(0.032)		(0.034)
	NPT	−1.053		−2.118*	−1.662*	−1.672*
		(0.647)		(0.910)	(0.778)	(0.847)
	NSG	2.292*	1.572*	3.597***	2.378***	3.163***
		(0.917)	(0.672)	(1.080)	(0.688)	(0.890)
Strategic controls	Distance	19.818*	18.264*	20.852**	22.503**	18.779*
		(8.490)	(8.375)	(7.790)	(8.256)	(7.776)
	Distance squared	−1.259*	−1.156*	−1.303**	−1.394**	−1.174*
		(0.532)	(0.528)	(0.492)	(0.517)	(0.490)
Recipient demand	Disputes (recipient)	0.157		0.474***	0.444***	0.483***
		(0.134)		(0.118)	(0.125)	(0.115)
	Superpower pact (recipient)	0.457				
		(0.858)				
	Superpower vote (recipient)			−1.596*	−1.355	−2.322**
				(0.759)	(0.759)	(0.757)
	Economic development (recipient)	0.023		0.035		0.026
		(0.020)		(0.023)		(0.024)
	Liberalization (recipient)	0.008		−0.012		−0.011
		(0.022)		(0.017)		(0.017)
	Openness (recipient)	−0.014**	−0.011*	−0.011**	−0.011**	−0.012*
		(0.005)	(0.005)	(0.004)	(0.004)	(0.005)
	NPT (recipient)	−0.016		−0.945		−0.472
		(0.690)		(0.526)		(0.520)
	Constant	−81.552*	−75.545*	−85.352**	−93.746**	−78.487*
		(34.033)	(33.259)	(30.625)	(32.682)	(30.712)
	N	81,952	81,952	78,143	78,143	78,920

*$p < .05$.
**$p < .01$.
***$p < .001$.
The dependent variable is sensitive nuclear assistance coded from 0 (no assistance) to 1 (assistance). Robust standard errors are in parentheses and are adjusted for clustering by dyad. The model is estimated after including spline corrections for temporal dependence (Beck, Katz, and Tucker 1998).

a powerful link between the presence of a common enemy and the patterns of sensitive nuclear assistance.

Next, I examine the hypothesis that states that are vulnerable to superpower pressure will be less likely to provide sensitive nuclear assistance. In the bivariate analysis, we find the expected negative correlations between *superpower pact* and *sensitive nuclear assistance* and between *superpower vote* and *sensitive nuclear assistance*. We also find the expected positive correlation between *nuclear weapon* and *sensitive*

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nuclear assistance. *Superpower pact* is statistically significant in the simple bivariate model, and *superpower vote* is statistically significant in the bivariate models with the controls for temporal dependence. *Nuclear weapon* is also statistically significant in both specifications. The rest of the relationships, however, are not statistically significant. Once I control for other relevant variables, however, a discernable relationship emerges. In each and every one of the multivariate models, the variable indicating the superpower dependence of the supplier is statistically significant and in the expected direction. States that are vulnerable to superpower pressure are less likely to provide sensitive nuclear assistance.

The findings of this analysis do not support rival explanations for why states transfer sensitive nuclear materials and technology. Some have argued that nuclear weapon states have an incentive to limit the size of the nuclear club. Thus, we may expect that they will be less likely to provide sensitive nuclear assistance. This hypothesis, however, is not supported by the evidence. Both the bivariate and multivariate analyses reveal a strong relationship between *nuclear weapon* and *sensitive nuclear assistance*, but in the opposite direction. As was discussed in the previous paragraph, nuclear weapon states are more, not less, likely to provide sensitive nuclear assistance, undermining arguments that nuclear weapon states are more likely to oppose nuclear proliferation.

The set of economic variables does not appear to offer much explanatory power either. It has been suggested that states with lower levels of economic development, or lower levels of economic growth, will be more likely to provide sensitive nuclear assistance because they will be more willing to take measures to improve their economic circumstances. This expectation is not met with much empirical support. The variable measuring the level of economic development of the supplier is in the expected direction and is statistically significant in the simple bivariate model, but does not reach statistical significance in any of the other bivariate or multivariate models.[30] Moreover, the sign on *economic development* is inconsistent, switching from negative to positive under different model specifications. The variable for economic growth is not statistically significant in any of the bivariate models. It is statistically significant in three of the four multivariate models in which it is included, but the sign on the coefficient is in the unexpected direction, suggesting that states experiencing slow economic growth are actually less likely to provide sensitive nuclear assistance. Neither is there a consistent, statistically significant relationship between openness to the international economy and sensitive nuclear assistance. *Openness* is negative and statistically significant in the simple bivariate model, but is not statistically significant in any of the other models. The coefficient for *trade dependence* is in the expected direction and is statistically significant in all of the bivariate and multivariate models, suggesting that states are more likely to provide sensitive nuclear assistance to states with which they possess a close trade relationship.

I briefly comment on the other control variables.[31] *Distance* and *distance squared* are statistically significant in each of the multivariate models, demonstrating the expected nonmonotonic relationship between distance and sensitive nuclear assistance.[32] *NPT* is negative and statistically significant in three of the four multivariate models in which it is included.[33] Membership in the NPT does appear to serve as a constraint on the behavior of the nuclear suppliers.[34] *NSG* is statistically significant and has a positive coefficient in each multivariate model, suggesting that, contrary to expectation, membership in the NSG may actually increase the likelihood that a state will export sensitive nuclear materials and technology. This finding cannot be explained by superior supply capabilities of NSG members because the analysis excludes states that are incapable of providing sensitive nuclear assistance. Instead, this result may be explained by three factors. First, due to its status as a nuclear cartel, the NSG may have failed to acquire international legitimacy and has, therefore, failed to impose a meaningful normative constraint on its members. Second, an adverse selection effect in the early days of the NSG may have initially brought in the states that were most likely to export sensitive technologies. These states joined the NSG, but continued to provide sensitive nuclear assistance. For example, the United States convinced a reluctant France to join the regime in 1975, but France continued the construction of a pilot-scale plutonium reprocessing plant in Pakistan until 1982. Third, the guidelines of the NSG allow states to export sensitive nuclear materials and technology as long as the exports are placed under international safeguards. NSG states may be more likely to provide sensitive nuclear assistance, but they may also be more likely to place their exports under safeguards. For example, Germany joined the NSG in 1975 and required safeguards on its sensitive nuclear exports to Brazil from 1978 to 1994.

[30] Using GDP, instead of GDP per capita, produces similar results.

[31] To ensure that the results were not being driven by the inclusion of specific control variables, I reran scores of models sequentially omitting right-hand-side variables one at a time. The core results were not affected.

[32] I also tried the unlogged variables for distance and distance squared. The findings were unaltered.

[33] I also included a joint NPT variable indicating whether both the potential recipient and the potential supplier were members of the NPT. To test the hypothesis that the existence of the NPT establishes a norm against nonproliferation, I also tried a dummy variable coded "1" for every observation after 1968 (the year in which the NPT was opened for signature). These variables were not statistically significant.

[34] This finding, however, may be driven by the nuclear export behavior of a few key countries. France and China provided sensitive nuclear assistance to a number of other countries before they joined the NPT, and Pakistan, a non-NPT state, has exported sensitive nuclear materials and technology to multiple recipients. In contrast, India and Israel, both non-NPT states, have never exported sensitive nuclear materials or technology.

