Holding All the Cards: Nuclear Suppliers and Nuclear Reversal

Lisa Langdon Koch

This is an Accepted Manuscript of an article published in *Journal of Global Security Studies* in March 2022, available at: https://doi.org/10.1093/jogss/ogab034

Do international nonproliferation institutions affect the decisions states make about their nuclear weapons programs? Most studies of nuclear reversal analyze outcomes, rather than decisions. However, states do not uniformly pursue nuclear weaponization, but proceed along different paths lined by decisions affecting state resources, research and development, and materials and production. These decisions, which may delay or undermine a program, are critically important to understanding nuclear proliferation processes and outcomes. Using a new data set of non-termination nuclear reversal decisions across three key aspects of program development, I capture more of the process of nuclear reversal. I investigate whether two major nonproliferation institutions, the Nuclear Suppliers Group (NSG) and the Nuclear Nonproliferation Treaty (NPT), influence state decisions about whether to continue investing in ongoing programs. I argue that NSG members have strengthened cooperation across three distinct policy eras, and find that the NGS's market controls have generated material constraints that raise the likelihood that states will make nuclear reversal decisions. I do not find evidence that the NPT contributes to reversal decisions within the context of ongoing programs. These findings have implications for the impact of international institutions on state behavior and for counter-proliferation policy effectiveness.

International cooperation has characterized both the pursuit of nuclear weapons and the efforts to prevent their proliferation. While the spread of nuclear weapons has always involved the transfer of nuclear technology, equipment, and material from one country to another, much of the work to slow the spread of nuclear weapons has also been multilateral. In particular, states have invested political and material resources to coordinate nonproliferation activities through international institutions.

Do these cooperative nonproliferation efforts affect the trajectories of states' nuclear weapons pursuits? Or has the nonproliferation regime failed to prevent the spread of nuclear weapons? Research on international nonproliferation institutions has sought to answer these questions by examining the Nuclear Nonproliferation Treaty (Fuhrmann and

Lupu 2016; Coe and Vaynman 2015; Fuhrmann and Berejikian 2012; Dai 2002; Rublee 2009; Sagan 1996), the International Atomic Energy Agency (Brown and Kaplow 2014; Miller 2017), and the Nuclear Suppliers Group (Gheorghe 2019; Koch 2019). The findings that emerge from these studies indicate that we still do not fully understand whether international nonproliferation institutions are effective.

The failure of these institutions to prevent all proliferation is obvious. But an all-or-nothing definition of proliferation obscures the full range of the nonproliferation regime's potential effects. Nonproliferation policy objectives are not limited only to preventing nuclear weapons acquisition, but also include slowing the progress of nuclear weapons development within states. Nuclear reversal, defined as a governmental decision to significantly slow, or suspend, a nuclear weapons program (Levite 2002), encompasses a wide range of policy decisions made in the context of a continuing program. These program reversal decisions are different from program outcomes like weapons acquisition or program dismantlement. After decisions are made, years may pass before the outcome occurs. I argue that to understand nuclear reversal, we should not study the conditions at the time the reversal outcome is realized, but at the time the political decision to reverse is made.

Nuclear reversal data is typically limited to program suspension or termination. In this study, I expand the definition of nuclear reversal to include non-termination decision-making, capturing more of the process of nuclear reversal. Each type of reversal decision contributes to a state's progress away from nuclear development and represents another piece of the nonproliferation puzzle. Significant reversal decisions slow the momentum of the nuclear program and have the potential to add months or years to the acquisition timeline. These decisions concern three key aspects of the development of a nuclear weapons program: the allocation of state resources to the program; research and development; and the material work of building facilities and producing material components, including the weapons themselves. To investigate the factors that increase the likelihood that governments will make significant program reversal decisions, I identify all nuclear reversal decisions made within all past and current nuclear weapons programs.

To investigate whether international institutions generate conditions that lead states to make reversal decisions, I examine two major nonproliferation institutions: the Nuclear Suppliers Group (NSG) and the Nuclear Non-Proliferation Treaty (NPT). First, while the effect of the NPT on the creation of new nuclear weapons programs has been widely studied, I take a new approach, investigating whether the treaty affects reversal behavior within nuclear weapons pursuers. Second, the global effort to control nuclear exports, led by the NSG, is one of the main barriers to nuclear trade that has been identified as relevant to nuclear reversal. However, the effects of more than half a century of the nuclear suppliers' export controls on nuclear reversal have not yet been modeled in quantitative work. I offer the first quantitative test of the NSG's theorized effect.

The results provide support for the argument that international cooperation has slowed proliferation. I find that the Nuclear Suppliers Group's market controls have raised the likelihood of nuclear reversal decision-making, and that the impact of the suppliers' efforts have increased as the regime has strengthened. However, the models do not provide evidence that states that sign the NPT are more likely to reverse. I argue that this does not suggest the NPT is ineffective, but rather that the NPT does not have a clear effect on *ongoing* nuclear weapons programs.

These findings have implications both for the nuclear reversal literature and for the broader literature on the impact of international institutions on state behavior. Reversal studies should consider the conditions under which leaders are likely to make nuclear decisions, rather than reducing analysis to selected milestone outcomes. And while nonproliferation institutions have not ended the spread of nuclear weapons, this study offers evidence that high levels of cooperation among state participants in an international institution can affect target-state behavior, even in the presence of cheating.

I proceed by examining the concept and practice of nuclear reversal decision making. I then discuss the organization and consolidation of the NSG and identify three distinct time periods corresponding to different stages of the operation nuclear export control regime. I offer hypotheses regarding the impact of the NSG's coordinated export controls on nuclear reversal, and test those hypotheses with data on significant nuclear reversal decisions. I conclude with a discussion of the implications of the findings and the limitations of this study, and propose avenues for future research.

Nuclear Reversal Decision Making

Nuclear reversal has not been as rare as commonly believed. The decision to start a nuclear weapons program is a political decision made by the country leader. Subsequent decisions to reverse an ongoing program also require authorization by the leader and are "profoundly political" (Perkovich 1999, 8). Numerous states that started down the path toward a nuclear arsenal made decisions along the way to slow their programs, or to suspend them entirely. Decisions of this magnitude may be debated by political officials, military elites, and nuclear scientists at high levels of government, but ultimately are made by the political executive (Born, Gill, and Hänggi 2010; McLean 1986; Miall 1987).

Over the last two decades, country studies and cross-national studies have contributed a great deal to our understanding of nuclear reversal. However, two key methodological weaknesses are broadly present within the literature. First, cross-national studies of nuclear reversal typically only examine reversal decisions that terminated a program (Debs and Monteiro 2017; Mattiacci and Jones 2016; Jo and Gartzke 2007; Paul 2000).[1] Reversal decisions sometimes appear to be termination decisions when they are made, but ultimately prove to be suspensions or slowdowns. Further, states may later decide to revive a slowed or suspended program; this has happened in Iran, Libya, North Korea, India, Taiwan, Yugoslavia, and Pakistan. Other states, after having begun a process of nuclear reversal, continue a gradual deceleration, and may ultimately decide to end the program: examples include Brazil, Argentina, Australia, Sweden, and Switzerland.

If states do not uniformly pursue nuclear weaponization at any cost and at full speed, but proceed along different paths, then the reversal decisions made along the way are critically important to understanding nuclear proliferation processes and outcomes. Only in hindsight can we determine whether a reversal decision followed by several years of diminishing nuclear activity was permanent or temporary. In a study of the conditions that contribute to nuclear reversal, omitting non-termination decisions results in an incomplete analysis at best, and introduces bias at worst.

[1] A recent exception is Spaniel 2019, who considers different levels of reversal in specifying a formal model; see especially Chapter 7.

Second, termination decisions rarely are made in isolation. States that terminate a program often make multiple reversal decisions over periods of several years (Levite 2002). Recent quantitative studies, which rely on program termination data, do not capture the full range of reversal decisions (Mehta 2020; Mattiacci and Jones 2016; Jo and Gartzke 2007.).[2] But each reversal decision has the potential to affect the course of a nuclear weapons program. Limiting the analysis to outcomes, rather than the decisions that shape the proliferation process, leads scholars to overlook crucial turning points along the path of nuclear development – decisions that do not immediately end programs, but that do slow them down.

Just as important is the insight that confining quantitative analysis to outcomes measures conditions at the time of the outcome, not at the time the decision was made that ultimately produced the outcome. I follow Levite (2002) in defining nuclear reversal as a governmental decision to significantly slow, or suspend, a nuclear weapons program. Mehta (2020) also incorporates Levite's definition in her study of nuclear reversal, allowing for the possibility that a reversing state may later restart its program after a freeze (Mehta 2020, 10–11; Levite 2002).

Sometimes, a decision and outcome fall years apart; other times, within a short period. I identify the political decision to pursue reversal, which allows me to avoid the conceptual and empirical muddling of the conditions at the time of an outcome with the conditions that existed at the time of the decision that ultimately led to the outcome. This represents a break from the standard measure of program termination.

---

[2] Although Mehta acknowledges the wider range of reversal decisions, particularly in her detailed case study of the Indian nuclear program, she uses program termination as her dependent variable when estimating her models.

For example, focusing only on the 1990 decision to terminate Brazil's nuclear weapons program, a militarized effort that was established as a parallel program to the civilian nuclear energy effort, would obscure an earlier decision that was of crucial importance. The earlier decision, a reversal of the program in 1986, was made in spite of the new civilian government's support for the nuclear weapons effort. Long delays and mounting costs led that government to slow progress toward nuclear facility and testing site construction (Kroenig 2010; Barletta 1997). Studies that include only 1990, and not 1986, in a model test only the conditions at the time of the last reversal and omit the program change that facilitated the 1990 decision. Such analyses do not engage with the realities of the complex nuclear proliferation process. This study is an effort to engage more fully with nuclear reversal as it actually occurs.

I identify reversal decisions in Table 1. In the section below on measurement, I discuss the sources I used to identify reversal decisions. The range of heterogeneous reversal decisions I include comprise all significant decisions, following Levite (2002), that a government undertakes that slow the momentum of the nuclear program and have the potential to add months or years to the acquisition timeline. These decisions concern three key aspects of the development of a nuclear weapons program: the allocation of state resources to the program, research and development, and the material work of building facilities and producing material components – ultimately, the weapons themselves. Because leaders consider many possibilities beyond the outcomes of acquisition or termination, we lose a great deal of the process of proliferation if we ignore the significant nuclear reversal decisions that fall shy of full termination. Incorporating the real-world heterogeneity of reversal decisions into a quantitative analysis allows me to investigate whether there may be common factors that affect all types of significant reversal decision-making.[3]

The table of reversal decisions offers insight into why nonproliferation studies should include the full scope of nuclear reversal. Each of these decisions not only affects nuclear development at key stages, but could itself later be reversed, including a decision to halt a nuclear weapons program. When a leader makes a nuclear reversal decision, that leader cannot know whether it will be overturned in the near or distant future. I thus argue that excluding a reversal decision because it is later overturned compromises the social scientific inquiry of reversal.