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TABLE 5. Substantive Effects of Variables on the Likelihood of Sensitive Nuclear Assistance, 1951–2000

Variable	Relative Risks	95% Confidence Intervals	First Differences	95% Confidence Intervals
Relative power	2.894	1.630 to 5.457	0.0012	0.0002 to 0.0047
Enemy	7.200	2.248 to 22.554	0.0057	0.0014 to 0.0199
Superpower pact	4.791	1.526 to 15.573	0.0033	0.0010 to 0.0089
Superpower vote	2.968	1.753 to 5.133	0.0011	0.0003 to 0.0044
Trade dependence	1.360	1.195 to 1.547	0.0003	0.0001 to 0.0010
NPT	8.559	1.620 to 47.546	0.0029	0.0003 to 0.0109

Note: The probabilities are calculated using the ReLogit estimates in model 3 of Table 4. Because the *Superpower pact* variable is not included in model 3, the probabilities for this variable are calculated using the ReLogit estimates in model 2 of Table 4. The calculations were performed to allow for the presentation of the relative risks as positive numbers. The entries for the *relative power* and *superpower vote* variables represent the effect of a change in the independent variable from one standard deviation above the mean to one standard deviation below the mean. The entries for the *trade dependence* and *disputes* variables represent the effect of a change from one standard deviation below the mean to one standard deviation above the mean. The entries for the *enemy* and *NPT* variables represent the effect of a change from 0 to 1 on the dichotomous variable. The entries of the s*uperpower pact* variable represents the effect of a change from 1 to 0 on the dichotomous variable. All other variables are held at their mean.

Turning to the demand-side variables, we see that the coefficient on *disputes* is positive and statistically significant in three of the four models in which it is included, indicating that states in a competitive security environment are more likely to receive sensitive nuclear assistance. The sign on *superpower vote (recipient)* is negative and statistically significant in the multivariate models, suggesting that states that are dependent on a superpower patron are less likely to receive sensitive nuclear assistance. The coefficient on *openness (recipient)* is negative and statistically significant in each multivariate model, providing support for the argument that states that are open to the international economy have less demand for nuclear weapons and are thus less likely to receive sensitive nuclear assistance. The other control variables are not statistically significant in any of the models.[35]

Table 5 interprets the substantive effect of these variables on *sensitive nuclear assistance*, using the results from Table 4, models 2 and 3. The entries represent the first differences and the relative risks (King and Zeng 2001) of *sensitive nuclear assistance* for a given change in the independent variable when all other variables are held at their mean. Probabilities are calculated using the approximate Bayesian method for predicting probabilities in rare events as recommended by King and Zeng (2001). Table 5 also reports the 95% confidence bounds using the procedure developed by King, Tomz, and Wittenberg (2000). Because sensitive nuclear assistance is a rare event, the differences between probabilities are small. Like other international relations scholars, working with rare events data (e.g., Bennet and Stam 2003), I focus on relative risks to illustrate the substantive effects of the explanatory variables. Turning first to *relative power*, Table 5 reveals that a state that lacks the ability to project power over a potential recipient state is nearly three times more likely to provide sensitive nuclear assistance to that state than is a similar state that has the ability to project power over the recipient state.

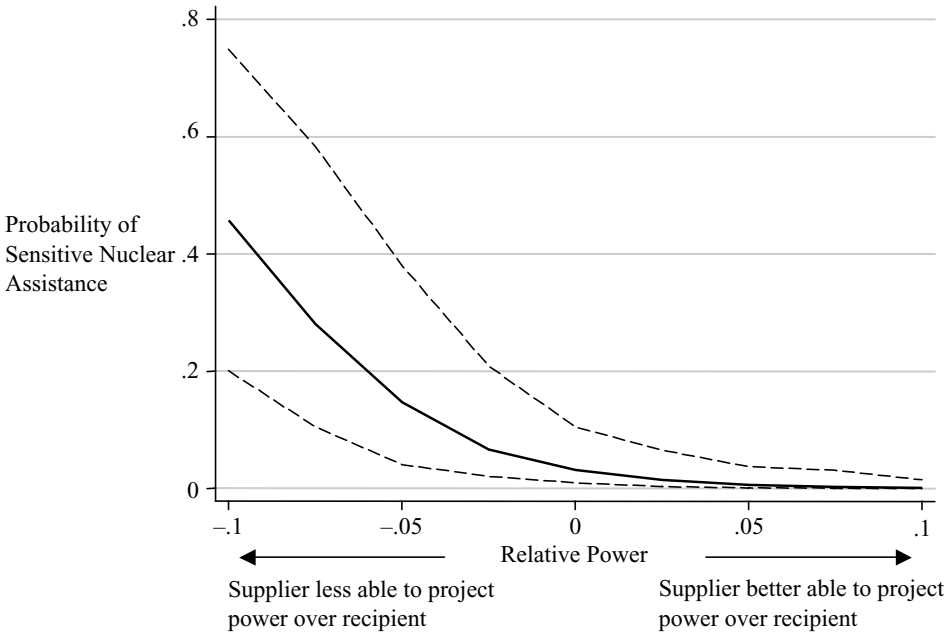
This effect of *relative power* on the probability of *sensitive nuclear assistance* is illustrated in Figure 1. In Figure 1, *enemy* is set to one, *superpower pact* is set to zero, and all other variables are held at their mean. The dashed lines represent the 95% confidence interval. Figure 1 demonstrates a clear negative relationship between *relative power* and the probability of *sensitive nuclear assistance*. When the capable nuclear supplier lacks the ability to project power over the potential recipient (represented in the graph by negative values of *relative power*), there is a substantial risk that the supplier state will export sensitive nuclear materials and technology. As the relative power distribution shifts in favor of the potential supplier, however, the risk that a state will export sensitive nuclear materials and technology declines. The probability of *sensitive nuclear assistance* decreases to near zero as the capable nuclear supplier gains the ability to project power over the potential nuclear recipient (represented in the graph by positive values of *relative power*).

Returning to the substantive effect of the other variables reported in Table 5, we see that states are over seven times more likely to provide sensitive nuclear assistance to a state with which they share an enemy than to a comparable state that is not threatened by a common enemy. A state that is not dependent on a superpower patron by virtue of a defense pact with a

[35] I also tried models that included variables for the regime type of the recipient, joint democracy of the supplier and the recipient, population size of the supplier and recipient, the number of nuclear weapon states in the international system, and a dummy for the Cold War period. None of these variables achieved statistical significance or altered the core findings.

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FIGURE 1. Effect of Relative Power on Sensitive Nuclear Assistance, 1951–2000



Note: The probabilities are calculated using the ReLogit estimates in model 2 of Table 4. *Enemy* is set to one, *superpower pact* is set to zero, and all other variables are held at their mean. *Relative power* is measured as the power of the supplier, discounted by the distance between the supplier and the recipient, minus the power of the recipient. The unit of measurement is the proportion of overall power in the international system. A *relative power* score of −0.1 indicates that, after discounting by distance, the supplier possesses 10% less of the total power in the international system than the recipient. Negative values of *relative power* suggest that the supplier lacks the ability to project power over the recipient. Dyad-years in this category include France-Japan 1973 (−0.059) and Pakistan-North Korea, 1999 (−0.011). A *relative power* score of 0.1 indicates that, after discounting by distance, the supplier possesses 10% more of the overall power in the international system than the potential recipient. Positive values of *relative power* suggest that that the supplier possesses the ability to project power over the recipient. Dyad-years in this category include France-Belgium 1960 (0.015) and the United States-North Korea 1951 (0.039). Dashed lines represent the 95% confidence interval.

superpower is nearly five times more likely to provide sensitive nuclear assistance than is a similar state that is dependent on a superpower patron. Furthermore, a state that is not dependent on a superpower patron, as measured by UNGA voting data, is about three times more likely to provide sensitive nuclear assistance than is a similar state that is dependent on a superpower.

The substantive importance of these variables is also evident when they are taken together (not shown). Sensitive nuclear assistance, a rare event, is extremely unlikely to occur under typical circumstances. Indeed, the baseline probability that a nuclear transaction will occur in any given dyad-year when all explanatory variables are held at their mean is .2%.[36] When the three strategic variables are set to the worst-case scenario (i.e., *relative power* and *superpower pact* set to their minimums and *enemy* set to its maximum), however, and all other variables are held at their mean, the probability of *sensitive nuclear assistance* increases to 62%.[37] Taken together, this analysis indicates that strategic factors have not only a statistically significant effect, but also a substantively significant effect on the probability of sensitive nuclear assistance.

Turning now to the substantive effect of the control variables, Table 5 shows that NPT membership has a substantive effect on the patterns of sensitive nuclear assistance. Non-NPT members are over eight times more likely to provide sensitive nuclear assistance than are states that are members of the NPT. In contrast, *trade dependence* has a small substantive effect on states' propensity to export sensitive nuclear technologies. States that are heavily dependent on trade with a particular trading partner are only about 36% more likely to provide sensitive nuclear assistance to that state than is a similar state that has no trade relationship whatsoever with that state. Thirty-six percent may not be a significant difference when one considers that a state with very high levels of trade with a particular state should be much more likely (indeed, more than 36% more likely) to trade any product with that state than with a similar state with which the supplier has absolutely no trade relationship.

DISCUSSION AND CONCLUSION

This article explains why states provide sensitive nuclear assistance to nonnuclear weapon states,

[36] The 95% confidence interval is .001 to .005. The probabilities reported here are calculated using the ReLogit estimates in Table 4, model 2.
[37] The 95% confidence interval is .125 to .945

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contributing to the international spread of nuclear weapons. I found that in order to explain patterns of sensitive nuclear assistance, one must look to the strategic environment of the nuclear supplier. The costs of the spread of nuclear weapons are concentrated on relatively powerful states. This simple logic of the differential costs of nuclear proliferation leads states to provide sensitive nuclear assistance under three conditions. First, because nuclear proliferation constrains states' ability to use conventional military power to their advantage, the more powerful a state is relative to a potential nuclear recipient, the less likely it is to provide sensitive nuclear assistance. States do not want to impose constraints on themselves. Second, precisely because nuclear proliferation constrains states' military freedom of action, however, states are more likely to provide sensitive nuclear assistance to states with which they share a common enemy. By providing sensitive nuclear assistance to these states, a nuclear supplier can impose strategic costs on rival states. Finally, because superpowers, states with global force projection capabilities, are threatened by nuclear proliferation anywhere in the international system, they pressure other states in an attempt to prevent sensitive nuclear transfers. States that are vulnerable to superpower pressure are less likely to provide sensitive nuclear assistance.

Arguments that contend that states are driven to provide sensitive nuclear assistance by an economic profit motive do not find support in the data. There is no discernable relationship between poor economic performance and sensitive nuclear assistance. This is not to say that economic motivations are irrelevant to state decisions to transfer sensitive nuclear materials and technology. Indeed, in many cases in which sensitive nuclear transfers occurred, the nuclear suppliers did seek economic benefits. What these findings do suggest, however, is that states are unlikely to pursue economic gains when the result undermines their own security. States may still seek economic benefits when they export sensitive nuclear technology, but they are only likely to do so when such behavior is consistent with underlying strategic conditions.

The empirical analysis provides some reassurance to proponents of the nuclear nonproliferation regime. The findings suggest that NPT members are less likely than non-NPT members to export sensitive nuclear materials and technology. Yet, the analysis also shows that NSG members are more likely to conduct sensitive nuclear transfers. The international institutions of the nuclear nonproliferation regime do not appear to impose a consistent restraining effect on sensitive nuclear exports.

This research on the causes of sensitive nuclear assistance suggests a new, supply-side approach to the study of nuclear proliferation. Scholars have analyzed state decisions to pursue nuclear weapons, but have not explained, through a theoretical lens, the behavior by other states that facilitates or impedes the spread of nuclear weapons to additional countries. There is substantial variation in whether, and the degree to which, states support or oppose nuclear proliferation to additional states. At one extreme, as this research shows, states are willing to provide sensitive nuclear assistance to help other states acquire nuclear weapons. At the other extreme, states are so opposed to nuclear proliferation in another state that they are willing to use military force to stop it. There are other more moderate measures by which states can affect the supply of nuclear proliferation. States show different inclinations to vote for or against nuclear nonproliferation measures in the IAEA Board of Governors and the United Nations Security Council. States also vary in their willingness to apply sanctions against states that are developing nuclear programs. All topics could become the focus of future scholarly inquiry. In fact, the conditions that determine whether states provide sensitive nuclear assistance may also shape state responses to other issue areas related to the supply of nuclear proliferation. For example, if relatively powerful states are more threatened by nuclear proliferation, as this article claims, we may expect that they may be more likely to support measures, such as preventive military strikes, designed to prevent other states from acquiring nuclear weapons.

The theoretical approach of this article may provide a helpful framework for the study of conventional arms transfers. Blanton (2000, 2005) has argued that the United States is more likely to transfer conventional arms to democratic countries. In contrast, this study found, analyzing the entire universe of nuclear suppliers, that power-based factors are paramount and that the regime type of the recipient does not affect decisions to transfer sensitive nuclear materials and technology.[38] Scholars could seek to understand further the conditions under which states export conventional military hardware by examining systematically the entire universe of potential suppliers and by including the strategic factors identified here among the explanatory variables. It is possible that relative power, the presence of a common enemy, and superpower dependence shape the probability that states will transfer conventional military, as well as nuclear materials and technology.

The argument of this article began with a simple insight grounded in the nuclear deterrence literature about the differential effects of nuclear proliferation. The existing scholarship on the consequences of nuclear proliferation has centered around the debate about whether the spread of nuclear weapons generates more or less stability at the level of the international system (e.g., Sagan and Waltz 1995). There has been less of a focus, however, on whether nuclear proliferation may threaten certain types of states more than others. The findings of this article are consistent with the observation that the spread of nuclear weapons may be worse for relatively powerful states than it is for relatively weak states. The spread of nuclear weapons imposes strategic costs on relatively powerful states because it undermines their ability to tap conventional military power as a source of strategic advantage. To the degree that nuclear proliferation

[38] See footnote 35.

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constrains more powerful rivals, however, the global spread of nuclear weapons, in certain circumstances, may improve the strategic environment of relatively weak states. This argument about the differential effects of nuclear proliferation contributes to our theoretical understanding of the consequences of nuclear proliferation.

In his 2007 annual report to Congress on the projected threats to the national security of the United States, Director of National Intelligence Michael J. McConnell assessed that, after terrorism, nuclear proliferation poses the greatest threat to U.S. national security.[39] This was not a new recognition. Nuclear proliferation has appeared as one of the top threats to U.S. national security in every such annual report for decades. In response to the continuing threat of nuclear proliferation, the United States has implemented a number of policies to stop states from transferring sensitive nuclear materials and technology. In May 2003, the United States announced the Proliferation Security Initiative, a program designed to allow the United States to interdict the international transfer of sensitive nuclear materials and technology. As was stated in the introduction, in October 2006, the United States issued a threat aimed to deter states from providing sensitive nuclear assistance. The effective execution of these and other nonproliferation policies requires an accurate assessment of which states are most likely to export sensitive nuclear materials and technology.