Table 1 Types of Nuclear Reversal Decisions

State Resources	Research and Development	Materials and Production
Decision to shift military expenditures and priorities from nuclear to conventional weapons programs Decision to make significant budget or resource reductions to the nuclear weapons program	Decision to suspend militarized nuclear research within a broader nuclear program, including limiting program scope to civilian nuclear energy, or suspending work on militarized components such as a test site	Decision to delay or suspend work on enrichment or reprocessing facilities Decision not to proceed with production of nuclear weapons despite being capable of doing so

[3] In fact, the heterogeneity of the dependent variable has always been present in quantitative studies of nuclear reversal, even though those studies only measure program "termination." Examples illustrating the existing, but unacknowledged, heterogeneity of previous studies of reversal include Japan and Germany (program termination due to losing a war – but also note Japan's earlier reversal in 1943); Switzerland and Sweden (termination of programs that had not yet been authorized to enter a production stage); South Africa (termination of program that had produced nuclear weapons); Libya (shipping out nuclear technology, equipment and materials after a decade of trying to trade them away for side payments); and Taiwan (dismantling a hot lab and most reprocessing facilities in 1977, and then after restarting later, dismantling a research reactor and pledging to stop further work in 1988). See the Appendix for more details about the heterogeneity of termination decisions.

		Decision to suspend production of nuclear weapons or related materials Decision to give up some quantity of nuclear equipment, technology, or weapons to a foreign state

For example, in 1979, the revolutionary regime that came to power in Iran halted the Shah's nuclear program, branding it a "Western" and exorbitantly expensive effort, and thus antithetical to the goals and values of the Islamic Revolution. The actions taken by the regime look a lot like program termination: almost all nuclear activities were halted, and foreign nuclear contracts were canceled. One facility, at Bushehr, was permitted to continue operating because the regime could not reassign the specialized equipment and technology to other purposes (Patrikarakos 2012; Tabatabai 2020). If the regime had continued along this path, operating only one facility and perhaps developing a civilian nuclear energy capability, we would describe this decision as a termination decision. However, within a few years, the regime decided to revive the nuclear weapons program (Patrikarakos 2012, 123; Tabatabai 2020, 14–15), and what could have been a termination decision is therefore classified instead as a suspension decision. Suspension and other significant reversals should be included alongside termination as nuclear reversals; all are significant decisions that comprise the process of nuclear reversal and may become permanent.

States neither stumble into a nuclear weapons capability, nor accidentally fall out of a nuclear weapons program, which is why these decisions are important. Why would a state decide to reverse course? Leaders make calculations about the value of the nuclear weapons program to the state, weighing benefits like state security and prestige against other important factors, such as the likelihood of success, to decide whether the nuclear pursuit is still worth the cost. In the nuclear pursuit literature, some studies have found that certain features of the security environment affect states' initial decisions to seek nuclear weapons, although the findings have been mixed (Singh and Way 2004; Jo and Gartzke 2007; Fuhrmann 2009a; Kroenig 2009b; Bleek and Lorber 2014; Fuhrmann and Horowitz 2015).

On the other hand, Solingen (2007) emphasizes that motivation alone is insufficient to explain nuclear behavior, and that a mix of external and internal factors lead to changes in the ways governments pursue nuclear weapons development. Schneider (2019) argues that individual leaders will perceive security situations differently, based on prior beliefs, while Fuhrmann and Horowitz (2015) argue that leaders that came to power through revolution have a unique perspective on the utility of nuclear weapons.

A nuclear weapons program is not the only option available to a government that faces serious security concerns, and carries risks to the state if the program is discovered. For example, Spaniel (2019) argues that, given favorable conditions, potential proliferators may strategically pursue and then reverse in order to capture the benefits of a deal with a rival state and mitigate the risk of a preventive strike. Whether a state is likely to succeed in the pursuit also matters. Several studies have found that constraints on a state's ability to develop nuclear weapons condition a state's potential for success (Hymans 2012; Jo and Gartzke 2007; Siverson and Starr 1990).

The benefits a program provides and the costs it incurs can change over time, and decisions to reverse a program may be based on different factors than the initial decision to start a program. Considering the conditions that shape the state's environment and constrain or free the state's choices, and that impact cost-benefit calculations, establishes links between observable factors and decisions (Siverson and Starr 1990, 48). Nonproliferation scholarship has increasingly recognized the importance of studying decision-making within the context of complex environments that include, but are not limited to, security concerns (Saunders 2019). I argue that, while security is an important condition of the nuclear weapons pursuit, pursuers may become frustrated by the difficulty of obtaining nuclear technology and lose sufficient political will to continue investing in the program, despite continuing to face security threats. The Nuclear Suppliers Group has created a serious constraint for nuclear pursuers by making the procurement of key materials significantly more difficult and costly.

The Evolution and Impact of the Nuclear Suppliers Group

By the early 1950s, President Dwight Eisenhower had realized that the availability of nuclear material and technology, offered by an increasing number of international suppliers, threatened US efforts to limit the spread of nuclear weapons. The International Atomic Energy Agency (IAEA) grew out of Eisenhower's proposal for an Atoms for Peace program, in which states receiving nuclear exports would pledge to use them only for peaceful purposes. With little authority or capacity to monitor the end-use of nuclear exports, the IAEA was positioned mainly to promote nuclear transfers, and only secondarily to protect against their misuse (Fischer 1997, 21–22; Walker 2001, 216–17).

But two decades later, states seeking to import nuclear goods found that the game was changing. When the United States insisted on renegotiating an agreement to provide a nuclear power reactor and fuel to Yugoslavia, the frustrated Yugoslav government sent a delegation of a half-dozen high-level officials to protest to the IAEA, which was named in the agreement as the official supplier. Decrying the monopoly the nuclear suppliers were maintaining on nuclear technology, the furious ministers and ambassadors railed against the Nuclear Suppliers Group (NSG) Guidelines and the related change in U.S. policy. Unfortunately for the Yugoslav delegation, the IAEA was powerless to help, despite holding legal status as the named supplier. The IAEA Director General spoke directly to US Vice President Walter Mondale, who explained the administration would not change its position. As David Fischer writes, while the IAEA was the supplier on paper, "in fact, the true supplier held all the cards" (1997, 263; and see Brezaric 1977).

I argue that the international export control regime created by the NSG in 1974 has increased the likelihood that nuclear weapons pursuers will reverse their programs. Supply-side controls on nuclear equipment and technology are imperfect and have not ended proliferation. But the export control regime has raised the financial and political costs of developing nuclear weapons, creating incentives for states to make nuclear reversal decisions. Those incentives have increased as the regime has grown stronger.

International institutions are defined by John Mearsheimer as "sets of rules that stipulate the ways in which states should cooperate and compete with each other" (1994, 8). Despite Mearsheimer's skepticism regarding the value of institutions, his definition is widely accepted in the international institutions literature and allows us to separate the institution from the possible range of outcomes the institution may influence.[4] Both

[4] For a discussion of the development of the political study of international institutions and the methodological and theoretical reasons why this definition is preferred in current scholarship, see Martin and Simmons 2013.

informal and formal sets of rules may comprise an international institution, and those rules may change over time. The NSG is not a treaty-based organization; the nuclear suppliers that join the NSG are therefore called participating governments rather than members. But the NSG has created a set of rules governing nuclear trade that its participants agree to follow. Most precisely, then, it is the Group's rules controlling nuclear exports that constitutes the international institution I examine here.

Much of the recent nuclear reversal literature has neglected, or has been positioned in opposition to, supply side arguments, which concern the factors that impact a state's capacity to develop nuclear weapons.[5] In their study of the effect of threats and security commitments on preventing nuclear proliferation, Debs and Monteiro (2017) address supply side factors as a secondary component of reversal, but limit their discussion to one factor, nuclear assistance. Levite (2002, 86) calls attention to supply side factors as relevant, as nuclear pursuers must "mobilize scare resources [and] overcome . . . technical hurdles," yet omits these factors from the theory and analysis**.** Kemp (2014) argues that the wide availability of open-source technical and scientific information about nuclear weapons development should mean that states can develop nuclear weapons using domestic industrial capabilities rather than relying on foreign assistance.

Yet despite the contention that states should be able to develop nuclear weapons alone, in practice, states seek help from foreign sources in hopes of shortening the acquisition timeline (Fuhrmann 2009b, 186; Beck et al. 2003). No state has ever pursued a nuclear weapons program in isolation. Sagan notes that the creation of the NSG and the

---

[5] Important studies on supply side factors include Miller 2018; Fuhrmann 2009a, 2009b; and Kroenig 2009a, 2009b.

strengthening of international nuclear export controls over time are factors that may affect nuclear weapons program development, including the time a state needs to move from possessing enrichment and reprocessing capabilities to being able to build a bomb.[6] Given the reality that proliferators spend significant time and resources to bring in nuclear transfers, whether the global effort to impede those transfers hampers nuclear development is worth investigating.

Under Article III of the NPT, signatories agreed to permit the sale of certain fissionable materials and equipment only under safeguard arrangements. But the political will to execute this agreement emerged only after India used unsafeguarded technology and materials from Canada and the United States to achieve its surprise 1974 nuclear test (Strulak 1993). A multilateral coalition of states formed the Nuclear Suppliers Group (NSG), and within months, began implementing controls prohibiting sensitive nuclear exports unless accompanied by IAEA safeguards (Anthony, Ahlstrom, and Fedchenko 2007, 38–39; Fischer 1997, 262).

These supply-side controls are often dismissed as ineffective. Nuclear weapons-seeking states can develop methods to circumvent the controls (Kemp 2014; Braun and Chyba 2004), and nuclear suppliers may not enforce the controls (Hymans 2012; Beck et al. 2003). A notable failure of the regime was Iraq's ability to evade export controls by purchasing non-controlled dual-use items (Solingen 2007). Debs and Monteiro (2017) claim that supply-side controls do not impose enough of a cost on a nuclear buyer to deter proliferation unless the controls are associated with credible threats to use force.

---

[6] States must be able to enrich uranium or reprocess plutonium to sufficient levels to fuel a nuclear bomb. See Sagan 2010, 96-99.

However, while the NSG's regime has not prevented all nuclear proliferation, it can manage proliferation (Stewart 2012; Solingen 2007, 29–30). The NSG's export control regime has had an observable, independent effect on nuclear weapons program decision-making in ways its critics have not seriously considered. In a recent study of the nuclear market, Gheorghe (2019) explicitly links the export control regime to a decrease in nuclear proliferation and discusses how the United States and Soviet Union led cooperation on export controls throughout the last decades of the Cold War. This cooperation, and the recruitment of other nuclear suppliers to the Group, was a rational step for the superpowers to take together.[7] One supplier alone could not control the market. But establishing a market control regime held the suppliers to a set of rules that would keep the playing field level.[8]

Export controls change proliferation outcomes when slowing proliferation extends the timeline to nuclear weapons acquisition. In a recent study, Koch (2019) argues that the controls have important secondary effects: the practical difficulties and delays dissuade interested states from progressing all the way to nuclear weapons acquisition. The methods states turn to in order to circumvent supply-side controls are costly and inefficient – and indicate that the regime is working well enough to prompt counter-actions, a point Gheorghe (2019) also makes. Reliance on dual-use items causes a program to invest money, time, and human capital to build equipment the state cannot procure.