Each of the three hypotheses presented in this article can guide intelligence analysts and policy makers as they attempt to identify and deter future nuclear suppliers. First, as a state's ability to project power increases or decreases, its propensity to provide sensitive nuclear assistance will adjust accordingly. During the Cold War, the Soviet Union was a superpower with global force projection capabilities and nuclear proliferation anywhere threatened to constrain its military power. Partly for this reason, the Soviet Union took a tough stand against nuclear proliferation and was loathe to provide sensitive nuclear assistance. However, Moscow's conventional military power collapsed along with the Soviet Union, and nuclear proliferation was no longer a limiting factor on Moscow's force projection capability. In this altered security environment, Russia became more willing to provide sensitive nuclear assistance. In 1995, for example, just five years after the collapse of the Soviet Union, Russia offered to construct a uranium enrichment facility in Iran.[40] China is on the opposite trajectory. China's power projection capability has traditionally been limited to a handful of states on its immediate borders. For most of the nuclear era, nuclear proliferation to states beyond this sphere of influence did not directly undermine Chinese power. In recent years, however, as China modernizes its military forces and begins to think about projecting force abroad, it is likely becoming more concerned that nuclear proliferation in distant regions could constrain its military might. This consideration may be contributing to the decline in sensitive nuclear exports from, and a heightened attention to nuclear nonproliferation in, Beijing.

Second, officials must recognize that states that are threatened by U.S. power can provide sensitive nuclear assistance to Washington's enemies in order to constrain U.S. military freedom of action. Military leaders in Pakistan, for example, supported sensitive nuclear exports to Iran, Libya, and North Korea in part because they assessed that, after the collapse of the Soviet Union, the United States had become too powerful in the Middle East and South Asia. They believed that by providing sensitive nuclear assistance to a band of states hostile to Washington, Pakistan, with the support of China, could form an alliance of "strategic defiance" against the United States.[41]

Third, policy makers should beware of the end of security alliances. States that depend on a superpower to provide for their security are less likely to export sensitive nuclear materials and technology. The collapse of the Soviet Union left a number of states without a superpower patron. North Korea, for example, may be at risk of providing sensitive nuclear assistance in part because it can do so without antagonizing a powerful protector. Officials must recognize that nuclear umbrellas can reduce the supply of, as well as the demand for, nuclear materials and technology. Correctly understanding the conditions under which states provide sensitive nuclear assistance matters not only for the scholarly study of nuclear proliferation, but also for efforts to prevent the further spread of the world's most dangerous weapon.

Appendix A: Cases of Sensitive Nuclear Assistance

U.S.S.R to China (1958–60). The Soviet Union provided China with designs and key component parts for the Jiuquan plutonium reprocessing plant and for the Lanzhou uranium enrichment facility. Moscow reneged on a promise to provide Beijing with a prototype atomic bomb (Lewis and Litai 1988, 60–1, 72, 112, 118–21; NTI).

France to Israel (1959–65). France helped Israel construct the Dimona plutonium reprocessing facility. The French are also believed to have transferred a nuclear weapon design (Cirincione et al. 2002, 225; Cohen 1998, 73–5; NTI). French nuclear assistance was formally approved by the Guy Mollet government in 1956. In a journalistic account of the development of Israel's nuclear program, Hersh (1991) erroneously suggests that, in 1960, French president Charles de Gaulle ordered a complete halt to nuclear cooperation with Israel, but that French bureaucrats continued the nuclear transfers without de Gaulle's knowledge or approval. In a scholarly history of Israel's nuclear program, however, Cohen (1998) documents de Gualle's decision to cease official French government involvement with Israel's nuclear program in 1960,

[39] Michael J. McConnell, "Annual Threat Assessment of the Director of National Intelligence for the Senate Armed Services Committee," February 27, 2007, Unclassified Statement for the Record.

[40] Russia later canceled the uranium enrichment transfer under intense pressure from the United States.

[41] On the strategic motivations behind Pakistan's sensitive nuclear exports, see, e.g., Corera 2006, 74–9.

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but to explicitly authorize French firms to continue the construction of the sensitive, plutonium reprocessing facility in Israel.

France to Japan (1971–4). France constructed a pilot-scale reprocessing plant for Japan at Tokai Mura (Gale 1978, 1124; Lester 1982, 422; Reiss 1988, 115).

France to Pakistan (1974–82). France helped Pakistan construct the Chasma and Pinstech reprocessing plants. French assistance to the Chasma plant was halted in August 1978 under U.S. pressure. France continued the construction of the pilot-scale facility at Pinstech until its completion in 1982 (Spector 1990, 90–117; Weissman and Krosney 1981, 74–84, 161–74).

France to Taiwan (1975). France agreed to provide Taiwan with a plutonium reprocessing facility. The French were able to transfer some of the component parts for the facility before Taiwan canceled the transaction under U.S. pressure. The United States dismantled the facilities related to reprocessing and confiscated the component parts (Spector 1984, 342–4; Weissman and Krosney 1981, 152–3).

Italy to Iraq (1976–8). Italy constructed a radiochemistry lab consisting of three lead-shielded hot cells capable of reprocessing plutonium in Iraq (NTI; Weissman and Krosney 1981, 97–9).

Germany to Brazil (1979–94). In 1975, Germany agreed to provide Brazil with ten nuclear reactors, a plutonium reprocessing plant, and a jet-nozzle uranium enrichment plant at Resende. Construction of the facilities began in 1979. After years of construction delays and cost overruns, Brazil decided to complete only two of the ten reactors and indefinitely postponed the construction of the reprocessing plant in 1985. In March 1994, Brazil also canceled the uranium enrichment plant (Jones et al. 1998, 231–42; NTI; Spector 1990, 242–66).

France to Egypt (1980–2). France constructed two hot cells for plutonium reprocessing in the Hot Laboratory and Waste Management Center in Egypt (Bhatia 1988, 61; NTI).

China to Pakistan (1981–3; 1984–6). In the early 1980s, China supplied Pakistan with a nuclear weapon design and enough highly enriched uranium for two nuclear weapons. Later, China is believed to have assisted Pakistan with the Kahuta uranium enrichment plant. In the 1990s, China also helped Pakistan with its reprocessing facility at Chasma. In 1995, China provided Pakistan with 5,000 ring magnets, a component part for use in a gaseous centrifuge uranium enrichment plant (Jones et al. 1998, 50, 57–8n; NTI; Shuey and Kan 1995). Medeiros (2005) claims that the 1995 ring magnet transfer (but not the nuclear assistance provided in the 1980s) may have been the result of lax export controls that allowed Chinese firms to export sensitive technology without the authorization of the central government. The 1990s transfers occurred after Pakistan is believed to have achieved a nuclear weapons capability and are not recorded as cases of sensitive nuclear assistance.

China to Iran (1984, 1987, 1989, 1995). China provided Iran with calutrons, a key component part for uranium enrichment using the electromagnetic isotope separation method (Albright, Berkhout, and Walker 1997, 359–60; NTI).

China to Algeria (1986–91). China constructed hot cells for Algeria at Ain Oussera and began the installation of a larger plutonium reprocessing facility (Albright and Hinderstein 2001; Jones et al. 1998, 163).

Pakistan to Iran (1987–95). Pakistan provided Iran with designs and key component parts for a gaseous centrifuge uranium enrichment plant. It may have also transferred a nuclear weapon design (Corera 2006; Langewiesche 2007; Montgomery 2005; NTI). President Pervez Musharraf (2006, 288–9) claims in his memoirs that, when he assumed the office of president in 1999, he was unaware of Pakistan's sensitive nuclear exports to Iran, Libya, and North Korea. There are reasons, however, to doubt Musharraf's claims. More important, regardless of whether Musharraf was initially aware of the transfers, there is overwhelming evidence that indicates that the nuclear exports were actively supported by senior government officials, including chiefs of the army staff and civilian heads of state (Bhatia 2008; Corera 2006; Frantz and Collins 2007; Langewiesche 2007; Levy and Scott-Clark 2007; Sagan 2006, 53).