---

[7] See also Anstey 2018, 983-85.

[8] William Burr (2014) discusses President Richard Nixon and Secretary of State/NSA Henry Kissinger's transformation from NPT skeptics to nonproliferation policy-makers, including their view that unilateral action would harm US economic interests, but a cooperative market control regime would allow the United States to maintain its advantage in the nuclear market.

States that turn to the black market to procure prohibited items typically pay more, and more importantly, the items they receive are likely to be unreliable, resulting in additional costs and delays (Kemp 2014; Corera 2006; Montgomery 2005). These obstacles interfere with nuclear weapons program development to the extent that frustrated states may become more likely to reverse their programs (Koch 2019).

South Korea's nuclear pursuits offer an example. Seoul first made serious efforts to import nuclear technology in 1972, succeeding in negotiating a contract for a 600 megawatt CANDU reactor from Canada in 1973, and opening negotiations for an NRX type research reactor. However, Canada was a founding participant of the NSG, and the controls the NSG began implementing in late 1974 led Ottawa not only to cancel the NRX negotiations with Seoul, but also to threaten to cancel the CANDU contract unless Seoul agreed to new safeguards and to ending its attempts to purchase a plutonium reprocessing plant from France (Bratt 2006, 114–16, 128–31; Kim 2001). Washington joined in, specifically invoking the NSG in pressuring Seoul to reverse course (Colby 1974). The roadblocks the NSG placed in South Korea's path to nuclear weapons led Seoul to pivot to an indigenous effort at developing reprocessing techniques, which ultimately failed after the lack of foreign support created significant delay and impeded program progress (Kim 2001, 66–67; Snyder 2010).

These actions were not due to the NPT, which had opened for ratification five years earlier. While Seoul decided to ratify the NPT in 1975, the nuclear weapons program was allowed to continue covertly, on a new course as an indigenous program with a dual-use focus (Kim 2001; Snyder 2010). Nor were Seoul's actions due to a change in the security environment or in the structure of the international system; the Cold War was still well underway. They were due to the new rules regarding nuclear export controls, which had been designed and implemented not through the NPT, but by seven NSG participating governments.

I argue that the NSG's impact on nuclear reversal has increased as the Group's participants have strengthened the export control regime. I identify three distinct time periods in the NSG's evolution. The first period, during which key nuclear suppliers began operating a functional export control regime, lasted from 1974-1978. In discussing this period, I explicitly contrast the two key international institutions of interest in this study: the NSG and the NPT. The second period began in 1979, when the NSG deepened cooperation among participating suppliers, and expanded both in terms of participants and items subject to control. The third period began in 1992, after the clandestine Iraqi nuclear weapons program was discovered. Iraq had imported technology and equipment that the NSG had not included in the control regime, and the revelation spurred the nuclear suppliers to significantly expand their reach.

First Period: 1974-1978

Even before the regime went into full effect, the key nuclear suppliers began acting as if it had, by intentionally slowing down their ongoing nuclear transfer negotiations with potential buyers (Burr 2014). Within two months of India's May 1974 test, the Zangger Committee, a group of nuclear suppliers and NPT signatories, had produced a "Trigger List" of material and equipment that required the potential importer to accept IAEA safeguards. Two months after that, the list was active, and the controls were already a part of contract negotiations ("INFCIRC/209 Memorandum B" 1974; Strulak 1993; Fischer 1997, 262; Anthony, Ahlstrom, and Fedchenko 2007, 39).[9]

The NSG participants – the United States, the Soviet Union, the United Kingdom, West Germany, Japan, Canada, and France (which was not party to the NPT) – began formally meeting in London in 1975 to discuss the specific terms of their mutual agreement to enact and enforce controls on nuclear exports. By the end of 1975, they had established common guidelines for safeguards and controls. Each participant pledged to adopt domestic policies to implement the guidelines and to formally notify each other of the adoption within one month. The Executive Secretary of the US Department of State wrote that the participating suppliers were "anxious to conclude this procedure" quickly (Springsteen 1975).

The NSG guidelines were, in both theory and practice, a significant departure from the NPT. Article IV of the treaty allowed for non-nuclear weapons states (NNWS) party to the treaty to engage in "the fullest possible exchange" of nuclear equipment and materials, and the Zangger Committee had operated within that framework. The NSG participants, on the other hand, intended to meaningfully limit the supply of sensitive nuclear technology for all NNWS, whether party to the NPT or not (Anstey 2018, 991–92). Further, the IAEA followed the NSG's lead, adopting safeguards policies in late 1977 that were informed by previously established NSG Guidelines (Fischer 1997, 333).

[9] For the NSG guidelines' incorporation into 1974-75 agreements made between France and South Korea; France and Pakistan; and West Germany and Brazil, see Fischer 1997, 262. For an example of Canada's new requirements, see Anthony, Ahlstrom, and Fedchenko 2007, 39.

Even in these early years of the NSG, the Group's export controls changed the game for nuclear weapons pursuers. Importing states with weapons ambitions now needed to find a supplier willing to defy the regime, or purchase the restricted items on the black market. Both of these options included risk, from uncertainty over whether a rogue supplier would renege, to the possibility that black market goods would arrive broken, incomplete, late, or not at all.[10] Nuclear pursuers could instead purchase unrestricted, industrial items that could be put to a dual use in a weapons program, or they could accept safeguarded technology through the regime and then attempt to reverse engineer the technology in a separate, clandestine program. But these methods added months, and often years, to nuclear weapons development (Koch 2019; Burr 2014; Kemp 2014; Beck et al. 2003).

In 1978, the NSG grew to sixteen participating governments (see Figure 1 for a yearly count), each of which agreed to implement specific controls on nuclear exports. The guidelines for nuclear export controls were published, establishing a public reference for nuclear export policy-making (Fischer 1997, 98). By this time, the regime had already delayed nuclear development in several states, including South Korea, Brazil, and Pakistan.[11] NSG controls were particularly important in contributing to South Korea's reversal decisions (Gheorghe 2019; Burr 2014).

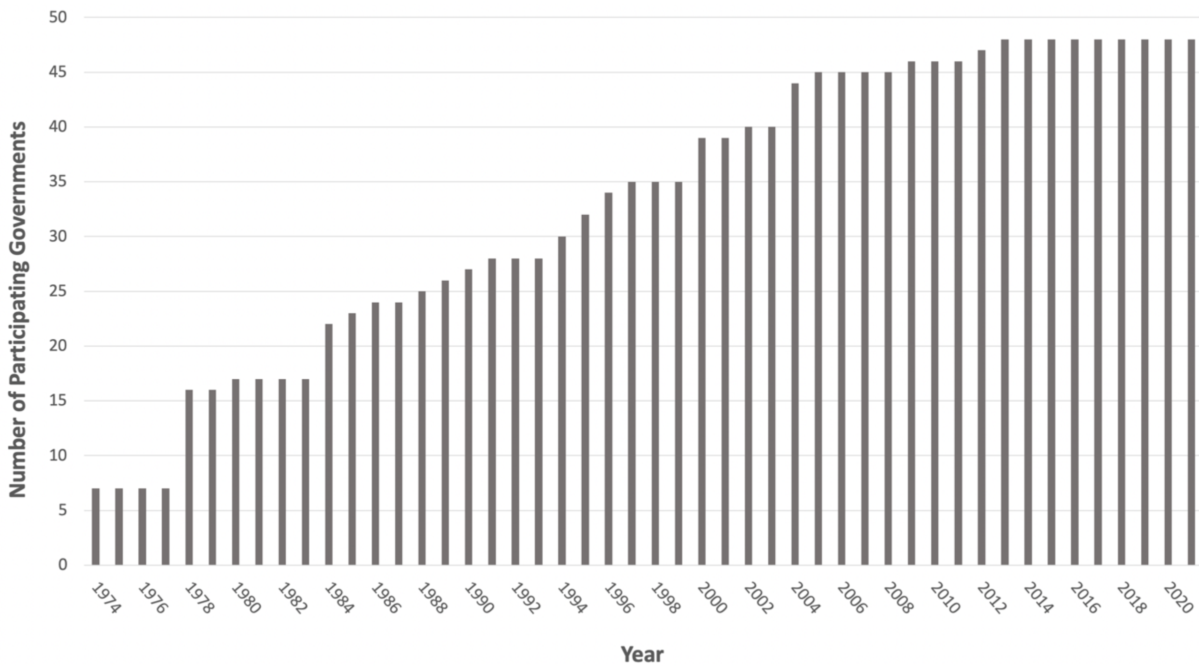
Second Period: 1979-1991

[10] Examples abound. In particular, see Corera 2006 and Kemp 2014.
[11] For Brazil's turn to reverse engineering, which led to large costs and delays, see Kassenova 2014 and Reiss 1995. For Pakistan's troubles in this first period of the regime, see F. H. Khan 2013, 106–10 and 169–71, who attributes a four-year delay in producing uranium reactor fuel to the new regime; M. A. Khan 1998, 4; and Tzeng 2013.

After the NSG's 1978 expansion, the second period saw the export control regime deepen and mature. Hibbs attests to the cohesion of the regime, describing how the United States and Soviet Union cooperated – "without interruption" – in overseeing the regime through the NSG during these decades (Hibbs 2017, 6). Fewer state suppliers were willing to break the rules, and those that were willing sometimes folded under pressure from other members of the Group, particularly the United States. At the second NPT Review Conference in 1980, the NNWS loudly registered their dismay with the NSG's limiting access to nuclear technology and equipment, to the extent that the issue "dominated" the conference (Fischer 1997, 98–102).[12]

Figure 1 Total NSG Participating Governments by Year, 1974-2021

[12] The other dominant issue was the non-nuclear weapons states' push for the negotiation of a nuclear test ban treaty.



As nuclear pursuers devised new tactics to circumvent the regime, the NSG responded strategically. Through the démarche program, which began as 1978 ended, intelligence sharing, and other diplomatic communications, NSG participants began to share evidence of proliferation activities and coordinate action against the offending states (Craig 2017; Burr 2014). Several participating governments unilaterally elected to require full-scope safeguards for nuclear exports (Anstey 2018, 990–91). And the NSG expanded the Trigger List, adding key items needed for heavy water, reprocessing, and enrichment (Dunn 2009).