Pakistan to Libya (1997–2001). Pakistan provided Libya with designs and key component parts for a gaseous centrifuge uranium enrichment plant. It also transferred a nuclear weapon design (Corera 2006; Langewiesche 2007; Montgomery 2005; NTI). These transfers were state sponsored.[42]

Pakistan to North Korea (1997–2002). Pakistan provided North Korea with designs and key component parts for a gaseous centrifuge uranium enrichment plant. It may have also transferred a nuclear weapon design (Corera 2006; Langewiesche 2007; Montgomery 2005; NTI). These transfers were state sponsored.[43]

Appendix B: Selected Cases of Nonsensitive Nuclear Assistance

Canada and the United States to India (1955). Canada supplied India with a nuclear reactor moderated with heavy water from the United States (Perkovich 1999). Nuclear reactors and heavy water do not qualify as sensitive nuclear assistance.

France to Japan (2001–present). The French firm AREVA assisted Japan in the construction of the Rokkasho-Mura plutonium reprocessing facility.[44] This does not qualify as sensitive nuclear assistance because it does not materially advance Japan's ability to produce a nuclear weapon. Japan has enjoyed the ability to reprocess plutonium since 1977 (Reiss 1988, 113).

Germany to Iraq (1985–94). German firms exported materials that Iraq used in the construction of its nuclear facilities (Morstein and Perry 2000; NTI). These materials consisted of dual-use industrial materials such as electrical components, industrial pipelines, soft iron, and furnace equipment. Germany did not export sensitive nuclear fuel cycle facilities, or their major component parts, to Iraq.

Israel to South Africa (1977–80). Israel may have provided missile technology and tritium to South Africa in exchange for natural uranium (Liberman 2004). Missile technology and tritium do not qualify as sensitive nuclear assistance as a define it. Although tritium can be used to transform a basic fission weapon into a higher-yield, "boosted" nuclear weapon, it cannot help a nonnuclear weapon state cross the nuclear threshold.[45] Despite much suspicion, there is no evidence that Israel provided South Africa with sensitive nuclear assistance. Some have speculated that South Africa may have also provided Israel with grounds for a nuclear test site, but this accusation has been dismissed by leading nuclear physicists.

[42] See Appendix A, Pakistan to Iran (1987–95).

[43] Ibid.

[44] AREVA Press Release, 2005, "AREVA to pursue its cooperation with JNFL to start up the Rokkasho-Mura reprocessing plant." Available at: www.areva.com/servlet/news/pressroom/pressreleases/cp_20_12_2005-c-PressRelease-cid-1134047550828-p-1140584426338-en.html.

[45] Coding Israel's transfer of tritium to South Africa as a case of sensitive nuclear assistance and rerunning the analysis did not change the results.

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Netherlands to Pakistan (1974–76). While working in the Netherlands in the mid-1970s, Pakistani scientist A.Q. Khan smuggled uranium enrichment designs and equipment from the Netherlands to Pakistan without the knowledge and approval of the Dutch government (Corera 2006). This case does not qualify as sensitive nuclear assistance because it was not sponsored by the state.

North Korea or Pakistan to Libya (2000). In February 2005, the U.S. government charged North Korea with transferring uranium hexafluoride to Libya. It is now believed that the uranium hexafluoride came from Pakistan. Uranium hexafluoride does not qualify as sensitive nuclear assistance.

North Korea to Syria (2001–7). North Korea may have helped Syria construct a nuclear reactor. Nuclear reactors are not considered sensitive nuclear assistance. Some have questioned whether North Korea may have also provided Syria with plutonium reprocessing capabilities, but there is no firm evidence that these countries engaged in any sensitive nuclear cooperation.

Russia to Iran (1995–present). Russia rebuilt the Bushehr light-water nuclear power reactors in Iran, but nuclear reactors do not qualify as sensitive nuclear assistance. Russia considered constructing a uranium enrichment facility, but canceled the deal under U.S. pressure.

Soviet Union to North Korea (1956–67). The Soviet Union assisted North Korea with the construction of a research reactor and provided basic scientific training, but did not assist North Korea with plutonium reprocessing or other sensitive nuclear technology (Wit, Poneman, and Gallucci 2004).

United States Atoms for Peace Program (1953–75). Under the Atoms for Peace program initiated by President Dwight D. Eisenhower in 1953, the United States transferred research reactors and provided basic scientific training to many developing countries. The United States stopped well short, however, of providing sensitive nuclear assistance (Hewlett and Holl 1989).

United States to France (1970s and 1980s). In this time period, the United States provided assistance to France designed primarily to improve the safety and security of French warheads (Ullman 1989). This does not qualify as sensitive nuclear assistance because France was, at this time, an established nuclear weapon state.

United States to India (1961, 2005). A U.S. firm, Vitro International, prepared blueprints for the construction of the physical site at the Trombay reprocessing facility in 1961, but did not work on the sensitive nuclear technologies. The sensitive technologies in the Trombay reprocessing facility were developed autonomously with the aid of declassified documents on plutonium reprocessing made available by the United Nations (Jones et al. 1998, 112; Perkovich 1999, 28). The U.S.-India nuclear deal signed in January 2005 is related to civilian nuclear assistance only and does not provide for the transfer of sensitive nuclear materials or technology. Furthermore, by the time of the U.S.-India nuclear deal in 2005, India was an established nuclear weapon state.

Appendix C: Selected Cases of Nonassistance

Argentina to Iran (1992). Argentina denied an Iranian request for hot cells (Hibbs 1992).

Argentina to Libya (1985). Argentina offered to sell reprocessing technology to Libya, but canceled the deal under U.S. pressure (Jones et al. 1998, 224).

China, Germany, Great Britain, and Yugoslavia to Iraq (1987–90). Iraq was able to acquire component parts and materials to be used in its uranium enrichment program from various suppliers in Europe and Asia. These were piecemeal acquisitions, however, that consisted almost entirely of unrestricted dual-use items. Iraq never received a substantial infusion of sensitive nuclear assistance from abroad in this time period (Albright and Hibbs 1992).

China to North Korea (1964). China denied a North Korean request for assistance with nuclear weapons technology (Wit, Poneman, and Gallucci 2004).

France to South Korea (1975–6). France agreed to sell reprocessing technology to South Korea, but canceled the deal under U.S. pressure (Katz and Marwah 1982, 227).

Germany to South Africa (1968–72). There has been speculation, but no concrete evidence, that a German firm assisted South Africa with jet-nozzle uranium enrichment after the German cabinet explicitly prohibited the cooperation (Rogers and Cervenka 1978). If the cooperation did occur, it was not state sponsored and would not count as sensitive nuclear assistance as I define it.

Italy to Argentina (1969). Experts once speculated that Italy may have assisted Argentina in the construction of the Ezeiza reprocessing facility. It is now believed that the facility was constructed indigenously (Spector 1984, 203).

Norway to Yugoslavia (1966). Norway considered selling reprocessing technology to Yugoslavia, but the deal was never consummated (Potter, Miljanic, and Slaus 2000).

Pakistan to Iraq and Syria (1990). Pakistan may have offered Iraq and Syria uranium enrichment technology, but the transactions were never executed (Mongtomery 2005, 173).

United States to Great Britain (1940–51 and 1960s). Contrary to the belief of many, the United States did not provide sensitive nuclear assistance, as it is defined here, to Great Britain. During the Manhattan Project, the United States selectively exploited Britain's expertise in nuclear physics while systematically denying the British access to America's most sensitive nuclear weapons research. Official U.S. policy was to prevent Britain from obtaining the bomb in this period (Gowing 1964, 1974; Rhodes 1995). The United States assisted Britain with its nuclear weapons arsenal in the 1960s, but this does not qualify as sensitive nuclear assistance because, by this time, Great Britain was an established nuclear weapon state.

REFERENCES

Achen, Christopher, and Duncan Snidal. 1989. "The Rational Deterrence Debate: A Symposium Rational Deterrence Theory and Comparative Case Studies." *World Politics* 41, 2 (January): 143–69.

Albright, David, Frans Berkhout, and William Walker. 1997. *Plutonium and Highly Enriched Uranium 1996: World Inventories, Capabilities, and Policies*. Oxford: Oxford University Press.

Albright, David, and Mark Hibbs. 1992. "Iraq's Shop-Til-You-Drop Nuclear Program." *The Bulletin of the Atomic Scientists* 48, 3 (April): 26–37.

Albright, David, and Corey Hinderstein. 2001. "Algeria: Big Deal in the Desert?" *The Bulletin of the Atomic Scientists* 57, 3 (May/June): 45–52.

Beck, Nathaniel, Jonathan N. Katz, and Richard Tucker. 1998. "Taking Time Seriously in Binary Time-Series—Cross-Section Analysis." *American Journal of Political Science* 42, 4 (October): 1260–88.

Bennett, Scott D., and Allan Stam. 2000. "EUGene: A Conceptual Manual." *International Interactions* 26, 2 (April-June): 179–204.

Bennett, Scott D., and Allan Stam. 2003. *The Behavioral Origins of War*. Ann Arbor: University of Michigan Press.

Betts, Richard K. 1987. *Nuclear Blackmail and Nuclear Deterrence*. Washington, DC: The Brookings Institution Press.

Betts, Richard K. 2000. "Universal Deterrence or Conceptual Collapse? Liberal Pessimism and Utopian Realism." In *The Coming*

https://doi.org/10.1017/S0003055409090017 Published online by Cambridge University Press

Crisis: Nuclear Proliferation, U.S. Interests, and World Order, ed., Victor A. Utgoff. Cambridge, MA: MIT Press.
Bhatia, Shyam. 1988. *Nuclear Rivals in the Middle East*. New York: Routledge.
Bhatia, Shyam. 2008. *Goodbye Shahzadi*. New Dehli: Eastern Book Corporation.
Blair, Bruce G. 1994. "Nuclear Inadvertence: Theory and Evidence." *Security Studies* 3, 3 (Spring): 494–500.
Blanton, Shannon Lindsey. 2000. "Promoting Human Rights and Democracy in the Developing World: U.S. Rhetoric versus U.S. Arms Exports." *American Journal of Political Science* 44: 123–131.
Blanton, Shannon Lindsey. 2005. "Foreign Policy in Transition? Human Rights, Democracy, and U.S. Arms Exports." *International Studies Quarterly* 49, 4 (December): 647–67.
Brodie, Bernard. 1946. *The Absolute Weapon: Atomic Power and World Order*. Manchester, NH: Ayer.
Bueno de Mesquita, Bruce. 1981. *The War Trap*. New Haven, CT: Yale University Press.
Bueno de Mesquita, Bruce, and William H. Riker. 1982. "An Assessment of the Merits of Selective Nuclear Proliferation." *Journal of Conflict Resolution* 26, 2 (June): 283–306.
Campbell, Kurt M., Robert J. Einhorn, and Mitchell B. Reiss. 2004. *The Nuclear Tipping Point: Why States Reconsider Their Nuclear Choices.* Washington, DC: Brookings Institution Press.
Chestnut, Sheena. 2007. "Illicit Activity and Proliferation: North Korean Smuggling Networks." *International Security* 32, 1 (Summer): 80–111.
Cirincione, Joseph, with Jon B. Wolfsthal and Miriam Rajkumar. 2002. *Deadly Arsenals: Tracking Weapons of Mass Destruction*. Washington, DC: Carnegie Endowment for International Peace.
Cohen, Avner. 1998. *Israel and the Bomb*. New York: Colombia University Press.
Corera, Gordon. 2006. *Shopping for Bombs: Nuclear Proliferation, Global Insecurity, and the Rise and Fall of the A.Q. Khan Network*. Oxford: Oxford University Press.
Donaldson, Robert H., and John A. Donaldson. 2003. "The Arms Trade in Russian-Chinese Relations: Identity, Domestic Politics, and Geopolitical Positioning." *International Studies Quarterly* 47, 4 (December): 709–32.
Feaver, Peter Douglas. 1993. *Guarding the Guardians: Civilian Control of Nuclear Weapons in the United States*. Ithaca, NY: Cornell University Press.
Frantz, Douglas, and Kathleen Collins. 2007. *The Nuclear Jihadist: The True Story of the Man Who Sold the World's Most Dangerous Secrets. . .and How We Could Have Stopped Him*. New York: Twelve.
Fuhrmann, Matthew. 2008. "Exporting Mass Destruction? The Determinants of Dual-Use Trade." *Journal of Peace Research* 45, 5 (September): 633–52.
Fuhrmann, Matthew. N.d. "Taking a Walk on the Supply Side: The Determinants of Civilian Nuclear Cooperation." *Journal of Conflict Resolution*. Forthcoming.
Gale, Robert W. 1978. "Nuclear Power and Japan's Proliferation Option." *Asian Survey* 18, 11 (November): 1117–33.