The NSG did not formally meet during this time period. Participants had not reached agreement on every issue, and gaps in the regime allowed determined states to use the black market to smuggle in illicit goods. Yet in practice, the work of the Group during this period brought about a "complete halt" to the legal nuclear market for reprocessing and enrichment technology and materials (Fischer 1997, 98). Even A. Q. Khan, Pakistan's infamous nuclear smuggler, faced significant difficulties in procuring equipment, both during this period and into the next, that can be attributed to the creation of the NSG's control regime.[13] Khan had once been able to ask his former colleagues at the Dutch laboratory where he had worked to ship him requested supplies. But after the regime was in place, the transactions were no longer so simple. Instead, Khan had to use increasingly complex work-arounds, including establishing sham companies and bank accounts, and had to rely on third parties like trade brokers, middle men, and shipping companies – all to avoid detection by the regime.[14] Such elaborate methods are not only expensive, but also introduce delay into the procurement process for clandestine programs.

Notably, Iraq was thwarted several times in its search to procure sensitive items during this period. In 1980, regulatory officials prevented West German firm NUKEM from exporting depleted-uranium metal fuel pins that Iraq planned to use for plutonium extraction (Spector 1990, 187). Iraqi scientists decided not to pursue gaseous centrifuges for uranium enrichment because the centrifuges could not be imported under the NSG regime. The program turned to gaseous diffusion instead, but export controls prevented the procurement of the machines needed to produce the necessary material, and Iraq did not have the ability to produce these machines domestically (Braut-Hegghammer 2011, 81). Then in the mid-1980s, when Iraq could not procure technology for the chemical enrichment of uranium under the NSG regime, the nuclear program squandered several

[13] Khan began smuggling materials for Pakistan's nuclear weapons program, but by 1990 had shifted to exporting lucrative items to other states, originating what would become an extensive black market network.
[14] Hibbs relates this account in Armin Rosen, "How North Korea Built Its Nuclear Program," *The Atlantic*, April 10, 2013.

years attempting to extract technical information from the French under the pretense that Iraq would eventually purchase safeguarded technology (Kay 1995, 92–93).

Iraq was able to circumvent some export controls over the decade. But after being frustrated again and again, the program turned to importing dual-use items that fell outside the NSG's control regime. Listing civilian uses on export permit applications, Iraq legally bought technology, equipment, tools, and raw materials – much of which was secretly put to use in the nuclear weapons program – from foreign suppliers like the United States (Albright and Hibbs 1992).

Third Period: 1992-Present

The most significant adjustment to the regime occurred after the 1992 disclosure of Iraq's dual-use importing practices. Within just a few months, the NSG's participating governments, spurred forward by the scandal, had agreed to substantially expand the list of controlled items to include nuclear-related dual-use equipment, materials, software, machinery, and technology. This new mandate also included the stipulation that full-scope IAEA safeguards would be required for non-nuclear weapons states importing significant nuclear items (Anthony, Ahlstrom, and Fedchenko 2007, 22–23).

The strengthening of the regime in 1992 changed the game again, as states must invest substantial resources and time in the effort to thwart the dual-use item restrictions. Even North Korea, with its offshore front companies and other elaborate workarounds, expends significant time and resources on this task (Braun et al. 2016, 43; Park and Walsh 2016, 57; Braun and Chyba 2004, 13). The NSG began holding yearly plenary meetings, and has continuously reviewed, adjusted, and added to its lists of controlled items. A standing technical working group proposes modifications that participating governments approve by consensus.[15]

During this third period, the NSG has become more effective at denying technology to nuclear hopefuls. In practice, these barriers to trade increase the expected costs of acquiring nuclear weapons. And since states cannot predict whether today's nuclear suppliers will remain willing and able to sell the same nuclear technology and equipment from year to year, they may be less likely to sink vast resources into precarious investments in enrichment and reprocessing capabilities. I thus offer two hypotheses:

Hypothesis 1: States are less likely to make reversal decisions prior to the advent of the NSG's export control regime in 1974.

Hypothesis 2: Subsequent to the start of the regime, states are more likely to make reversal decisions during periods in which the regime is more robust.

Research Design

Measuring Nuclear Reversal Decisions

Testing the impact of the NSG's export control regime on nuclear reversal requires data on both regime strength and nuclear reversal decisions. If the regime's barriers to trade hamper nuclear proliferation, then I expect to observe that nuclear reversal becomes more likely as the regime strengthens. I identified nuclear reversal decisions across the population of states that began a nuclear weapons program. In a given year, a state's nuclear reversal decision is coded as 1, and 0 otherwise. Each of the ten states that

[15] I thank Mark Hibbs for explaining this process to me in personal correspondence, 12 January 2018.

succeeded in acquiring nuclear weapons (including South Africa and Israel) clearly belongs on a list of nuclear weapons pursuers, but states that have not yet acquired nuclear weapons may be more difficult to categorize. Scholars continue to debate the merits of various cases, and reasonable people may disagree about the inclusion or exclusion of several possible nuclear weapons hopefuls. I include several robustness checks (see the Appendix) to include, or exclude, disputed programs.

After earlier quantitative proliferation studies were published, as researchers requested government document declassification and conducted new studies, new information about the start dates of several nuclear weapons programs became available. Using both new evidence and long-standing research, I have compiled a slightly revised list of countries and dates. I have detailed this research, including explanations and sources, in the Appendix (A1). I report results obtained using the updated dates below, and report those obtained using, and report those obtained using dates compiled by Singh and Way (2004), and Jo and Gartzke (2007) in the Appendix (A2). The main results are robust across different combinations of key dates and cases. Table 1-A in the Appendix lists each state that has had a nuclear weapons program, along with any decisions to reverse, between 1941-2001. Each of the states enters the data set in the year its nuclear weapons program was initiated and remains until its program ends, or until 2001, the last year included in this study.[16]

---

[16] I do not drop states from the data set post-nuclear weapons acquisition because states may still make reversal decisions even after becoming nuclear weapons powers. There are two reasons I believe the assumption that nuclear weapons states cannot reverse would compromise the integrity of the study. First, the case of South Africa after acquisition is the most obvious reason not to do this, since South Africa dismantled its program post-acquisition. Dropping South Africa at acquisition would mean excluding a case, and indeed an extreme case, of nuclear reversal, potentially biasing the results. Further, while states

Determining when a nuclear reversal decision was made can be difficult, as the decision itself is typically made in secret, and governments may deliberately misrepresent the true state of their nuclear programs. In some cases, a reversal decision is documented directly or confirmed by key witnesses; in others, the date of the decision is less clear. I conducted extensive case research, relying primarily on government documents and the existing case literature, to identify the decisions themselves. When accounts conflicted, I prioritized information supported by interviews and government documents over secondary source material. I document all sources (A1).

To address concerns regarding secrecy and misrepresentation, I chose 2001 as the last year of data collection to improve the likelihood that information on reversal decisions would be available. Allowing for a substantial interval of time to elapse between the event and the attempt to observe it allows for documentation to become available. While I claim neither to have discovered nor substantiated every instance of nuclear reversal, excluding the recent past is a prudent measure taken to increase confidence that my accounting is as complete as possible.[17]

A second complicating factor is the infrequency of nuclear reversal decision-making. Drawing conclusions about the causal relationships between explanatory variables and events requires greater caution when observing a relatively small set of events. However, wishing for more perfect, or simply more, information should not preclude the attempt to

perceive enormous benefits to maintaining an existing nuclear arsenal, I have no theoretical reason to assume that nuclear weapons powers cannot reverse course. Allowing states to remain in the data set post-acquisition means that I capture post-acquisition reversals in Russia, the United Kingdom, France, and China.

[17] The lack of declassified government documentation in Israel, Iran, and North Korea poses a particular challenge. Researchers should be cautious in assessing broad claims that hinge on a single case.

perform the analysis. Careful identification of reversal decisions reduces uncertainty on the input side of the models, and robustness checks, described below, reduce uncertainty in the models' outputs.

Measuring NSG Regime Strength

To test whether the NSG's export control regime has had an effect on the likelihood of nuclear reversal, I use an index ranging from 0 to 2 as a measure of the strength of the regime during each of the three time periods detailed above. Following the theory, I expect a stronger regime to interfere more with a state's ability to pursue nuclear weapons development and to thus make reversal decisions more likely. Prior to 1974, neither the NSG nor the export control regime existed, and the variable is coded as 0. The variable is coded as 1 from 1974 – the initial organization of the NSG and the early establishment and implementation of the regime – to 1978. The change from no regime, to the existence of a regime, is the most substantial change according to the theory, and is measured accordingly in the index. From 1979 to 1991, the strength of the regime is coded as 1.5, representing an increase in regime strength. Beginning in 1992, the variable is coded as 2, to account for the creation in that year of restrictions on dual-use items and of the requirement of full-scope safeguards on new exports. As noted above, both of these controls significantly strengthened the NSG's regime from 1992 onward. As an alternative measure of regime strength, I use an index ranging from 0 to 3, in which each period is represented by a 1-unit increase; the results are robust to this alternative measure and are reported in the Appendix (A4). States that acquired nuclear weapons before 1974 could not be affected by a regime that did not exist, and thus receive a 0 for this variable, as do states post-1974 upon achieving nuclear weapons status.

I use a second alternative measure of the export control regime in order to conduct a quantitative test of my claim that the regime has strengthened over time. Perhaps the measurement of the NSG's effectiveness over time should be treated not as a continuous variable, but as a categorical variable. By treating the different time periods as categorical variables, no ordering is imposed, and no assumption of strength or weakness is assigned.[18] I find that each NSG time period, compared to the baseline (the time period before the NSG was created), has a positive and statistically significant effect, supporting the claim that each distinct time period within the NSG regime does have an independent effect on nuclear reversal likelihood. I report these results in the Appendix (A4).

Independent Variables

The main competing explanation for a market-centered theory of nuclear reversal is the unilateral or multilateral use of *economic sanctions* to attempt to coerce governments into reversal. While there have been a few cases of apparent success (Solingen 2012; Montgomery 2005; Braun and Chyba 2004), most scholars agree that economic sanctions are generally ineffective at bringing about policy change (Lacy and Niou 2004; Drezner 1999; Pape 1997) and have rarely caused leaders to make nuclear reversal decisions within the context of an existing nuclear weapons program (Miller 2018; Singh and Way 2004).[19] Further, Miller (2018) demonstrates that states that start nuclear weapons programs under the credible threat of sanctions have already determined that sanctions will not cause enough harm to necessitate nuclear reversal. I operationalize the presence of sanctions that impose limits on nuclear material, knowledge, training, or financing, using

[18] I thank an anonymous reviewer for this suggestion.
[19] For an opposing view, see Mehta 2020 on the effects of economic sanctions when used by the United States in concert with positive inducements.

data from Hufbauer (2007). If the state is the target of nuclear sanctions in a given year, then I code that as 1, and 0 otherwise. As a robustness check, I use Hufbauer's accounting of all types of economic sanctions (A4).