Gartzke, Erik. 2006. *Codebook for the Affinity of Nations Index, 1946–2002, Version 3.0*. http://dss.ucsd.edu/~egartzke/.
Gartzke, Erik, and Matthew Kroenig. N.d. "A Strategic Approach to Nuclear Proliferation." *Journal of Conflict Resolution*. Forthcoming.
Ghosen, Faten, and Glenn Palmer. 2003. *Codebook for the Militarized Interstate Dispute Data, Version 3.0*. http://www.correlatesofwar.org/COW2%20Data/MIDs/MID_v3.0.codebook.pdf.
Gibler, Douglas M., and Meredith Sarkees. 2002. *Coding Manual for v3.0 of the Correlates of War Formal Interstate Alliance Data Set, 1816–2000.* Unpublished manuscript.
Glaser, Charles L. 1991. *Analyzing Strategic Nuclear Policy*. Princeton, NJ: Princeton University Press.
Glaser, Charles L., and Steve Fetter. 2001. "National Missile Defense and the Future of U.S. Nuclear Weapons Policy." *International Security* 26, 1 (Summer): 40–92.
Gleditsch, Kristian. 2002. "Expanded Trade and GDP Data." *Journal of Conflict Resolution* 46, 5 (October): 712–24.
Gowa, Joanne. 1994. *Allies, Adversaries, and International Trade*. Princeton, NJ: Princeton University Press.
Gowing, Margaret. 1964. *Britain and Atomic Energy, 1939–1945*. London: Macmillan.
Gowing, Margaret. 1974. *Independence and Deterrence: Britain and Atomic Energy 1945–1952, Vols. 1 and 2*. London: Macmillan.
Hersh, Seymour. 1991. *The Samson Option: Israel's Nuclear Arsenal and American Foreign Policy*. New York: Random House.
Hewlett, Richard G., and Jack M. Holl. 1989. *Atoms for Peace and War, 1953–1961: Eisenhower and the Atomic Energy Commission*. Berkeley: University of California Press.
Hibbs, Mark. 1992. "Iran Sought Sensitive Nuclear Supplies from Argentina." *Nucleonics Week* 24 September: 2–3.
Ho, Daniel, Kosuke Imai, Gary King, and Elizabeth A. Stuart. 2007. "Matching as Non-Parametric Preprocessing for Reducing Model Dependence in Parametric Causal Inference." *Political Analysis* 15: 199–236.
Holloway, David. 1994. *Stalin and the Bomb: The Soviet Union and Atomic Energy, 1939–1956*. New Haven, CT: Yale University Press.
Horowitz, Michael. 2004/2005. "Who's Behind That Curtain? Unveiling Potential Leverage over Pyongyang." *The Washington Quarterly* 28, 1 (Winter): 21–44.
Hymans, Jacques E.C. 2006. *The Psychology of Nuclear Proliferation: Identity, Emotions, and Foreign Policy*. Cambridge: Cambridge University Press.
Jabko, Nicholas, and Steven Weber. 1998. "A Certain Idea of Nuclear Weapons: France's Non-Proliferation Policies in Theoretical Perspective." *Security Studies* 8, 1 (Fall): 108–50.
Jaggers, K., and T.R. Gurr. 1995. "Tracking Democracy's Third Wave with the Polity III Data." *Journal of Peace Research* 32, 4 (July): 469–82.
Jervis, Robert. 1989. *The Meaning of the Nuclear Revolution: Statecraft and the Prospect of Armageddon*. Ithaca, NY: Cornell University Press.
Jo, Dong-Joon, and Erik Gartzke. 2007. "Determinants of Nuclear Weapons Proliferation: A Quantitative Model." *Journal of Conflict Resolution* 51, 1 (February): 167–94.
Jones, Rodney W., and Mark G. McDonough, with Toby F. Dalton and Gregory D. Koblentz. 1998. *Tracking Nuclear Proliferation: A Guide in Maps and Charts*. Washington, DC: Carnegie Endowment for International Peace.
Kapur, S. Paul. 2005. "India and Pakistan's Unstable Peace: Why Nuclear South Asia Is Not Like Cold War Europe." *International Security* 30, 2 (Fall): 127–52.
Katz, James Everett, and Onkar S. Marwah. 1982. *Nuclear Power in Developing Countries*. Lexington, MA: Lexington Books.
Keohane, Robert O. 1984. *After Hegemony: Cooperation and Discord in the World Political Economy*. Princeton, NJ: Princeton University Press.
King, Gary, Michael Tomz, and Jason Wittenberg. 2000. "Making the Most of Statistical Analyses: Improving Interpretation and Presentation." *American Journal of Political Science* 44, 2 (April): 341–55.
King, Gary, and Langche Zeng. 2001. "Logistic Regression in Rare Events Data." *Political Analysis* 9, 2 (Spring): 137–63.
Kinsella, David. 1994. "Conflict in Context: Superpower Arms Transfers and Third World Rivalry during the Cold War." *American Journal of Political Science* 38, 3 (August): 557–81.
Kinsella, David, and Herbert K. Tillema. 1995. "Arms and Aggression in the Middle East: Overt Military Interventions, 1948–1991." *Journal of Conflict Resolution* 39, 2 (June): 306–29.
Klein, James P., Gary Goertz, and Paul F. Diehl. 2006. "The New Rivalry Dataset: Procedures and Patterns." *Journal of Peace Research* 43, 3 (May): 331–48.
Knorr, Klaus. 1962. "Limited Strategic War." In *Limited Strategic War*, eds. Klaus Knorr and Thorton Read. Princeton, NJ: Princeton University Press.
Koremenos, Barbara, Charles Lipson, and Duncan Snidal. 2001. "The Rational Design of International Institutions." *International Organization* 55, 4 (Autumn): 761–99.
Krasner, Stephen, ed. 1983. *International Regimes*. Ithaca, NY: Cornell University Press.
Krasner, Stephen D. 1976. "State Power and the Structure of International Trade." *World Politics* 28, 3 (April): 317–47.