NPT ratification. Within the category of international nonproliferation institutions, the NPT, as the primary international nonproliferation treaty, may have ushered in a system of nonproliferation norms and behaviors causing ratifying states to be less likely to start nuclear weapons programs (Fuhrmann and Lupu 2016; Rublee 2009; Sagan 1996). Ratification could lead states to make nuclear reversal decisions, although some states appear to use ratification as cover to continue their clandestine nuclear weapons programs.[20] I code ratification as 1 if a state has ratified the treaty, and 0 otherwise.

Latent capacity. A latent state has not acquired usable nuclear weapons, but is often referred to as being "a screwdriver's turn away" from producing a nuclear bomb. If the state's nuclear facilities can produce fissile material (plutonium or highly enriched uranium) for use in nuclear weapons, then the state is likely to be able to fabricate nuclear weapons within a time span of a few months to a year or two (Fuhrmann and Tkach 2015; Sagan 2010; Levite 2002). States with confidence in domestic nuclear capacity may engage in reversal in order to "hedge" – suspending or slowing a program while maintaining the option to rapidly restart it later. At higher levels of development, states are better able to establish this option to either restart or move toward weapons production (Volpe 2017). Mattiacci and Jones (2016, 540) argue that higher levels of nuclear development capacity reduce the cost of restarting a nuclear weapons program, and find that a state with greater nuclear development capacity is more likely to choose to conclude its program. Hedging

[20] Australia appears to be one such case. See Walsh 1997, 3, 11–13; and Cawte 1992, 129.

may also allow a state to satisfy domestic political actors that would otherwise be unwilling to support nuclear reversal (Volpe 2017, 526–27; Levite 2002, 74–75). However, states may pursue higher nuclear weapons development capacity levels in order to increase their ability to compel adversaries and extract concessions (Schelling 1966; Volpe 2017; Fuhrmann and Sechser 2014; Gartzke and Jo 2009), and may be emboldened to initiate disputes (Mehta and Whitlark 2017). To test whether higher levels of capacity are associated with reversal, I use Fuhrmann and Tkach's measure, which sets the threshold for nuclear latency at whether the state is operating an enrichment or reprocessing (ENR) facility (Fuhrmann and Tkach 2015). As an alternative measure of capacity, I employ Jo and Gartzke's index of seven factors comprising a state's level of nuclear development (Jo and Gartzke 2007).

Strategic rivalry, *Borders*, and *Cold War*. A state in a high-conflict security environment is likely to have stronger incentives to continue along the path to nuclear weapons to maintain or improve the ability to pursue state interests. States may seek nuclear weapons for their deterrent effects (Gartzke and Kroenig 2009; Jo and Gartzke 2007; Singh and Way 2004; Paul 2000; Sagan 1996; Schelling 1966), for protection against nuclear or even conventional attack (Narang 2014; Gartzke and Jo 2009; Bueno de Mesquita and Riker 1982), to use to extract concessions from non-nuclear opponents (Kroenig 2018; Beardsley and Asal 2009) or to increase bargaining power with nuclear opponents (Kroenig 2018), or for diplomatic leverage to achieve strategic interests without armed conflict (Gartzke and Jo 2009). The presence of a strategic rival may lead a state to more highly value the deterrent effect, and the resulting secondary security benefits, of nuclear weapons. Colaresi et al. (2007) argue that the expectation of threat and hostility that occurs within the context of a strategic rivalry makes conflict de-escalation less likely, logic which can be extended to conceptualize nuclear reversal behavior within a strategic rivalry. A state involved in such a rivalry may be more likely to perceive security threats from its rival, and less likely to unilaterally slow or suspend its nuclear weapons program, than a state without a strategic rival. I use data from Thompson and Dreyer (2011) to identify whether a state was part of a strategic rivalry.[21]

I also measure the number of land borders a state shares with other states (Stinnett and et al. 2002). This preexisting geographic feature serves as a proxy for the security environment; the more neighbors a state has, the more potential exists for conflict (Bremer 1992). As a robustness check, I use an alternative measure: a five-year moving average of the number of militarized interstate disputes in which each state is involved (A4).

The end of the Cold War represented a change in the international order that could affect the likelihood of nuclear reversal, although I note above that the United States and Soviet Union cooperated to administer the NSG's control regime both during the late decades of Cold War and afterward. I employ a post-Cold War variable coded as 1 beginning in 1992, and 0 otherwise.

Security guarantees. A defense pact with a nuclear-armed ally may mitigate a state's security concerns and change that state's motivation to continue pursuing nuclear weapons (Bleek and Lorber 2014; Singh and Way 2004; Sagan 1996). However, security guarantees may not be viewed as credible and do not appear to determine nuclear reversal decisions

---

[21] The concept of a strategic rivalry encompasses the contextual dynamic of leader decision-making better than the concept of an enduring rivalry (Diehl 1998). Enduring rivalry data relies upon dispute history to classify pairs of states as rivalrous or non-rivalrous, meaning the potential outcome of rivals' reactions – conflict – is also the measure for determining the existence of a rivalry.

(McManus 2018; Lanoszka 2018; Debs and Monteiro 2017; Solingen 2007; Jo and Gartzke 2007; Kroenig 2009b; Fuhrmann 2009a). Further, concerns that the protecting power may abandon the defense pact may instead increase the fearful protégé's determination to pursue an independent nuclear deterrent.[22] I employ Bleek and Lorber's (2014) data set on defense pacts. If a state has a security guarantee from a nuclear-armed protector, the variable is coded as 1, and 0 otherwise.

Democracy, *Neopatrimonial regimes*, and *Leader characteristics*. Some studies have found weak support for the supposition that democracies are more likely to reverse (Jo and Gartzke 2007; Solingen 2007; Singh and Way 2004). I use the Polity IV index to measure regime type (Marshall and Jaggers 2002). Hymans (2012) and Montgomery (2013) find that neopatrimonial regimes are more likely to fail at acquiring nuclear weapons. Since it is possible these regimes are also more likely to reverse nuclear programs, I include Montgomery's index of neopatrimonial characteristics in a robustness check (A4). Personalist dictators (Way and Weeks 2014), as well as leaders that participated in a rebellion against the state (Fuhrmann and Horowitz 2015), may more highly value nuclear weapons as a method of securing their regimes. Personalist dictators may also face fewer constraints in pursuing nuclear weapons than their counterparts. I include each of these characteristics in robustness checks to test whether these leaders are less likely to make nuclear reversal decisions (A4).

[22] Lanoszka 2018 points out that since a nuclear weapons-seeking protégé has already considered the potential costs of proliferating and has chosen to risk incurring them, the conditions of a defense pact are unlikely to compel that state to reverse. See also Debs and Monteiro 2017; Paul 2000; Goldstein 2000.

Wealth. State wealth may influence leaders' decisions to continue their costly nuclear weapons programs. I include GDP as a measurement of state wealth in Model 6.

I use logit regressions to estimate the probability that a state will make a nuclear reversal decision. Since observations within each state cannot be assumed to be independent of each other, model errors may be correlated within each state's grouping of observations. Without controlling for this possibility, standard errors could appear artificially small, and confidence intervals could appear artificially narrow. This analysis employs robust standard errors, clustered at the country level, to estimate more precise regression coefficients.

Because many states in the data set experienced multiple reversals, I include a cubic polynomial to model time dependence: time since the last reversal (T), time squared (T2), and time cubed (T3). Using the cubic polynomial avoids the estimation problems due to separation that can arise from using temporal fixed effects in logit models. I rescale the variables by dividing T by 100, and then calculate its square and cube, to reduce any potential collinearity among the three time variables (Carter and Signorino 2010).

Results

The results of several estimated logit models are shown in Table 2. As the value of the covariate increases, positive coefficients indicate that the likelihood of nuclear reversal increases as well; negative coefficients indicate that the likelihood of nuclear reversal decreases. Figure 2 displays confidence intervals for the covariate coefficients in selected models, and Figure 3 displays conditional marginal effects. The results of the models indicate that the NSG's export control regime, and a state's strategic rival status, have statistically significant impacts on the risk of nuclear reversal. The proxy for conflict (the number of shared borders) and NPT ratification are sometimes significant, although both variables exhibit some sensitivity to model specification, and the confidence intervals for both variables either consistently include or approach zero.

The models that measure the strength of the NSG's global export control regime (Models 4-8) consistently find that the regime has increased the likelihood of nuclear reversal, at the 95 percent level. In models 4, 5, 7, and 8, this effect was significant at the 98 percent level. States were approximately six times more likely to make reversal decisions after the NSG began controlling nuclear transfers. This effect is substantially larger when comparing the pre-NSG era to the post-1992 evolution of the regime, as states were approximately sixteen times more likely to make reversal decisions under the strengthened regime.

In comparing the weakest period of nuclear export control, the time before the organization of the NSG, to the strongest period, after the export control regime strengthened its controls to include dual-use items and full-scope safeguards on new exports, and holding the value of all other covariates at their means, results show a 12.8% increase in the likelihood that a state will make a nuclear reversal decision. From the first to the second period of the export control regime, there was a 3.6% increase in the probability of nuclear reversal, and from the second to the third period, results indicate a 5.5% increase.

These findings stand in stark contrast to the findings reported from models 3 and 5, which include a measure of the post-Cold War environment to test an alternative explanation for nuclear reversal. The post-Cold War variable does not approach statistical significance at the 90% level in either model.[23] The sanctions covariates, reported here and in the Appendix (A4), do not approach statistical significance.

The simple variable measuring NPT ratification failed to achieve significance at the 90 percent level in models 2 and 3, but achieved significance at the 95 percent level in models 4-6, and at the 90 percent level in models 7 and 8. However, the 95% confidence intervals included (models 2, 3, 7, 8) or approached (model 6) zero in most models. Surprisingly, in all models, NPT ratification was negatively associated with nuclear reversal. This result might be partially explained by states using treaty ratification as a cover for proliferation activities. Another possibility is that the NPT-ratifying nuclear weapons states are driving these results; the variable accounts for every NPT member, whether that member is a nuclear or non-nuclear weapons state. In the Appendix (A4), I report results using a measure of NPT ratification that codes only NNWS ratifiers as 1, and 0 otherwise. NPT ratification does not achieve statistical significance at the 90% level, suggesting that NNWS that ratify the NPT are not more likely to make nuclear reversal decisions.

[23] As a robustness check, I also included the Cold War variable in models 6-8. Compared to the findings reported in Table 2, there were neither substantive nor significant changes to the covariate effects.

Table 2 *The estimated effect of independent variables on nuclear reversal decision making, 1941-2001*

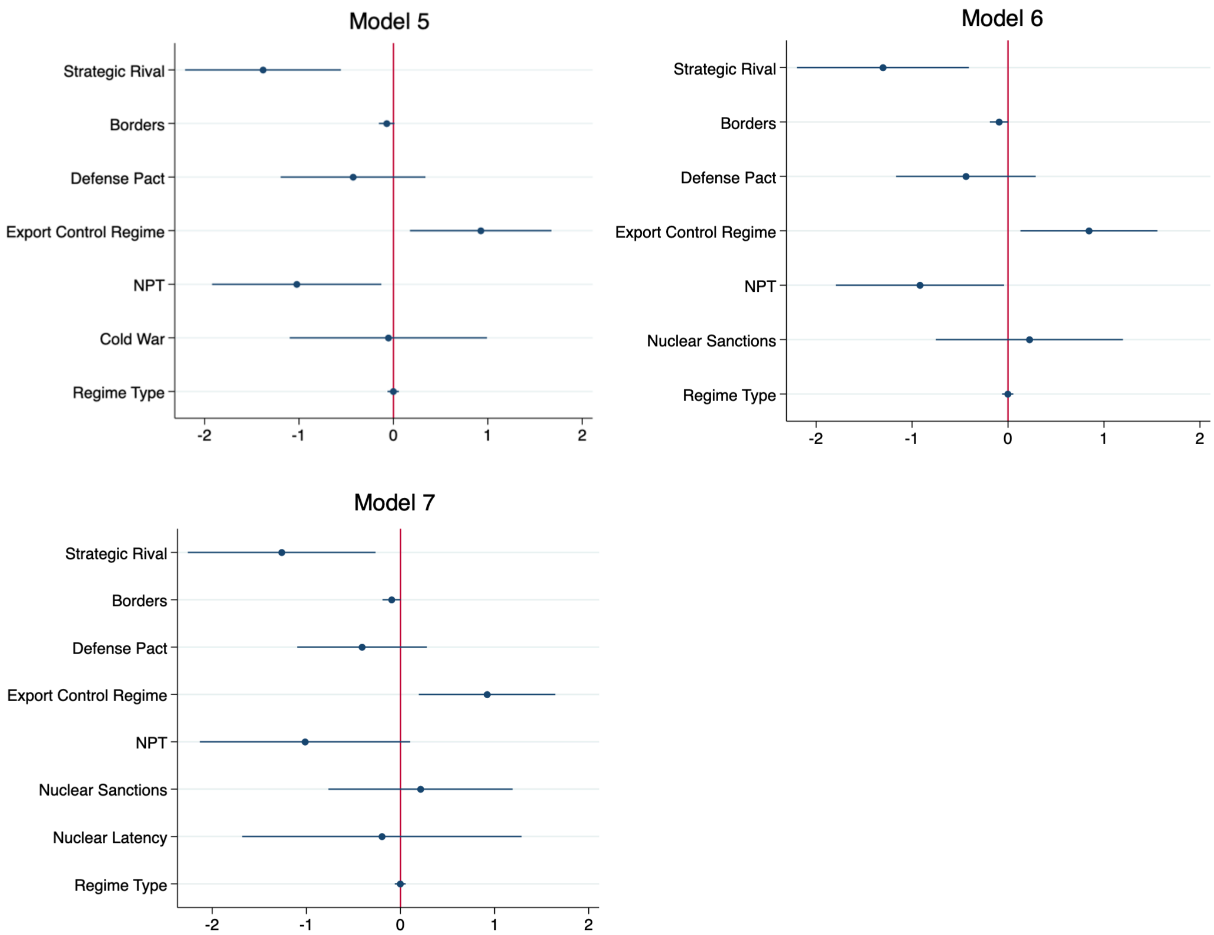
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*
STRATEGIC RIVAL	-1.2871***	-1.2981***	-1.3201***	-1.3846***	-1.3815***	-1.3042***	-1.2621**	-1.3449**
	(0.4112)	(0.4120)	(0.4326)	(0.4111)	(0.4209)	(0.4575)	(0.5088)	(0.5249)
BORDERS	-0.0729	-0.0765	-0.0797*	-0.0722*	-0.0717*	-0.0941*	-0.0944*	-0.0789*
	(0.0448)	(0.0465)	(0.0452)	(0.0416)	(0.0417)	(0.0489)	(0.0493)	(0.0476)
DEFENSE PACT	-0.4535	-0.4416	-0.4292	-0.4235	-0.4277	-0.4392	-0.4088	-0.3843
	(0.4001)	(0.4045)	(0.4076)	(0.3764)	(0.3911)	(0.3713)	(0.3515)	(0.3807)
EXPORT CONTROL REGIME				0.9161**	0.9242**	0.8430**	0.9202**	0.8683**
				(0.3614)	(0.3822)	(0.3642)	(0.3701)	(0.3615)
NPT RATIFICATION		-0.2579	-0.3068	-1.0283**	-1.0246**	-0.9185**	-1.0138*	-0.9227*
		(0.3219)	(0.3416)	(0.4569)	(0.4572)	(0.4475)	(0.5703)	(0.5334)
NUCLEAR SANCTIONS						0.2230	0.2131	0.1593
						(0.4974)	(0.4995)	(0.4982)
NUCLEAR LATENCY							-0.1972	-0.2824
							(0.7572)	(0.7598)
COLD WAR			0.2849		-0.0536			
			(0.4784)		(0.5331)			
REGIME	-0.0121	-0.0216	-0.0229	-0.0026	-0.0023	-0.0033	-0.0028	-0.0052
	(0.0269)	(0.0317)	(0.0315)	(0.0301)	(0.0308)	(0.0298)	(0.0293)	(0.0320)
GDP								-0.0000
								(0.0000)
T	8.2888	8.4519	8.5162	7.0537	6.9754	-4.6136	-4.4100	-5.1692
	(12.2693)	(12.1056)	(12.1459)	(12.4072)	(12.3359)	(13.8186)	(13.5845)	(13.4222)
T2	-26.9305	-26.6484	-26.6283	-17.7565	-17.4085	55.1960	53.4988	58.3349
	(59.3668)	(59.0080)	(58.7733)	(58.9343)	(58.2744)	(68.8727)	(67.4128)	(66.2998)
T3	27.7928	28.3552	27.2178	21.9284	21.7683	-94.1358	-91.0891	-95.0575
	(73.2989)	(59.0080)	(72.2894)	(71.6443)	(71.2596)	(90.9126)	(88.6602)	(85.9063)
CONSTANT	-2.1620***	-2.0623***	-2.0492***	-2.3060***	-2.3069***	-1.8461**	-1.8584**	-1.6508*
	(0.6945)	(0.7480)	(0.7372)	(0.8215)	(0.8225)	(0.8037)	(0.7791)	(0.8987)
Model N	N=693	N=693	N=693	N=693	N=693	N=686	N=686	N=638
Pseudo R^2	0.0590	0.0600	0.0609	0.0819	0.0819	0.0919	0.0922	0.0809

Notes: Standard errors are in parentheses. * p<.10; ** p<.05; *** p<.01.

Because the two international institutions of interest in this study, the NSG and the NPT, are largely contemporaneous, their unique institutional effects may be difficult to separate. To address this concern, I split the sample to investigate whether the variable measuring the strength of the NSG remains statistically significant when only non-NPT states remain in the population. I re-estimated model 7 for only the population of states that did not ratify the NPT. The results, which are reported in the Appendix (A4), largely confirm the main models' findings, with three interesting exceptions. First, the export control regime variable now achieves statistical significance at the 99% level, and the variable's coefficient attains a larger value than in the full sample models reported in the main findings. Second, as I discuss below, the variable measuring the number of land borders a state shares with other states does not consistently achieve statistical significance in the main models. However, in the split sample, the number of shared borders achieves statistical significance at the 95% level, although its effect remains substantively small (near-zero). Third, nuclear latency, which I also discuss below, did not achieve statistical significance in the main models but now has a negative, substantive, and significant ($p < .01$) effect on nuclear reversal, indicating that a latent capability reduces the likelihood a state will reverse its nuclear weapons program. Given the very small number of observations (210) in this sample, however, these findings should be interpreted with caution.

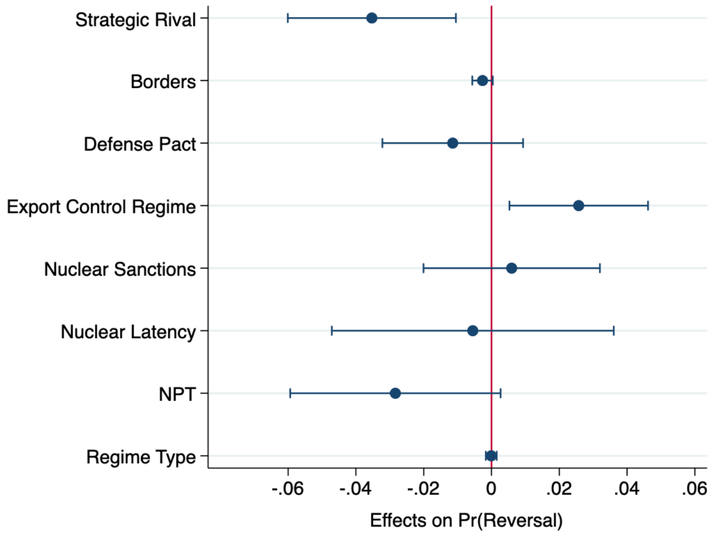
One element of the security environment, the presence of a strategic rival, consistently affected the likelihood of nuclear reversal. Across all models, strategic rivalry achieved statistical significance at the 99 or 95 percent level. In model 7, and holding the value of all other covariates at their means, a state with a strategic rival is 5.7% less likely to make a nuclear reversal decision than a state without such a rival. If a state gains a strategic rival, the likelihood of reversal is estimated to decrease by a factor of 3.5.

Figure 2 Predictors of Nuclear Reversal (Logit), Models 5 – 7



Note: 95% confidence intervals

Figure 3 Conditional Marginal Effects of Covariates on Nuclear Reversal, Model 7



Note: 95% confidence intervals

Other features of the external security environment did not affect nuclear reversal at statistically significant levels. The model indicates that states sharing a greater number of land borders with other states may be slightly less likely to reverse, but the effect is substantively small, and in each model, the 95% confidence interval for this variable includes zero. A security guarantee from a nuclear-armed protector did not have any statistically significant effect on nuclear reversal. Together, these findings support the argument that the expectation of threat present in the context of a strategic rivalry causes states to more highly value a nuclear weapons program.

Nuclear latency, as measured by enrichment or reprocessing activity, did not achieve statistical significance when included in models using the full set of observations. Nuclear pursuers do not appear more likely to pursue a strategy of nuclear hedging as their capability levels rise. I offer a cautious interpretation of this finding. It is likely that nuclear latency matters a great deal to nuclear pursuers, but that latency is associated with competing responses. Latent states may be more likely to reverse because the cost of restarting later is low, but they may also have pursued latency in order to gain an advantage over adversaries, making them unlikely to reverse course. I suggest that the null finding does not indicate that latency is irrelevant, but rather that states respond to latency in different ways.

No domestic regime or leader characteristic had a statistically significant effect on nuclear reversal. The models indicate that external conditions affect nuclear reversal decision-making more than the specific regime characteristics and leader experience measured in this study. GDP was not statistically significant, a finding which is unsurprising, given how willing many states have been to pursue nuclear weapons despite economic strain. A plot of the probability of nuclear reversal as a function of time (A3) indicates that the likelihood of reversal remains fairly steady during the lifespan of most programs, with less than a 4% variance.