https://doi.org/10.1017/S0003055409090017 Published online by Cambridge University Press

Kroenig, Matthew. N.d. "Importing the Bomb: Sensitive Nuclear Assistance and Nuclear Proliferation." *Journal of Conflict Resolution*. Forthcoming.
Langewiesche, William. 2007. *The Atomic Bazaar: The Rise of the Nuclear Poor*. New York: Farrar, Straus and Giroux.
Lester, Richard K. 1982. "U.S.-Japanese Nuclear Relations: Structural Change and Political Strain." *Asian Survey* 22, 5 (May 1982): 417–33.
Levy, Adrian, and Katherine Scott-Clark. 2007. *Deception: Pakistan, the United States, and the Secret Trade in Nuclear Weapons*. New York: Walker and Company.
Lewis, John W., and Xue Litai. 1988. *China Builds the Bomb*. Stanford, CA: Stanford University Press.
Liberman, Peter. 2004. "Israel and the South African Bomb." *The Nonproliferation Review* 11, 2 (Summer): 46–80.
Maoz, Zeev, Lesley G. Terris, Ranan D. Kuperman, and Ilan Talmud. 2007. "What Is the Enemy of My Enemy? Causes and Consequences of Imbalanced Relations, 1816–2001." *Journal of Politics* 69, 1 (February): 100–15.
Mearsheimer, John J. 1990. "Back to the Future: Instability in Europe after the Cold War." *International Security* 15, 1 (Summer): 5–56.
Mearsheimer, John J. 1993. "The Case for a Ukranian Nuclear Deterrent." *Foreign Affairs* 72, 3 (Summer): 50–66.
Medeiros, Evan S. 2005. *Chasing the Dragon: Assessing China's System of Export Controls for WMD-Related Goods and Technologies*. Santa Monica, CA: RAND Corporation.
Montgomery, Alexander H. 2005. "Ringing in Proliferation: How to Dismantle an Atomic Bomb Network." *International Security* 30, 2 (Fall): 153–87.
Morstein, Jennifer Hunt, and Wayne D. Perry. 2000. "Commercial Nuclear Trading Networks as Indicators of Nuclear Weapons Intentions." *The Nonproliferation Review* (Fall/Winter): 75–91.
Musharraf, Pervez. 2006. *In the Line of Fire: A Memoir*. New York: Free Press.
Nichol, J.P., and G.L. McDaniel. 1982. "Yugoslavia." In *Nuclear Power in Developing Countries*, eds. James Everett Katz and Onkar S. Marwah. Lexington, MA: Lexington Books.
Nuclear Threat Initiative (NTI). Country Profiles. http://nti.org/e_research/profiles/index.html. (December 6, 2008).
Oneal, John R., and Bruce Russett. 1997. "The Classical Liberals Were Right: Democracy, Interdependence, and Conflict, 1950–1985." *International Studies Quarterly* 41, 2 (June): 267–94.
Orlov, Vladimir A., and Alexander Vinnikov. 2005. "The Great Guessing Game: Russia and the Iranian Nuclear Issue." *The Washington Quarterly* 28, 2 (Spring): 49–66.
Paul, T.V. 2000. *Power Versus Prudence: Why Nations Forgo Nuclear Weapons*. Montreal: McGill-Queen's University Press.
Paul, T.V. 2003. "Chinese-Pakistani Nuclear/Missile Ties and Balance of Power Politics." *The Nonproliferation Review* 10, 2 (Summer): 21–9.
Perkovich, George. 1999. *India's Nuclear Bomb: The Impact on Global Proliferation*. Berkeley: University of California Press.
Pilat, Joseph F. 1985. "The French, Germans, and Japanese and the Future of the Nuclear Supply Regime." In *The Nuclear Suppliers and Nonproliferation: International Policy Choices*, eds. Rodney W. Jones, Cesare Merlini, Joseph F. Pilat, and William C. Potter. Lexington, MA: Lexington Books, 81–92.
Posen, Barry R. 2000. "U.S. Nuclear Policy in a Nuclear-Armed World, or What If Iraq Had Had Nuclear Weapons?" In *The Coming Crisis*, ed. Victor Utgoff. Boston: MIT Press, 57–190.
Potter, William C. 1982. *Nuclear Power and Nonproliferation: An Interdisciplinary Perspective*. Cambridge, MA: Oelgeschlager, Gunn & Hain.
Potter, William C. 1985. "U.S.-Soviet Cooperative Measures for Nonproliferation." In *The Nuclear Suppliers and Nonproliferation: International Policy Choices*, eds. Rodney W. Jones, Cesare Merlini, Joseph F. Pilat, and William C. Potter. Lexington, MA: Lexington Books.
Potter, William C. ed. 1990. *International Nuclear Trade and Nonproliferation: The Challenge of the Emerging Nuclear Suppliers*. Lexington, MA: Lexington Books.
Potter, William C., Djuro Miljanic, and Ivo Slaus. 2000. "Tito's Nuclear Legacy." *The Bulletin of Atomic Scientists* 56, 2 (March/April): 63–70.
Powell, Robert. 1990. *Nuclear Deterrence Theory: The Search for Credibility*. Cambridge: Cambridge University Press.
Powell, Robert. 2003. "Nuclear Deterrence Theory, Nuclear Proliferation, and National Missile Defense." *International Security* 27, 4 (Spring): 86–118.
Quester, George. 1973. *The Politics of Nuclear Proliferation*. Baltimore: Johns Hopkins University Press.
Quester, George. 1983. "The Statistical 'N' of the 'Nth' Nuclear Weapon States." *Journal of Conflict Resolution* 27, 1 (March): 161–79.
Ramsey, Fred L., and Danniel W. Schafer. 2002. *The Statistical Sleuth: A Course in Methods of Data Analysis*. Belmont, CA: Duxbury.
Reiss, Mitchell. 1988. *Without the Bomb: The Politics of Nuclear Nonproliferation*. New York: Columbia University Press.
Rhodes, Richard. 1995. *The Making of the Atomic Bomb*. New York: Simon and Schuster.
Richelson, Jeffrey T. 2006. *Spying on the Bomb: American Nuclear Intelligence from Nazi Germany to Iran and North Korea*. New York: W.W. Norton.
Rogers, Barbara, and Zedenk, Cervenka. 1978. *The Nuclear Axis: Secret Collaboration between West Germany and South Africa*. New York: Times Books.
Sagan, Scott D. 1993. *The Limits of Safety: Organizations, Accidents, and Nuclear Weapons*. Princeton, NJ: Princeton University Press.
Sagan, Scott D. 1996/1997. "Why Do States Build Nuclear Weapons: Three Models in Search of a Bomb." *International Security* 21, 3 (Winter): 54–86.
Sagan, Scott D. 2006. "Keeping the Bomb Away from Tehran." *Foreign Affairs* 85, 5 (September/October): 45–59.
Sagan, Scott D., and Kenneth Waltz. 1995. *The Spread of Nuclear Weapons: A Debate*. New York: W.W. Norton.
Sands, Amy. 1990. "Emerging Nuclear Suppliers: What's the Beef?" In *International Nuclear Trade and Nonproliferation*, ed. William C. Potter. Lexington, MA: Lexington Books.
Sanjin, Gregory. 1999. "Promoting Stability or Instability? Arms Transfers and Regional Rivalries, 1950–1991." *International Studies Quarterly* 43, 4 (December): 641–70.
Schelling, Thomas. 1960. *The Strategy of Conflict*. Cambridge, MA: Harvard University Press.
Schelling, Thomas. 1966. *Arms and Influence*. New Haven, CT: Yale University Press.
Sekhon, Jasjeet S. N.d. "Multivariate and Propensity Score Matching Software with Automated Balance Optimization: The Matching Package for R." *Journal of Statistical Software*. Forthcoming.
Sekhon, Jasjeet S., and Alexis Diamond. 2008. "Genetic Matching for Estimating Causal Effects: A General Multivariate Matching Method for Achieving Balance in Observational Studies." http://sekhon.berkeley.edu/papers/GenMatch.pdf. (December 18, 2008).
Sekhon, Jasjeet S., and Walter Mebane. 1998. "Genetic Optimization using Derivatives." *Political Analysis* 7: 187–210.
Shuey, Robert, and Shirley A. Kan. 1995. "Chinese Missile and Nuclear Proliferation: Issues for Congress." *CRS Issue Brief*, 29, September 9.
Singer, J. David, Stuart Bremer, and John Stuckey. 1972. "Capability, Distribution, Uncertainty, and Major Power War, 1820–1965." In *Peace, War, and Numbers*, ed. Bruce Russett. Beverly Hills, CA: Sage.
Singh, Sonali, and Christopher R. Way. 2004. "The Correlates of Nuclear Proliferation: A Quantitative Test." *Journal of Conflict Resolution* 48, 6 (December): 859–85.
Snyder, Glenn H. 1965. "The Balance of Power and the Balance of Terror." In *The Balance of Power*, ed. Paul Seabury. San Francisco: Chandler.
Solingen, Etel. 1998. *Regional Orders at Century's Dawn: Global and Domestic Influences on Grand Strategy*. Princeton, NJ: Princeton University Press.
Solingen, Etel. 2007. *Nuclear Logics: Contrasting Paths in East Asia and the Middle East*. Princeton, NJ: Princeton University Press.
Solingen, Etel. 1994. "The Political Economy of Nuclear Restraint." *International Security* 19, 2 (Fall): 126–69.
Spector, Leonard S. 1984. *Nuclear Proliferation Today*. New York: Vintage.

https://doi.org/10.1017/S0003055409090017 Published online by Cambridge University Press

Spector, Leonard S. 1990. *Nuclear Ambitions: The Spread of Nuclear Weapons 1989–1990*. Boulder, CO: Westview.
Strulak, Tadeusz. 1993. "The Nuclear Suppliers Group." *Nonproliferation Review* 1, 1 (Fall): 2–10.
Thayer, Bradley. 1994. "The Risk of Nuclear Inadvertence: A Review Essay." *Security Studies* 3, 3 (Spring): 428–93.
Ullman, Richard H. 1989. "The Covert French Connection." *Foreign Policy* 75 (Summer): 3–33.
Waltz, Kenneth. 1979. *Theory of International Politics*. New York: McGraw-Hill.
Waltz, Kenneth. 1995. "More May Be Better." In *The Spread of Nuclear Weapons: A Debate*, eds. Scott D. Sagan and Kenneth N. Waltz. New York: W.W. Norton.
Weber, Steven. 1991. "Cooperation and Interdependence." *Daedalus* 120, 2: 183–201.
Weissman, Steve, and Herbert Krosney. 1981. *The Islamic Bomb: The Nuclear Threat to Israel and the Middle East*. New York: New York Times Books.
Wit, Joel S., Daniel B. Poneman, and Robert L. Gallucci. 2004. *Going Critical: The First North Korean Nuclear Crisis*. Washington, DC: Brookings.

https://doi.org/10.1017/S0003055409090017 Published online by Cambridge University Press