In summary, this study contributes evidence to support institutions-based and security-based theories of nuclear reversal. First, the NSG's export control regime raises the likelihood of nuclear reversal across the life of a nuclear weapons program. The impact of the regime has increased as the regime has strengthened. The barriers to trade established under the regime, and the regime's ability to adapt to states' efforts to circumvent those barriers, increase costs, delay, and uncertainty for nuclear-pursuing states. As the expected costs of acquiring nuclear weapons increase, states may be more likely to lose confidence in a program's chances of success.

Second, states with strategic rivals are less likely to make nuclear reversal decisions. Of the three features of the security environment tested in these models, strategic rivalry is the only one with a statistically significant impact on reversal likelihood. This supports the argument that the expectation of threat present in the context of a strategic rivalry causes governments to more highly value a nuclear weapons program. Rival states may turn to nuclear weapons not only to deter aggression, but also to match or exceed the rival's capabilities. This does not imply that strategic rivals never make reversal decisions; indeed, the evidence indicates that they do. But a state with a strategic rival should be more hesitant and require more assurance to reverse than a state without such an adversary.

The development of new, and better, quantitative measures would serve to address some of the limitations of this study. Current measurements of nuclear sanctions do not capture information about strength, severity, and enforcement – characteristics that are likely to have a strong effect on the ability of sanctions to compel. The export control regime index is a first attempt to account for the evolution of the regime; future research could refine the measure. And important features of nuclear reversal, like domestic coalitions, have not yet been operationalized. This study offers a contribution to the ongoing debate over nuclear reversal, but important questions remain.

Nuclear Suppliers: Holding the Cards and Changing the Game

Since the Nuclear Suppliers Group created the nuclear export control regime, have the participating governments come to hold all the cards on the nuclear market? While the regime has not ended proliferation, and determined states spend time and resources to work around the controls, the evidence indicates that the regime has had a positive effect on the likelihood of reversal decisions across the life of a nuclear weapons program. The suppliers may only be holding some of the cards, but enough to have changed the game.

The findings have broader implications for our understanding of how international institutions shape state behavior. Determined states find ways to evade institutional constraints. States may join an institution and later renege, or may join hypocritically, using the institution as cover for clandestine activity. Several states began nuclear weapons programs after signing the Nuclear Nonproliferation Treaty (NPT), including Iraq, Iran, and Syria. Others, like North Korea, Libya, and Taiwan, signed the NPT while actually in the process of pursuing nuclear weapons.

But cheating and reneging do not necessarily signify either institutional failure or regime ineffectiveness. The cheaters are conspicuous in part because most states have operated within the regime, neither pursuing nor acquiring nuclear weapons in the era of nonproliferation institutions. Indeed, the high level of cooperation among the NSG's participating governments, facilitated by the institution's established practices and annual meetings, has been successful enough to make cheating necessary in the first place.

Nuclear suppliers have good reason to continue to cooperate and enforce the regime. States serve their own interests by preventing proliferation and maintaining balance in the nuclear market. To strengthen the regime today, nuclear suppliers can build enforcement capacity among NSG participants. States require significant legal, administrative, and physical resources to control nuclear exports. The more experienced nuclear suppliers can make a greater and more coordinated effort to assist states that lack the capacity to detect violations and enforce national export laws.

Political divisions among participating governments, however, may threaten the effectiveness of the institution. The review process NSG members undertake to improve the export control lists has become more formal over time; currently, a standing technical working group proposes revisions that must be approved by consensus. As the NSG considers divisive issues, such as whether to allow India, which remains outside the NPT, to join the Group, the process for making technical decisions about export controls must stand apart from political entanglements. The effectiveness of the regime depends on the cooperation and consensus of governments that view participation as serving national interests. And the NSG has advanced nonproliferation policies and practices that other organizations and states have imitated. More than once, the IAEA has followed the NSG's lead, adopting stronger safeguards policies stemming from guidelines the NSG had already implemented. If nuclear reversal is more likely when the NSG maintains stronger control over the nuclear market, then the Group's uncertain future is particularly worrisome.

Acknowledgements

For their helpful comments, I thank Matthew Fuhrmann, Eliza Gheorghe, Henrietta Toivanen, workshop participants at Claremont McKenna College, three anonymous reviewers, and the editors of *Journal of Global Security Studies*. I thank Allan Stam, James Morrow, Philip Potter, Matthew Wells, and Leanne Powner for valuable discussions during conceptual stages of this project.

Supplementary Information

Supplementary information is available at the *Journal of Global Security Studies* data archive.

References

Albright, David, and Mark Hibbs. 1992. "Iraq's Shop-Till-You-Drop Nuclear Program." *Bulletin of the Atomic Scientists* 48 (3): 27–37.
Anstey, Isabelle. 2018. "Negotiating Nuclear Control: The Zangger Committee and the Nuclear Suppliers' Group in the 1970s." *The International History Review* 40 (5): 975–95.
Anthony, Ian, Christer Ahlstrom, and Vitaly Fedchenko. 2007. *Reforming Nuclear Export Controls: The Future of the Nuclear Suppliers Group*. Oxford: Oxford University Press.
Barletta, Michael. 1997. "The Military Nuclear Program in Brazil." CISAC, Stanford University.
Beardsley, Kyle, and Victor Asal. 2009. "Winning with the Bomb." *Journal of Conflict Resolution* 53 (2): 278–301.
Beck, Michael D., Richard T Cupitt, Seema Gahlaut, and Scott A. Jones. 2003. *To Supply or to Deny: Comparing Nonproliferation Export Controls in Five Key Countries*. The Hague: Kluwer Law International.
Bleek, Philipp C., and Eric B. Lorber. 2014. "Security Guarantees and Allied Nuclear Proliferation." *Journal of Conflict Resolution* 58 (3): 429–54.
Born, Hans, Bates Gill, and Heiner Hänggi, eds. 2010. *Governing the Bomb: Civilian Control and Democratic Accountability of Nuclear Weapons*. Oxford: Oxford University Press.
Bratt, Duane. *The Politics of CANDU Exports*. Toronto: University of Toronto Press.
Braun, Chaim, and Christopher F. Chyba. 2004. "Proliferation Rings: New Challenges to the Nuclear Nonproliferation Regime." *International Security* 29 (2): 5–49.
Braun, Chaim, Siegfried Hecker, Chris Lawrence, and Panos Papadiamantis. 2016. "North Korean Nuclear Facilities After the Agreed Framework." CISAC, Stanford University.
Braut-Hegghammer, Malfrid. 2011. "Revisiting Osirak: Preventive Attacks and Nuclear Proliferation Risks." *International Security* 36 (1): 101–32.
Bremer, Stuart A. 1992. "Dangerous Dyads: Conditions Affecting the Likelihood of Interstate War, 1816-1965." *Journal of Conflict Resolution* 36 (2): 309–41.
Brezaric, J. 1977. "Nuclear Problems." *Review of International Affairs*, no. 649 (April): 22–24.
Brown, Robert L., and Jeffrey M. Kaplow. 2014. "Talking Peace, Making Weapons: IAEA Technical Cooperation and Nuclear Proliferation." *Journal of Conflict Resolution* 58 (3): 402–28.
Bueno de Mesquita, Bruce, and William H. Riker. 1982. "An Assessment of the Merits of Selective Nuclear Proliferation." *Journal of Conflict Resolution* 26 (2): 283–306.
Burr, William. 2014. "A Scheme of 'Control': The United States and the Origins of the Nuclear Suppliers' Group, 1974–1976." *The International History Review* 36 (2): 252–76.
Carter, David B., and Curtis S. Signorino. 2010. "Back to the Future: Modeling Time Dependence in Binary Data." *Political Analysis* 18 (3): 271–92.
Cawte, Alice. 1992. *Atomic Australia, 1944-1990*. Kensington, NSW: NSW Press.
Coe, Andrew, and Jane Vaynman. 2015. "Collusion and the Nuclear Nonproliferation Treaty." *Journal of Politics* 77 (4): 983–97.
Colaresi, Michael P., Karen Rasler, and William R. Thompson. 2007. *Strategic Rivalries in World Politics*. Cambridge: Cambridge University Press.
Colby, William. 1974. "Memorandum from Director of Central Intelligence Colby to Secretary of State Kissinger." US Department of State Office of the Historian. Document 99. Foreign Relations of the United States, 1969-1976, Volume E-11, Part 2, Documents on

South America, 1973-1976. https://history.state.gov/historicaldocuments/frus1969-76ve11p2/d99?platform=hootsuite.

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.

Craig, Malcolm. 2017. *America, Britain and Pakistan's Nuclear Weapons Programme, 1974-1980: A Dream of Nightmare Proportions*. London: Palgrave Macmillan.

Dai, Xinyuan. 2002. "Information Systems in Treaty Regimes." *World Politics* 54 (4): 405–36.

Debs, Alexandre, and Nuno P. Monteiro. 2017. *Nuclear Politics: The Strategic Causes of Proliferation*. New York: Cambridge University Press.

Drezner, Daniel W. 1999. *The Sanctions Paradox: Economic Statecraft and International Relations*. Cambridge: Cambridge University Press.

Dunn, Lewis A. 2009. "The NPT: Assessing the Past, Building the Future." *The Nonproliferation Review* 16 (2): 143–72.

Fischer, David. 1997. *History of the International Atomic Energy Agency: The First Forty Years*. Vienna: International Atomic Energy Agency.

Fuhrmann, Matthew. 2009a. "Spreading Temptation: Proliferation and Peaceful Nuclear Cooperation Agreements." *International Security* 34 (1): 7–41.

———. 2009b. "Taking a Walk on the Supply Side: The Determinants of Civilian Nuclear Cooperation." *Journal of Conflict Resolution* 53 (2): 181–208.

Fuhrmann, Matthew, and Jeffrey D. Berejikian. 2012. "Disaggregating Noncompliance: Abstention Versus Predation in the Nuclear Nonproliferation Treaty." *Journal of Conflict Resolution* 56 (3): 355–81.

Fuhrmann, Matthew, and Michael C. Horowitz. 2015. "When Leaders Matter: Rebel Experience and Nuclear Proliferation." *The Journal of Politics* 77 (1): 72–87.

Fuhrmann, Matthew, and Yonatan Lupu. 2016. "Do Arms Control Treaties Work? Assessing the Effectiveness of the Nuclear Nonproliferation Treaty." *International Studies Quarterly* 60 (3): 530–39.

Fuhrmann, Matthew, and Todd S. Sechser. 2014. "Signaling Alliance Commitments: Hand-Tying and Sunk Costs in Extended Nuclear Deterrence." *American Journal of Political Science* 58 (4): 919–35.

Fuhrmann, Matthew, and Benjamin Tkach. 2015. "Almost Nuclear: Introducing the Nuclear Latency Dataset." *Conflict Management and Peace Science* 32 (4): 443–61.

Gartzke, Erik, and Dong-Joon Jo. 2009. "Bargaining, Nuclear Proliferation, and Interstate Disputes." *Journal of Conflict Resolution* 53 (2): 209–33.

Gartzke, Erik, and Matthew Kroenig. 2009. "A Strategic Approach to Nuclear Proliferation." *Journal of Conflict Resolution* 53 (2): 151–60.

Gheorghe, Eliza. 2019. "Proliferation and the Logic of the Nuclear Market." *International Security* 43 (4): 88–127.

Hibbs, Mark. 2017. "A More Geopoliticized Nuclear Suppliers Group?" *Strategic Trade Review* 3 (5).

———. 2018, January 12, 2018.

Hufbauer, Gary Clyde. 2007. *Economic Sanctions Reconsidered*. Washington, DC: Peterson Institute for International Economics.

Hymans, Jacques E. C. 2012. *Achieving Nuclear Ambitions: Scientists, Politicians, and Proliferation*. Cambridge University Press.

"INFCIRC/209 Memorandum B." 1974. International Atomic Energy Agency.

Jo, Dong-Joon, and Erik Gartzke. 2007. “Determinants of Nuclear Proliferation.” *Journal of Conflict Resolution* 51 (1): 167–94.

Kassenova, Togzhan. 2014. “Brazil’s Nuclear Kaleidoscope: An Evolving Identity.” Washington, D.C.: Carnegie Endowment for International Peace.

Kay, David A. 1995. “Denial and Deception Practices of WMD Proliferators: Iraq and Beyond.” *The Washington Quarterly* 18 (1): 83–105.

Kemp, R. Scott. 2014. “The Nonproliferation Emperor Has No Clothes: The Gas Centrifuge, Supply-Side Controls, and the Future of Nuclear Proliferation.” *International Security* 38 (4): 39–78.

Khan, Feroz Hassan. 2013. *Eating Grass: The Making of the Pakistani Bomb*. New Delhi: Cambridge University Press.

Khan, Munir Ahmad. 1998. *The Nuclearization of South Asia and Its Regional and Global Implications.* Islamabad: Institute of Regional Studies.

Kim, Seung-Young. 2001. “Security, Nationalism and the Pursuit of Nuclear Weapons and Missiles: The South Korean Case, 1970-82.” *Diplomacy & Statecraft* 12 (4): 53–80.

Koch, Lisa Langdon. 2019. “Frustration and Delay: The Secondary Effects of Supply-Side Proliferation Controls.” *Security Studies* 28 (4): 773–806.

Kroenig, Matthew. 2009a. “Exporting the Bomb: Why States Provide Sensitive Nuclear Assistance.” *The American Political Science Review* 103 (1): 113–33.

———. 2009b. “Importing the Bomb: Sensitive Nuclear Assistance and Nuclear Proliferation.” *Journal of Conflict Resolution* 53 (2): 161–80.

———. 2010. *Exporting the Bomb: Technology Transfer and the Spread of Nuclear Weapons*. Ithaca: Cornell University Press.

———. 2018. *The Logic of American Nuclear Strategy: Why Strategic Superiority Matters*. New York: Oxford University Press.

Lacy, Dean, and Emerson M. S. Niou. 2004. “A Theory of Economic Sanctions and Issue Linkage: The Roles of Preferences, Information, and Threats.” *Journal of Politics* 66 (1): 25–42.

Lanoszka, Alexander. 2018. *Atomic Assurance: The Alliance Politics of Nuclear Proliferation*. Ithaca: Cornell University Press.

Levite, Ariel E. 2002. “Never Say Never Again: Nuclear Reversal Revisited.” *International Security* 27 (3): 59–88.

Marshall, Monty G., and Keith Jaggers. 2002. “Polity IV Project: Political Regime Characteristics and Transitions, 1800–2000. Dataset Users’ Manual.” Center for Systemic Peace.

Mattiacci, Eleonora, and Benjamin T. Jones. 2016. “(Nuclear) Change of Plans: What Explains Nuclear Reversals?” *International Interactions* 42 (3): 530–85.

McLean, Scilla, ed. 1986. *How Nuclear Weapons Decisions Are Made*. New York: St. Martin’s Press.

McManus, Roseanne W. 2018. “Making It Personal: The Role of Leader-Specific Signals in Extended Deterrence.” *The Journal of Politics* 80 (3): 982–95.

Mearsheimer, John J. 1994. “The False Promise of International Institutions.” *International Security* 19 (3): 5–49.

Mehta, Rupal N. 2020. *Delaying Doomsday: The Politics of Nuclear Reversal*. Oxford: Oxford University Press.

Mehta, Rupal N., and Rachel Elizabeth Whitlark. 2017. “The Benefits and Burdens of Nuclear Latency.” *International Studies Quarterly* 61 (3): 517–28.
Miall, Hugh. 1987. *Nuclear Weapons: Who’s in Charge?* London: The MacMillan Press Ltd.
Miller, Nicholas L. 2017. “Why Nuclear Energy Programs Rarely Lead to Proliferation.” *International Security* 42 (2): 40–77.
———. 2018. *Stopping the Bomb: The Sources and Effectiveness of US Nonproliferation Policy*. Ithaca, N.Y.: Cornell University Press.
Montgomery, Alexander H. 2005. “Ringing in Proliferation: How to Dismantle an Atomic Bomb Network.” *International Security* 30 (2): 153–87.
———. 2013. “Stop Helping Me.” In *The Nuclear Renaissance and International Security*, edited by Adam N. Stulberg and Matthew Fuhrmann. Stanford, California: Stanford Security Studies.
Narang, Vipin. 2014. *Nuclear Strategy in the Modern Era: Regional Powers and International Conflict*. Princeton: Princeton University Press.
Pape, Robert A. 1997. “Why Economic Sanctions Do Not Work.” *International Security* 22 (2): 90-136.
Park, John, and Jim Walsh. 2016. “Stopping North Korea, Inc.: Sanctions Effectiveness and Unintended Consequences.” Cambridge, Mass: MIT Security Studies Program.
Patrikarakos, David. 2012. *Nuclear Iran: The Birth of an Atomic State*. London: I.B. Tauris & Co Ltd.
Paul, T.V. 2000. *Power versus Prudence: Why Nations Forgo Nuclear Weapons*. Montreal: McGill-Queen’s University Press.
Perkovich, George. 1999. *India’s Nuclear Bomb: The Impact on Global Proliferation*. Berkeley: University of California Press.
Potter, William C., and Gaukhar Mukhatzhanova. 2010. *Forecasting Nuclear Proliferation in the 21st Century. Volume 1, The Role of Theory*. Stanford, Calif.: Stanford University Press.
Reiss, Mitchell. 1995. *Bridled Ambition: Why Countries Constrain Their Nuclear Capabilities*. Washington, D.C: Woodrow Wilson Center Press.
Rublee, Maria Rost. 2009. *Nonproliferation Norms: Why States Choose Nuclear Restraint*. Athens, GA: University of Georgia Press.
Sagan, Scott D. 1996. “Why Do States Build Nuclear Weapons: Three Models in Search of a Bomb.” *International Security* 21 (3): 54–86.
———. 2010. “Nuclear Latency and Nuclear Proliferation.” In *Forecasting Nuclear Proliferation in the 21st Century. Volume 1, The Role of Theory*, edited by William C. Potter and Gaukhar Mukhatzhanova, 80–101. Stanford, Calif.: Stanford University Press.
Saunders, Elizabeth N. 2019. “The Domestic Politics of Nuclear Choices—A Review Essay.” *International Security* 44 (2): 146–84.
Schelling, Thomas C. 1966. *Arms and Influence*. New Haven: Yale University Press.
Schneider, Jonas. 2019. “The Study of Leaders in Nuclear Proliferation and How to Reinvigorate It.” *International Studies Review*, 1–25.
Singh, Sonali, and Christopher R. Way. 2004. “The Correlates of Nuclear Proliferation: A Quantitative Test.” *Journal of Conflict Resolution* 48 (6): 859–85.
Siverson, Randolph M., and Harvey Starr. 1990. “Opportunity, Willingness, and the Diffusion of War.” *American Political Science Review* 84 (1): 47–67.

Snyder, Scott. 2010. "South Korean Nuclear Decision Making." In *Forecasting Nuclear Proliferation in the 21st Century. Volume 1, The Role of Theory*, edited by William C. Potter and Gaukhar Mukhatzhanova. Stanford, Calif.: Stanford University Press.

Solingen, Etel. 2007. *Nuclear Logics: Contrasting Paths in East Asia and the Middle East*. Princeton, NJ: Princeton University Press.

———. 2012. *Sanctions, Statecraft, and Nuclear Proliferation*. Cambridge: Cambridge University Press.

Spaniel, William. 2019. *Bargaining over the Bomb: The Successes and Failures of Nuclear Negotiations*. Cambridge, UK: Cambridge University Press.

Spector, Leonard S. 1990. *Nuclear Ambitions: The Spread of Nuclear Weapons 1989-1990*. Boulder: Westview Press.

Springsteen, George S. 1975. "Memorandum to NSA Brent Scowcroft, 'Nuclear Suppliers Guidelines.'" The Digital National Security Archive. https://nsarchive2.gwu.edu/nukevault/ebb467/docs/doc%2016A%2012-31-75%20guidelines.pdf.

Stewart, Ian J. 2012. "Antiproliferation: Tackling Proliferation by Engaging the Private Sector." Belfer Center Discussion Paper. Cambridge, Mass: Harvard.

Stinnett, Douglas M., and et al. 2002. "The Correlates of War (Cow) Project Direct Contiguity Data, Version 3.0." *Conflict Management and Peace Science* 19 (2): 59–67.

Strulak, Tadeusz. 1993. "The Nuclear Suppliers Group." *The Nonproliferation Review* 1 (1): 2–10.

Tabatabai, Ariane. 2020. "Nuclear Decision-Making in Iran." New York, NY: Columbia University CGEP.

Thompson, William R., and David Dreyer. 2011. *Handbook of International Rivalries, 1494-2010*. Washington, DC: CQ Press.

Tzeng, Peter. 2013. "Nuclear Leverage." *The Nonproliferation Review* 20 (3): 473–92.

Volpe, Tristan A. 2017. "Atomic Leverage: Compellence with Nuclear Latency." *Security Studies* 26 (3): 517–44.

Walker, J. Samuel. 2001. "Nuclear Power and Nonproliferation: The Controversy over Nuclear Exports, 1974-1980." *Diplomatic History* 25 (2): 215–49.

Walsh, Jim. 1997. "Surprise Down Under: The Secret History of Australia's Nuclear Ambitions." *The Nonproliferation Review* 5 (1): 1–20.

Way, Christopher, and Jessica L. P. Weeks. 2014. "Making It Personal: Regime Type and Nuclear Proliferation." *American Journal of Political Science* 58 (3): 705–19.